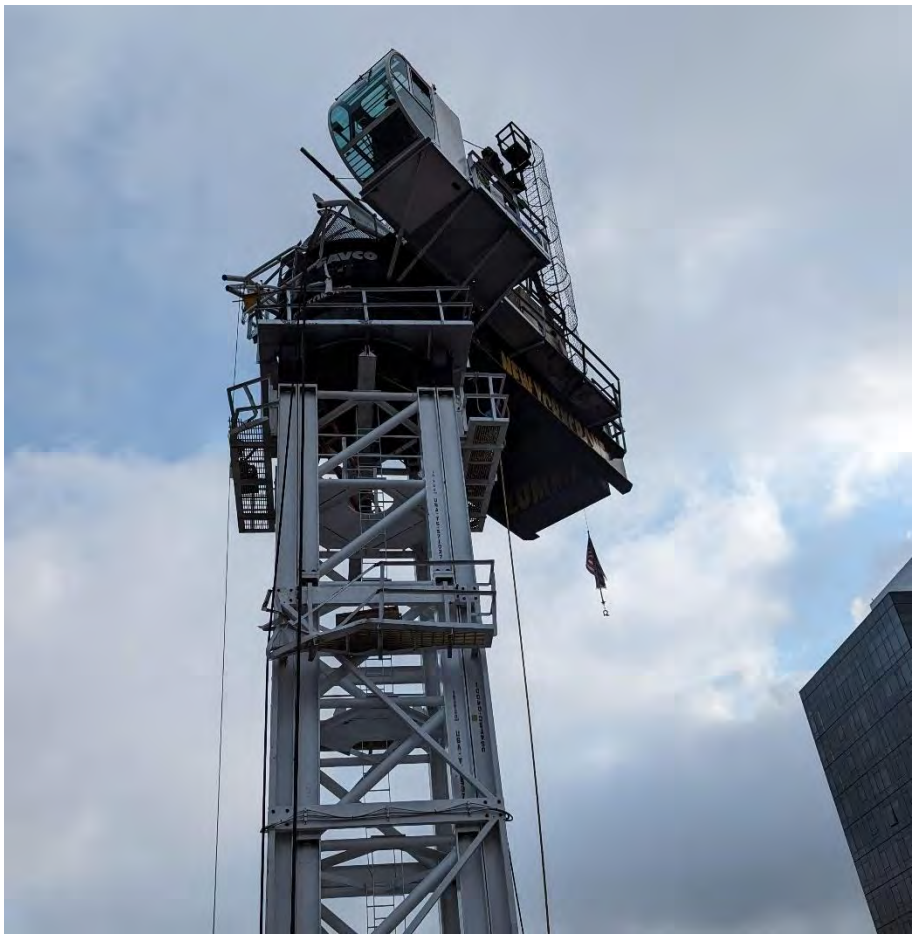
Forensic Investigation
Crane Fire at 550 Tenth Avenue

Prepared for:
New York City Department of Buildings



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EXECUTIVE SUMMARY

EVENT

On July 26, 2023, a fire broke out on the deck of a Favelle Favco (FF) tower crane at the new building construction site at 550 10th Avenue in New York City. The fire resulted in a boom collapse which injured several people and damaged a building facade. The crane, owned by New York Crane & Equipment Corp (NYCE) was being leased by Cross Country Construction LLC (CCC). An employee of CCC was operating the crane at the time of the accident. The on-deck fire extinguisher, while insufficient to extinguish the fire, facilitated the safe evacuation of the operator. The fire watch was effective, and the contractor shut down the street, preventing any loss of life.

FORENSIC TEAM

The New York City Department of Buildings (DOB) engaged a team led by Gilsanz Murray Steficek (GMS) to perform a forensic engineering evaluation. The team also included Crane Tech Solutions (CTS), to provide expertise in design and safe operation of cranes, Edgett Williams Consulting Group (EWCG), to provide expertise in cables and materials handling systems, and T. J. Russo Consulting (Russo) to provide fire investigation expertise. At the request of the DOB, each team member provided their own independent reports. The team examined the effect of the fire on the crane, interviewed various individuals who had knowledge of the event, took samples, and commissioned hydraulic oil lab tests. The team also examined the maintenance records maintained by the equipment user, operator and crane owner. GMS also reviewed technical literature on the topics of tower crane fires, the fire risks associated with hydraulic oil mists, and the impact of fires on structural cables.

FINDINGS

This investigation determined with a high level of confidence that the fire was due to the release of flammable hydraulic fluid mist that came in contact with a hot surface when a hose connection to the power pack failed. The hose was found separated from its crimp fitting. The hydraulic oil that began flowing onto the deck fueled the fire. Since the fire was not extinguished, the heat output increased, the luffing rope failed, and the boom collapsed. Due to the deterioration of the hose after the fire, the investigation could not determine whether the leak or other signs of deterioration had preceded the hose separation.

REGULATION COMPLIANCE

In terms of compliance with regulations, GMS concluded that the construction operations at this site failed to meet the intent of the provisions of Chapter 33 of the 2014 New York City Building Code (NYCBC) on Safeguards During Construction or Demolition. The operation did not meet the requirements of 2014 NYCBC Section 3301.5 (Unsafe conditions and equipment) which states that “Any structure, temporary construction, operation, or equipment found to be defective or unsafe, and posing a risk to the public and property, shall be immediately secured and corrected, or removed from the site.” The defective equipment in this case was the hydraulic oil hose that failed. Required inspections that could have identified signs of defects in the hydraulic oil hose were not performed.

Crane related inspections intended to verify the safe condition of equipment stipulated in Section 3319 of the 2014 NYCBC and 1-RCNY§3319-01 were only partially met. The investigation found that:

- There was no documentation proving that all inspections required by the manufacturer (FF) in FF's Installation, Operations, Maintenance Manual, Crane Serial Number 1475 (hereafter referred to as FF Manual) were executed.
    - It should be noted that the daily, weekly, and monthly inspection forms/checklists provided by CCC and the 100-hour (monthly), 250-hour (three month) and six month Service Work Order (SWO) checklists provided by NYCE differ slightly from the daily, weekly (40-hour), monthly (100-hour), and three month (250-hour) maintenance logs/checklists included in the FF Manual. See Exhibit 15 (Inspection Forms) of CTS's report and APPENDIX 4: SECTION 3.5 (CHECK LISTS) OF FF MANUAL on page 41 of this report.
- Written records attesting to leak inspections could be found only in the three-month (250-hour) SWO checklists used by NYCE. See Exhibit 15 (Inspection Forms) of CTS's report.
- The FF required weekly (40-hour) inspections did not take place.

PRECEDENT

Bulletin 2016 FFCA-EB-030, issued by FF in 2016 following a similar fire accident in Australia in 2012, contains instructions and recommendations to limit a fire's damaging effect. The crane manufacturer (FF) transmitted this bulletin to the crane owner NYCE. Although Bulletin 2016 FFCA-EB-030 was not mandatory, NYCE should have implemented some or all the recommendations and informed the equipment user (CCC) of Bulletin 2016 FFCA-EB-030 so they could have taken appropriate measures.

RECOMMENDATIONS

While fires in cranes are an unusual occurrence (DOB datasets in NYC Open Data show there are no violations for a previous crane fire), below is a list of issues to consider to avoid a similar accident in the future:

- The DOB should reiterate to all crane manufacturers that they are required to notify the DOB of all mandatory and voluntary bulletins.

- Crane owners should inform equipment users of all the bulletins, including bulletins indicating voluntary prevention, so they can take appropriate measures.

- Due to the rarity of a fire, it is not clear that the crane personnel were aware of the inherent risk posed by a damp, or leaking hose. Operators and owners should all be trained to inspect hydraulic hoses and all hose fittings to ensure that they are in safe, working condition.

- Extinguishers of adequate capacity should be provided on every diesel-powered tower crane and on any other crane where extinguishers are required by the manufacturers.

- After the incident, the DOB modified the Required Protocol for Third Party Certification to include the requirements of FF Bulletin 2016 FFCA-EB-030. This protocol includes the installation of a fire suppression kit on diesel cranes. To add this requirement to the Building Code, the DOB should work in conjunction with crane owners, operators and fire protection specialists.

ADDITIONAL GMS COMMENTS

Although this accident should not have happened, in GMS's opinion it is commendable that some personnel acted with common sense and prevented the loss of life by shutting down the street. Construction companies and the DOB should consider publicizing how the contractor's decision to close the street likely saved lives. By doing so the industry can learn and promote among employees the importance of prompt action from this example.

INTRODUCTION

THE FIRE INCIDENT

On July 26, 2023, a fire started on the deck of a Favelle Favco (FF) M440D tower crane at the new building construction site at 550 10th Avenue in Manhattan, New York. The operator could not put out the fire but managed to escape without harm. Employees of Cross Country Construction, LLC (CCC) were instructed to stop all street traffic. The firefighting operations by the Fire Department (FDNY) were televised in real time. Hosing the fire with water was not initially successful. At the time of the fire, the crane was hoisting a bucket carrying nearly 14,000 pounds of concrete. The luffing wire rope carrying the load was only several feet above the blaze. Within minutes, the rope snapped due to the heat, causing the crane's boom to collapse. The contractor managed to stop street traffic before the boom fell to the ground. According to *The New York Times*[1], the falling boom injured several people and damaged an adjacent building's facade. The fire continued several minutes after the boom collapsed.

DOB INVESTIGATION

The New York City Department of Buildings (DOB) had approved the crane and its installation as per their standard procedures and protocols, and subsequently initiated an incident investigation. On August 2, 2023, the DOB issued a request for proposals for emergency procurement for a forensic engineering consultant for the 550 10th Avenue crane collapse. The main task was to prepare a report to determine the cause and origin of the July 26, 2023 crane failure at 550 10th Avenue.

FORENSIC INVESTIGATION TEAM

Gilsanz Murray Steficek (GMS) assembled a forensic team consisting of Crane Tech Solutions (CTS) providing expertise in crane operations, TJ Russo Consultants (Russo) providing expertise in fire investigations, Edgett Williams Consulting Group (EWCG) for cable examination, and Lehigh University's Advanced Technology for Large Structural Systems Engineering Research Center (ATLSS) for materials testing and expertise in the metallurgic effects of fire. The team was notified of the award via DOB email on August 29, 2023. As it was determined during the course of the investigation that no mechanical tests were to be performed, there was no role for ATLSS.

GMS ROLE & REPORT OVERVIEW

GMS is the lead engineer of this report. At DOB's request, GMS, CTS, Russo, and EWCG prepared independent reports for which they are solely responsible.

[1] "Crane Partially Collapses in Midtown Manhattan, Injuring 11," *The New York Times*. https://www.nytimes.com/2023/07/26/nyregion/crane-collapse-nyc-hudson-yards.html

This report provides a forensic determination of the most probable cause of the July 26, 2023 crane failure at 550 10th Avenue, identifies and determines the actual and/or probable cause of the fire's origin on the deck, the probable effect of heat on the luffing rope, and the condition of components likely involved in the initiation of the fire. The report also provides an opinion on past maintenance and inspections. The analysis is based on data collected in the field, available records, GMS's evaluation of the results of the hydraulic oil tests, and GMS's assessment of the information, conclusions and recommendations provided in the CTS and Russo reports.

GMS had representatives at the site on September 8, 2023, and from September 26 to September 29, 2023, when the crane was dismantled and some items were taken in possession by the New York City Department of Investigation (DOI). GMS was also present on October 24, 2023, when a joint inspection took place at the NYCE yard.

CTS and Russo interviewed individuals with knowledge of the fire incident or activities preceding the fire. Based on the interviews and field observations, GMS and its consultants provided their opinions on safety measures and responses during the incident.

GMS and its consultants reviewed the crane logs, inspection and maintenance, and repair reports of the crane and its mechanical components (including the luffing rope) for compliance with DOB regulations as well as the most recent manufacturer recommendations outlined in Favelle Favco Engineering Bulletin FFCA-EB-030 Rev A dated July 1, 2016 (hereafter referred to as Bulletin FFCA-EB-030).

The "Summary of the Investigation" section of this report uses the findings of the CTS, Russo, and EWCG reports but also includes GMS's engineering opinion and comments on the facts related to the incident beyond those discussed in the CTS and Russo reports.

The "Compliance with New York City Regulations" section of this report provides a systematic GMS analysis of various participants' compliance with codes and regulations.

To provide technical support for the report, GMS has reviewed recent literature on crane fire incidents, the effect of fire on wire ropes, and risks related to hydraulic systems. GMS presents the findings in Appendices 1 through 3.

PROJECT PERMIT INFORMATION:

Address: 550 10th Avenue, New York, NY 10018
Block: 1050
Lot: 61
BIN: 1076207

The construction project associated with the crane fire incident was a new building project for a 45-story mixed-use multi-tenant residential building (occupancy classification R-2). Information regarding the building permit for this project can be found below:

Application number: 121209281
Original application date: 01/22/2021

Original application filed by: Handel Architects
Applicable building code: 2014 New York City Building Code (NYCBC)
Application approval date: 10/25/2021
Building permit number: 121209281-01-NB
Date first permitted (a.k.a. Seq. No. 01 date): 07/14/2022
Proposed job start date: 07/14/2022
Permit issued to: Gregory Bauso (GC-003427) and Monadnock Construction Inc.
Site safety manager: Felix F. De La Torre (License No: M001722)
Concrete contractor listed on Seq. No. 3 through 6 of work permit: Thomas A. Costigan (Registration No. 604003-GC) of Cross Country Construction LLC
Concrete safety manager listed on Seq. No. 3 of work permit: Charles Giovinco (Registration No: 002195- CS)

The crane involved in the fire incident was owned by New York Crane & Equipment (NYCE) and rented to Cross Country Construction LLC (CCC), a concrete subcontractor. CCC employees operated and inspected the crane daily. NYCE was responsible for servicing the crane upon request and performing monthly maintenance checks. Prior to on-site delivery, Certified Testing & Inspections, Inc. (CTI) performed the required third-party tower crane inspection. Additional information regarding the tower crane is listed below:

Manufacturer: Favelle Favco
Model number: M440D
Crane type: Tower crane

DOB Crane prototype number: CP00000331
Model (Month/Year): 01/1998

DOB crane device number: CD00004052
Manufactured Date: 01/2009
Device Serial Number: 1475
Owner Information: Salvatore Isola of New York Crane & Equipment Corp (NYCE)
Actual Rated Capacity: 55 Tons
Actual Boom: 165 Feet
Actual Jib: 10 Feet

DOB crane notice number: CN00045622
Applicant: Steve Valjato, PE (License No. 082512) of Valjato Engineering PC
Equipment User: Thomas Costigan (License No. 155496) of Cross Country Construction LLC
Device Installer: Charles Keenan (Master Rigger License No. 000181) of XLO Consultants LLC
Lift Director: John Delriccio (License No. 170846) of Cross Country Construction LLC
Hoisting Machine Operators: Daniel McClain (License No. 007965) and Timothy McClain (License No. 009361)
Number of Phases: 5
Last Phase Height: 524.9 ft
Additional Information: CN00045622 was associated with a set of 11 drawings. The set was approved by the DOB on 3/22/2023.

SUMMARY OF THE INVESTIGATION

RUSSO REPORT ON FIRE INITIATION

Russo's independent report concluded that the fire originated at the power pack engine compartment. Russo found physical evidence "of a separation or failure to a hydraulic hose" (see Photo 1 on page 10). The metal braided hose was found separated from its crimp fitting and severely burnt at that end (see Photo 2 on page 11). The separation had occurred at the crimp fitting located at the slew pump. The crimp did not show any sign of physical damage. All other hoses were found still intact and attached at the fittings. Russo concluded that this one hose failure likely led to the release of a flammable oil mist that ignited upon contact with a hot surface. According to Russo the rapid growth of the fire would be consistent with a dispersed fuel such as from a failed hose. Russo cites the National Fire Protection Association 921, *Guide for Fire and Explosion Investigations* to explain the ignition of atomized liquids or mists when in contact with hot surfaces. A GMS discussion on the literature concerning fire risks related to hydraulic oil has been provided in Appendix 1.



Photo 1 Failed hose, with spiral delamination.



Photo 2 Fitting corresponding to the hose.

The diesel tank was not affected by the fire. Russo also noted that only one fire extinguisher was available on the deck for immediate firefighting efforts.

CTS REPORT ON CRANE MAINTENANCE AND INSPECTION

CTS conducted an in-depth investigation and provided a report concentrating on inspection and maintenance activities performed prior to the incident. These activities included inspections and various repairs by NYCE, as well as those by CCC employees. CTS reviewed existing inspection reports and conducted interviews with numerous participants. The documents indicated that the operators completed the daily inspection checklist, and the oiler performed monthly inspections. Documents and interviews revealed several instances where the operator (CCC) contacted the crane owner (NYCE) for specific repairs or adjustments.

CTS found credible written information that the subject tower crane appears to have had all the required maintenance prior to its arrival at site.

CTS's report concluded that the insufficient written documentation prevented its investigation from opining on the sufficiency of the maintenance performed while the crane was on site. The weekly (40 working hours) inspections outlined in the Installation, Operations, Maintenance Manual, Crane Serial Number 1475, delivered March 2008 (hereafter referred to as FF Manual) were not performed. The daily and monthly inspection forms completed by CCC lacked references to the deterioration or leakage of the hydraulic system.

Between April 5, 2023, and July 3, 2023, NYCE was requested by CCC to service the crane on site seven times. Both CTS's and Russo's reports discuss these instances as reflected in the interviewees' answers and the Service Work Orders. The issues that required remediation were mainly related to the load hoisting speed. On at least two occasions the temperature of the hydraulic oil required adjustment. CTS observed that one liter of hydraulic fluid was not drawn monthly as required by the FF Manual. It does not appear that any issues with the operation of the slew pump or the operational pressures were reported.

Both the Russo and CTS reports noted the presence of oil absorbing pads, commonly referred to as "diapers" in the burnt debris area. The diapers are typically used to mitigate leaks.

Both the Russo and CTS reports mention that based on interviews with NYCE, the failed hose was either original to the crane, which was manufactured in 2008, or replaced in 2011. Multiple hoses located near the front of the crane platform that were not affected by the fire were dated 2008, the year the crane was built. It is probable that the failed hose was also manufactured and installed in 2008.

CTS considered using a laboratory to evaluate the failed hose and fitting but determined that the results would not provide conclusive causational evidence of why the failure occurred.

INTERVIEWS BY CTS AND RUSSO

Four employees of CCC and three employees of NYCE were interviewed using questions prepared by CTS. In both the Russo and CTS reports, the seven interviewees are referred to as follows:

- CCC Lift Director interviewed on December 19, 2023 = Lift Director (also referred to as LD in Russo's report)
- CCC Crane Operator interviewed on December 19, 2023 = HMO 1
- CCC Crane Operator interviewed on December 20, 2023 = HMO 2
- CCC Maintenance Engineer, Oiler interviewed on December 20, 2023 = HMO 3
- NYCE Mechanic interviewed on January 3, 2024 = Mechanic 1
- NYCE Mechanic interviewed on January 4, 2024 = Mechanic 2
- NYCE General Manager interviewed on January 31, 2024 = GM

Russo was present during the interviews, as well as representatives from OSHA, the DOI, and the DOB. The CTS and Russo reports provide comments on the interviews. No leaks were reported in the documents submitted by the operators from CCC, or the mechanics from NYCE. However, an operator (HMO 2) declared that "all cranes have seeps and leaks." After HMO 2 had observed a drip from the drum, he informed HMO 3.

When asked about the presence of diapers, HMO 1 acknowledged that diapers were used for "Any leak, or when refilling." He had placed a diaper to stop a leak at the motor and informed HMO 3 about it. He would make an entry in the daily log only if there was a big puddle.

HMO 3 acknowledged only one drip from the motors.

Also, LD mentioned that at one point HMO 3 had informed him about an oil leak.

Per CTS's report, the leak definitions provided by HMO 1, HMO 2, and HMO 3 ranged "from not seeing any to one that said he felt all cranes had some leakage." Only one interviewee (Mechanic 2) provided a precise definition of a leak. He defined a leak as a fitting feeling damp to the touch.

It is to be noted that the crane FF Manual require daily inspection for leaks. When analyzing the NYCBC, GMS could not identify a clear or quantitative definition of a leak. In common language a drip is less severe than a leak.

There was contradictory information on the number of fire extinguishers, with two operators claiming there had been two. During the post-fire inspection Russo had found only one small handheld fire extinguisher. Per Section 1.4 of Bulletin FFCA-EB-030, FF "recommends owners/operators have at least two 9kg Class B fire extinguishers available on the machinery deck of the crane." The single fire extinguisher that Russo found at the site of the incident was smaller than what was recommended in the FF bulletin (see Exhibit 3 of CTS's report for a copy of Bulletin FFCA-EB-030).

OTHER INSTANCES OF CRANE FIRES

GMS reviewed records of past NYC crane ECB violations[2] and could not identify any mention of a fire incident.

GMS also reviewed several technical papers studying crane accidents. Fires in tower cranes were either not mentioned or included in "other" categories due to their extreme rarity.

In 2012, a fire on an FF tower crane located in Sydney, Australia led to the failure of the boom. Another tower crane fire and boom collapse occurred in Prahran, Melbourne, Australia in 2016. (See APPENDIX 3: REVIEW OF TOWER CRANE FIRES on page 39 for a more in-depth summary of GMS's findings from our review of various technical papers on tower crane fires).

BULLETIN FFCA-EB-030

The July 26, 2023 NYC crane incident shared similarities with the 2012 Australian FF tower crane fire. Although the official Australian report published by SafeWork[3] did not definitively identify a cause, it provided a series of recommendations. In response, a 2016 FF bulletin (FFCA-EB-030) outlined preventative measures to reduce fire initiation and enhance early-stage fire suppression. See Exhibit 3 of CTS's report for a copy of Bulletin FFCA-EB-030.

[2] DOB ECB violations list can be found at: https://data.cityofnewyork.us/Housing-Development/DOB-ECB-Violations/6bgk-3dad/about_data

[3] SafeWork is the workplace health and safety regulator in New South Wales, Australia. See the following website for a copy the SafeWork alert published after the 2012 Sydney tower crane incident: https://www.safework.nsw.gov.au/resource-library/construction/tower-cranes/tower-crane-safety/risks-associated-with-fires-on-tower-cranes-safety-alert

Bulletin FFCA-EB-030 expands upon the original crane FF Manual 's leak inspection procedures, mandating immediate attention to any leaking hoses or fittings. Although unable to prevent all fires, the instructions enable a rapid response, effectively minimizing the risk of a large fire.

CTS and Russo investigators concluded that none of the recommendations of Bulletin FFCA-EB-030 had been implemented at the 10th Avenue crane prior to the incident. CTS's investigation found evidence that NYCE was aware of the recommendations, but CTS could not find any evidence that the NYC DOB had received a copy of this bulletin. After reviewing NYCE's obligations under the 2014 NYCBC, 1-RCNY 3319-01, and Bulletin FFCA-EB-030, GMS concluded that while the recommendations of Bulletin FFCA-EB-030 are not compulsory, a risk-conscious owner would have at least attempted to comply with some of them.

LUFFING CABLE FAILURE

EWCG visually inspected the luff rope (see Photo 3). In their report, EWCG note that the luff wire rope outside of the area of heat exposure was in acceptable condition and showed no signs of unusual or advanced wear as a result of its intended normal use. EWCG concluded that the fundamental cause of the loss of the crane payload is due to the load exceeding the ultimate strength of the rope at the point of the fire.



Photo 3 Failed Luffing Cable

CTS calculations on the tension in the luffing rope prior to failure indicated that the tension was well within high factors of safety, exceeding ASME B30.3-2016 (Tower Cranes) provisions.

Separate investigations were conducted by the Occupational Safety and Health Administration (OSHA) and the New York City Fire Department (FDNY). The OSHA and FDNY reports are not available at this time.

GMS ANALYSIS

Fire Origin.

GMS agrees with the conclusions of the CTS and Russo reports that that the fire originated in the Power Pack/engine compartment area of the crane. GMS also agrees with CTS that the fire was due to the release of a hydraulic fluid when a hose connected to the power pack failed. In GMS's opinion this conclusion has a high level of confidence. The hose was found to be separated from its crimp fitting. GMS, Russo, and CTS could not establish with a high level of certainty the cause of the hose failure.

A guideline published by the Society of Automobile Engineers (SAE) entitled *SAE J1273: Recommended Practices for Hydraulic Hose Assemblies* provides examples of hose failures, including failures of steel wire reinforced rubber hose assemblies. The failure examples include leakage or disconnection of hose fitting end as well as leakage from the hose fitting connection. The causes listed by SAE J1273 for these failures are mainly related to the original installation. In GMS's opinion, it would be unlikely that a deficient mounting would show its effect after many years in operation at multiple different construction sites.

However, a possible cause for the hose failure that is not listed in SAE J1273 would be the wear and tear of the hydraulic hose. Although the fire-related deterioration of the failed hose obscured evidence of wear (e.g., cover abrasion, internal tube erosion, or wire reinforcement fatigue, wear and tear, or other conditions at the failed end), CTS found evidence that the failed hose was original to the crane. This evidence includes marks on some of the nearby crane hoses indicating the year 2008, the same year that the crane was manufactured. In an interview with CTS and Russo, the NYCE General Manager acknowledged that the failed hose may have been original to the crane as they could not locate any invoices indicating a replacement. It should be noted that one NYCE mechanic (Mechanic 1) stated in their interview with CTS and Russo that NYCE replaced the failed hose in 2011, however this claim is not supported with any written documentation of a hose replacement. Whether the failed hose was replaced in 2011 or original to the crane, this would indicate that the hose was between 12 to 15 years old at the time of failure.

According to SAE J1273 hose service life can be affected by a variety of interacting factors (pressure, temperature, hose movement, etc.). The combined effects of these factors on service life are often unpredictable; hence, SAE considers it improper to provide generic guidelines and notes that each system should be evaluated separately.

As noted previously in this report, CTS initially planned to destructively test these hoses to try to determine the reason(s) for hose failure. However, CTS's opinion is that such testing would not provide conclusive causational data on why the hose failed, and therefore no testing was performed.

As fire damage to the failed hose has prevented the investigative team from assessing what was the condition of the failed hose immediately prior to the fire incident, conclusions about the failure mechanism based on currently available information will not be fully definitive.

A more detailed summary of GMS's review of literature on hose failures can be found in APPENDIX 1: RISKS ASSOCIATED WITH HYDRAULIC FLUIDS AND HOSE FAILURES on page 29.

Ignition.

According to Russo the fire started when the mist of hydraulic oil that formed due to the hose failure reached a hot surface. GMS has reviewed literature on fire initiation and found agreement with Russo's opinion. In fact, one of the technical papers reviewed by GMS indicate that a fire can start not only with a mist, but also when droplets of fuel come in contact with a hot surface. Furthermore, the same paper refers to hot engine manifolds as being one of the most common scenarios of a hot surface leading to fire ignitions.[4]

A more detailed summary of GMS's review of literature on fire initiation can be found in APPENDIX 1: RISKS ASSOCIATED WITH HYDRAULIC FLUIDS AND HOSE FAILURES on page 29.

Hydraulic oil.

According to a September 21, 2022 entry in the NYCE maintenance report, the hydraulic oil used was Mobil's Nuto H 46, an ISO V46 grade oil that is considered acceptable per FF Manual.[5]

Nuto H 46 is not listed as a fire-resistant fluid. Mobil's Safety Data Sheets (SDS)[6] classifies Nuto H 46's flammability risk as 1 in a scale of 0 to 4 with 0 representing minimal hazards/risks and 4 representing significant hazards/risks. Mobil recommends the H series for applications "where hydraulic oil contamination or leakage is unavoidable." GMS notes that the Mobil data sheet warns in *Section 5 Fire-fighting measures* that "Specific hazards arising from the chemical: Pressurized mists may form a flammable mixture."

After the start of the fire, hydraulic oil began flowing onto the deck providing fuel for the fire. Per maintenance records, there was approximately 275 gallons of fuel when the tank was last filled. After the incident, the oil tank was found close to empty with some oil mixed with water from FDNY operations remaining in the tank.

The Analytical Testing Services lab results of the samples of hydraulic fluid taken from the failed crane indicated that flash point of the hydraulic oil was 240°C (based on ASTM D92 testing methods) and the autoignition temperature (based on ASTM D659 testing methods) ranged between 360°C and 369°C. See Exhibit 5 of CTS's report for a copy of the Analytical Testing Services' lab results.

[4] Babrauskas, V. (2022). Ignition of gases, vapors, and liquids by hot surfaces. *Fire technology*, 58(1), 281-310.
[5] The FF crane manual requires an ISO V46 oil. Nuto H 46 has a grade ISO V46.
[6] A copy of Mobil's NUTO H 46 Safety Data Sheet can be obtained at: https://www.mobil.eg/en-eg/lubricants/industrial-products/nuto-h-46

GMS's review of technical literature found that mists can ignite at temperatures below the liquid's flash point because the large surface area of the droplets allows for rapid evaporation and the formation of a flammable vapor-air mixture.

It is generally acknowledged that once the liquid begins to burn, the resulting fire temperature will almost certainly far exceed the liquid's auto-ignition temperature. Since the fire was not put out immediately, the heat output increased. The luffing rope failure was a predictable consequence.

See APPENDIX 1: RISKS ASSOCIATED WITH HYDRAULIC FLUIDS AND HOSE FAILURES on page 29 for a more detailed summary of GMS's technical literature review on fire initiation due to mist from hydraulic oil leaks and the relationship between fire initiation and flash points.

Failure of the luffing rope.

The fire occurred mainly in the area of the power pack. The heat was so intense that it deformed several steel elements. The fact that the aluminum pan melted indicates that the temperature reached at least 500°C or possibly much higher (900°C). A graphic effort by GMS suggested that the flame temperature was at around 700°C at the luffing rope level (see Figure 4 of APPENDIX 2: FAILURE TEMPERATURE OF THE LUFFING ROPE on page 36).

Fontanari et al[7] indicates that "the rope exposure to high temperatures is particularly critical, since it produces a rapid deterioration of the wires' mechanical properties…The wire exposition to temperatures above 300°C activates the dislocation movements responsible for the annealing, thus producing an irreversible loss of the beneficial effect of work-hardening on the mechanical properties."

GMS's review of recent literature on the effects of fires on wire ropes indicates that wire ropes fail in 10 to 15 minutes when exposed to the heat of a fire. See APPENDIX 2: FAILURE TEMPERATURE OF THE LUFFING ROPE on page 35 for a summary of GMS's technical literature review.

As predicted by technical literature, the luffing rope failed. The boom collapse followed immediately.

As noted in their report, CTS calculated that the safety factor of the luffing rope at the site exceeded the safety factor requirements of *ANSI Standard B 30.3 – Tower Cranes*. GMS performed independent calculations to verify the CTS calculations of safety factors at the wire rope at the moment of failure. GMS's results were within 5% of CTS's.

Maintenance and inspection prior to fire.

Various publications and codes highlight the fire risks posed by the use of hydraulic oil under pressure. These publications include those issued by OSHA, SAE, ISO, and even Mobil.

[7] V. Fontanari, M. Benedetti, B.D. Monelli, F. Degasperi, Fire behavior of steel wire ropes: Experimental investigation and numerical analysis, *Engineering Structures*, Volume 84, 2015, Pages 340-349, https://doi.org/10.1016/j.engstruct.2014.12.004

SAE J1273, NYCBC regulations, and the FF Manual emphasize regular inspection as a means of eliminating or minimizing risk. To ensure thorough and consistent observations, FF included several inspection checklists in the crane manual. A checklist provides a structured approach to identify potential issues. The DOB requires checklists be kept and logged to allow verification that each inspection item has been addressed.

Although the FF manufacturer and code mandated inspections anticipate failures with precursory symptoms like leaks, the CTS and Russo investigations could not establish the exact cause of the hose separation at the crimp. Recommendations and technical internet postings,[8] including those from the Society of Automobile Engineers (SAE) suggest that sudden separations are possible. The potential causes of sudden separations include high oil pressure, corrosion of the metal, or degradation of the hose. However, it is more likely that leaks or signs of fitting slippage on hoses precede larger failures. A more detailed summary of GMS's review of literature on hose failures can be found in APPENDIX 1: RISKS ASSOCIATED WITH HYDRAULIC FLUIDS AND HOSE FAILURES on page 29.

National standards (ASME 30.3) and good practice (SAE J1273*)* recommend specific inspections to observe leaks. Leaks usually precede larger failures or lead to fire initiation. Preventive replacement in the case of a leak is usually recommended. When an item is not listed on a checklist, it is more likely that the operator will not give that item sufficient attention.

The weekly (40-hour) checklist inspections required by the FF Manual did not take place. Other inspections required by the FF Manual were not all logged by CCC and NYCE, leaving open the possibility that they were not executed. Records of "prior engine start" checklists were not kept or did not take place. Records of checklists of daily and monthly maintenance inspections were properly maintained and made available to investigators. However, as previously noted, the FF checklists/inspection forms used by CCC and the SWO checklists used by NYCE differed slightly from the checklists/maintenance logs included in the FF Manual.

The FF checklists used by CCC at the site for daily inspections lacked FF Manual daily checklist's lines for inspection of leaks, potentially deemphasizing the risk[9]. Operators and mechanics may have only paid superficial attention to leaks. During the interviews conducted by CTS and Russo, the operators' definitions of leaks were vague. Mechanics and operators are not expected to be familiar with the precise definition of leak by SAE J1176 (see Appendix 1), but they should note droplets, drips or seepage. It seems that when inspecting for leaks they were applying loose personal views that were quite distant from SAE J1176's technical definition. (See CTS's report for a summary of the CCC and NYCE interviews.)

[8] "What Are the Most Common Causes of Hydraulic Hose Failure?" by Mac Hydraulics https://mac-hyd.com/2017/07/31/common-causes-of-hydraulic-hose-failure/

[9] See APPENDIX 4: SECTION 3.5 (CHECK LISTS) OF FF MANUAL on page 40 of this report for a copy of the FF Manual's daily checklist.

Review of Compliance with Regulations and Instructions.

GMS researched various national standards (ASME 30.3), national guidelines (SAE) and New York City regulations on fire prevention and protection during construction, particularly those specific to cranes. In general, the regulations rely on various levels of periodic inspections, including daily inspections. Given that the fire started and used hydraulic oil as a combustible, the inspection and maintenance of hydraulic oil hoses is crucial in the mitigation of fires on tower cranes. GMS found that authorities covering the use of oil hoses clearly warn of the risk of mist-related fires. In "Recommended Practices for Hydraulic Hose Assemblies," (Appendix 1), SAE warns that fluids escaping from pressurized systems may form a mist or fine spray that can flash or explode upon contact with an ignition source, recommending replacement upon visual inspection of leaks. Similar provisions were found in the International Organization for Standardization (ISO) publication "Hydraulic fluid power - Hose assemblies" (Appendix 1).

GMS systematically reviewed compliance with NYC regulations and concluded that the construction operations at the 550 10th Avenue site failed to meet the general intent of the provisions of the 2014 NYC Building Code (NYCBC) Chapter 33 "Safeguards During Construction or Demolition." The construction activities resulted in harm to individuals and adjoining buildings.

Requirements for crane-related inspections stipulated in 2014 NYCBC Section 3319 “Cranes and Derricks” and 1-RCNY 3319-01, intended to prevent a fire, were only partially met. According to the NYCBC, performance of manufacturer-required inspections is compulsory. As noted earlier in the report, the weekly inspections required by the FF Manual did not take place, records of "prior engine start" checklists were not kept or did not take place, and records of daily and monthly maintenance inspections checklists provided by CCC and NYCE differed slightly from the checklists/maintenance logs included in the FF Manual.

In general, the purpose of an inspection checklist is to ensure thorough and consistent observations. Not all checklist inspections required by the manufacturer were logged, leaving open the possibility that they were not executed. Records of checklists for daily and monthly maintenance inspections were maintained and made available to investigators. Checklists used for daily inspections did not match those from the FF Manual and lacked lines for inspection of leaks, potentially deemphasizing the risk.

Interview transcripts revealed varying views among operators and mechanics regarding the importance of leaks, and no written record was found indicating repair or replacement of the hoses.

Fire science recognizes that despite many preventive regulations and warnings, fires will always occur. When prevention fails, it is important to implement measures that reduce the impact of the fire. The on-deck fire extinguisher, while insufficient to extinguish the fire, facilitated the safe evacuation of the operator. The fire watch allowed time for the contractor to shut down the street preventing any loss of life.

At the time of the incident, there were no mandates in place by code, rule, or the FF manufacturer for early fire warning or fire suppression systems and none of these systems were in place at the time the fire began. A 2016 FF Bulletin (FFCA-EB-030) issued following a similar fire incident contains instructions

and recommendations aimed at limiting the damaging effect of a fire; these recommendations include measures for early detection and fire suppression. None of the items listed in Bulletin FFCA-EB-030 were implemented by NYCE at 550 10th Avenue. The FF bulletin's recommendation to install two 9kg Class "B" fire extinguishers might have offered a chance to put out the fire before total boom failure.

In terms of hose and fitting maintenance and daily operations the recommendations do not differ substantially from the inspections instructions in the FF Manual's daily checklists. However, Bulletin FFCA-EB-030 does emphasize that "Any leaking hoses or fittings should be attended immediately." Other instructions include the elimination of "extraneous materials in the power pack area." Neither CTS's nor Russo's investigations reported the presence of any such "extraneous materials."

Code Proposals

GMS has reviewed literature on recent fire-related crane accidents and found that they are rare events (see Appendix 3). However, any fire risk assessment must take into account the significant costs associated with a tower crane collapse. Such risks justify changes in regulations that are aimed at preventing or mitigating such accidents, including changes that have already been implemented by the DOB since the July 26, 2023 fire incident**.**

After the incident, the DOB has already issued a revised Erecting Tower Cranes: Required Protocol for Third-Party Certifications (see Exhibit 6 of CTS's report) that incorporates the recommendations of Bulletin FFCA-EB-030. This protocol includes the installation of a fire suppression kit on diesel cranes. To add this requirement to the Building Code, the DOB should work in conjunction with crane owners, operators and fire protection specialists.

The distribution of the bulletin to the owners might not necessarily lead to a distribution to equipment users and operators. Prior to renting the equipment to a user, the crane owner has the obligation to make sure that all safety measures are in place, including sharing with the user all information related to the crane (e.g. all mandatory and voluntary bulletins, inspection checklists, etc.). The code may state such obligation. All checklists need to be modified to include an inspection of leaks.

It is GMS's opinion that if properly carried out, the pre-accident hose inspections required by the FF Manual (and as a result implicitly required by NYCBC) would have been sufficient to avoid a fire accident. They might be improved by requiring replacement of the hose as soon as a leak is observed. Additionally, the training of operators and mechanics should emphasize what constitutes a leak and what measures are required to address said leaks.

COMPLIANCE WITH NEW YORK CITY REGULATIONS

In NYC, building construction activities, including crane operations, are regulated by the NYC Building Code. The reference building code for this construction project is 2014 NYCBC as modified by 1-RCNY 3319-01, Chapter 3300 Safeguards during Construction or Demolition. The 1-RCNY 3319-01 makes references to portions of ISO and ASME, requiring compliance with certain parts of these standards.

A systematic enumeration of the relevant requirements is provided for a clearer understanding of the investigation conclusions. This chapter lists the relevant code sections. To distinguish quotations from opinions on the level of compliance, the quotations are indented and italicized.

GENERAL CHAPTER 33 PROVISIONS

Chapter 33 of the NYCBC includes several general provisions applicable to all construction activities, including cranes.

> *3301.1 Scope. The provisions of this chapter shall govern the conduct of all construction or demolition operations with regard to the safety of the public and property. For regulations relating to the safety of persons employed in construction or demolition operations, OSHA standards shall apply.*

Note: OSHA conducted its own investigation of the incident.

Per **3301.1.2 Fire Code** construction is supposed to comply also with the applicable provisions of the New York City Fire Code (NYC FC). Some specific references to the NYC FC are to be found in the 2014 NYCBC Section **3303 Safeguards and Maintenance of Site**. The section contains general requirements applicable to all construction sites and operations, including cranes. The paragraphs that require compliance with the NYC FC include:

- 3303.4.6 Storage of combustible material and equipment.
- 3303.4.9 Internal combustion-powered equipment
- 3303.7 Fire prevention and fire protection.

These requirements are of a general nature and not applicable to this incident**.**

3303.7.2 Fire extinguishers.

> *Fire extinguishers shall be provided in accordance with the New York City Fire Code*

The NYC FC includes in Section FC 3315 Portable Fire Extinguishers

> *Cranes fueled by liquid motor fuel or flammable gas shall be provided with a portable fire extinguisher with a minimum 10-B: C rating located either in the crane's cab or in its immediate vicinity.*

The fire extinguisher was a dry chemical extinguisher with a classification of 1-A:10B-C. It met the FC criteria.

3301.1.3 Manufacturer Specifications & 3301.4 Inspection

Per **3301.1.3 Manufacturer Specifications** all equipment is required to be used per such specifications and the code. Where there is a discrepancy, the stricter requirement shall apply.

> Per **3301.4 Inspection**. *Structures, temporary construction, operations, and equipment shall be inspected as required by this code. Where this code does not provide for specific inspection criteria, any equipment, except hand tools, that would affect the safety of the public and property when operated shall be inspected by a competent person designated by the contractor*

> *using the equipment before the equipment is used at the site and periodically thereafter throughout the job. A record of such inspections shall be kept at the site.*

Together the **Sections 3301.1.3** and **3301.4** of the 2014 NYCBC compel the user to inspect by the "stricter requirements" and to maintain on site all records of such inspections. **Section 3301.7** of the 2014 NYCBC reiterates the need to keep reports and inspection documents on site. Results of inspection shall be logged.

The FF Manual included a weekly (40 hours) inspection form, but these inspections did not take place, hence no records of such inspections were made available to CTS.

3301.5 Unsafe conditions and equipment

> ***3301.5 Unsafe conditions and equipment.*** *Any structure, temporary construction, operation, or equipment found to be defective or unsafe, and posing a risk to the public and property, shall be immediately secured and corrected, or removed from the site.*

Specifically crane-related inspections intended to verify safe condition of an equipment stipulated in the Section 3319 of the 2014 NYCBC and 1-RCNY§3319-01 were only partially met.

Tower Crane Fire Control Provisions

Probably, because of the rarity of fire events on tower cranes, codes and engineering standards have only a few specific instructions for active fire controls (human action or automatic device) installation. NYCBC, NYC FC and OSHA have only instructions for the type and presence of fire extinguishers (**1 RCNY §3319-01.)** on tower cranes.

The only fire protection specific provision related to the case refers to refueling. The NYC FC contains **§3305-01 Crane Aerial Fueling Operations** that sets forth requirements for the aerial fueling of cranes with diesel fuel or other combustible liquids at construction sites and other locations. It prohibits fueling a crane aerially with a flammable liquid and sets various conditions for the performance of refueling, including the supervision by a holder of a certificate of fitness for refueling with diesel.

The crane was refueled under the supervision of a certificate holder.

COMPLIANCE WITH 1-RCNY 3319-01

Tower crane accidents have the potential to cause significant damage. A couple of tower crane accidents in NYC resulted in fatalities and building collapses. To prevent accidents NYC has issued a number of bulletins and directives that are reflected in the 1-RCNY 3319-01. The regulation includes a number of compulsory periodic inspections, qualification requirements for operators, etc.

COMPLIANCE WITH 1-RCNY 3319-01 INSPECTION PROVISIONS

The maintenance and the inspections performed prior to the accident are extremely important as they represent the essential means used to prevent malfunctions or limit the effect of accidents such as a fire conflagration.

Section (k)(1) of 1-RCNY 3319-01 requires a frequent inspection to be performed before each shift.

Section (k)(3) 1-RCNY 3319-01 notes that

> ***(3) Periodic inspection.*** *must be performed at one to twelve month intervals, or as specifically recommended by the manufacturer, depending upon its activity, severity of service, and environment.*
>
> > ***(i) Inspection items.*** *At a minimum, the periodic inspection must include a check of all of the items listed for a frequent inspection by paragraph (1) above, and a check for the following:*
> >
> > *…*
> >
> > ***(G)*** *Gasoline, diesel, electric or other power plants for improper performance or non-compliance with safety requirements.*

1 RCNY 3319-01, **Section (d)(1)(i)** requires crane manuals to include the following as part of the certificate of approval process:

> ***(J)*** *Inspection criteria, including a schedule of manufacturer-recommended inspections.*
>
> ***(K)*** *Maintenance criteria, including a schedule of manufacturer-recommended maintenance*.

The 1-RCNY 3319-01 requires the manuals to include manufacturer's inspection and maintenance checklists for all approved components together with the necessary schedules of performance. Updates to inspection and maintenance checklists are to be provided.

Per CTS's report, CTS found that the daily inspection checklists provided by CCC "used what appears to be a Favelle Favco form, but it was different from the one contained in the manual. The one in the manual included additional items, more fluid level, and the power pack checks. The forms did not have the DOB requirement "Inspect – Hydraulic and pneumatic hoses" (1 RCNY §3319-01 (k)(1)(i)(B) 1.). This regulation requires the daily inspection to include items in the ASME30.3 (2016 edition) (3-2.1.3(k)). During the interviews, none of the interviewees knew the source of the form used."

Using available documents and records of interviews, CTS investigated the maintenance and inspection of the crane. The CTS report found that the DOB was provided with the monthly (100 hours) and daily inspection records only after a request was made after the incident. There was no record of the weekly (40 hours) inspection. The daily and monthly inspection checklists provided by CCC and NYCE were slightly different from the ones referred to in the FF Manual but appear to have been originated by Favco.

The maintenance inspections were performed by the oiler, but records were not logged as required by the code.

Records of draining the hydraulic oil at 100 hours were not found and the mechanics' responses were not satisfactory.

1-RCNY 3319-01 AND LICENSING

1 RCNY has provisions related to licensing of operators, including the need to be licensed per **Article 405 of chapter 4 of Title 28 of the Administrative Code**.

§ 28-405.2 Classification.

Hoisting machine operator licenses shall be classified as follows:

1. *Class A license: License to operate cranes with a boom, including jibs and any other extensions to the boom, not exceeding 200 feet (60 960 mm) in length, derricks, and other hoisting machines….*

The tower crane at 10th Avenue had a boom not exceeding 200 ft. CTS believes that the operators were properly certified.

1-RCNY 3319-01 AND SAFETY BULLETINS

In 2012 a significant fire occurred on an FF tower crane in Australia. FF issued an engineering Bulletin (FFCA-EB-030) in response to recommendations by SafeWork[10].

Bulletin FFCA-EB-030 states that the recommendations are "not compulsory to implement in other parts of the World" but advises all customers to follow the recommendations given. A copy FFCA-EB-030 is available as CTS Exhibit 3.

Specific 1-RCNY 3319-01 instructions provided in **Section (d)(1):**

(xi) ***Safety bulletins and recall notices****. Certification from the manufacturer that safety bulletins and recall notices for the crane or derrick will be provided…*

CTS Exhibit 8 proves that Bulletin FFCA-EB-030 was sent to the crane owner.

1-RCNY 3319-01 **Section (d)(6)** states the following:

(6) ***Safety bulletins and recall notices****. The department will provide to each manufacturer a list containing the serial numbers of all cranes and derricks registered in New York City manufactured by such manufacturer. The manufacturer in turn must provide to the department all safety bulletins and recall notices issued by such manufacturer related to cranes and derricks found on the list provided by the Department when the safety bulletin or recall notice is issued. No fee will be charged to file such bulletin or notice with the department.*

Safety bulletins and recall notices will not be considered part of a crane or derrick's certificate of approval and will not impact the validity of any such certificate. The department may require proof that a crane or derrick with a certificate of operation or a certificate of on-site inspection, or a crane or derrick for which such certificate(s) are sought complies with the safety bulletin or recall notice.

CTS could not find proof that Bulletin FFCA-EB-030 had reached NYC DOB. Independent of such fact an owner is required to comply with the bulletin when it is mandatory.

[10] https://www.safework.nsw.gov.au/resource-library/construction/tower-cranes/tower-crane-safety/risks-associated-with-fires-on-tower-cranes-safety-alert

Bulletin FFCA-EB-030 states that the recommendations are "not compulsory to implement in other parts of the World" but advises all customers to follow the recommendations given. Although described as not compulsory, a prudent owner would have implemented at least some of the recommendations.

The purpose of Bulletin FFCA-EB-030 recommendations is to lower the potential of a fire starting and to minimize the presence and exposure of combustible materials. In addition, since the potential of a fire starting cannot be completely eliminated there are recommendations for additional measures that ensure an early detection and a sufficient capacity to extinguish the incipient fire.

Bulletin FFCA-EB-030 Recommendations

Bulletin FFCA-EB-030 distinguishes two types of actions – immediate and longer term. Although described as not compulsory, a prudent owner would have implemented at least some of the recommendations.

On the following pages, excerpts from Bulletin FFCA-EB-030 are indented and italicized to distinguish the bulletin excerpts from GMS commentary.

> *1.1.1. Any leaking hoses or fittings should be attended immediately.*

This recommendation matches those of ISO and SAE. See GMS Appendix 1.

In GMS's opinion some interview responses by HMOs, and the diapers discovered at the scene of the fire indicate that "immediate" was not the usual response.

According to Russo, the HMOs interviewed agreed that they would have been concerned only when a "puddle" would have appeared. Per Russo's report "Testimony from HMO3 disclosed he observed 'seepage' from various hoses, but his determination was that it was not severe and did not require notification to his superiors or the crane owner. HMO2 further indicated that it is normal for any crane to have some 'leakage or seepage' from the hoses, connections, or fittings. All agreed if they noticed a 'puddle of fluid' on the platform that they would consider that an issue which required remediation."

> *1.2 Hydraulic hoses*
>
> *Owners and operators are requested to inspect all hoses that are used for the transmission of flammable liquids (hydraulic hoses, fuel lines, etc.) within the power pack and winch systems to ascertain their fire ratings If any offending hose is found on a crane in service …the offending hose should be wrapped in a fire blanket until a convenient time.*

The CTS investigation found marks on the hoses indicating the year 2008. It is supposed that these were original to the crane. FF should have been aware whether the originally supplied hoses have a fire rating.

> *1.3 Fire Detection*
>
> *Install any suitable fire detection device (which could possibly be a small camera) into the power pack system to aid early detections.*

No such system was installed.

1.4 Fire Extinguishing

FFC recommends owners/operators to have at least two 9kg Class B fire extinguishers available on the machinery deck of the crane.

According to Russo the handheld fire extinguisher on the subject crane was well below the size recommended by the manufacturer, weighing less than 4 pounds.

In GMS's opinion, the simplest Bulletin FFCA-EB-030 recommendation to implement was the fire extinguishers. It would have offered a better chance to put out the fire.

OSHA REGULATIONS & RECOMMENDATIONS

Note on OSHA vs NYC DOB Regulations: the NYC Building Code is more comprehensive and specifically tailored to the unique urban environment of New York City, while OSHA standards apply nationally and focus on worker safety. NYC's regulations are designed to address the challenges of operating cranes in a densely populated area with numerous high-rise buildings.

Licensing requirements: NYC has stricter licensing requirements for crane operators and riggers. The city maintains the power to revoke licenses or discipline operators who violate local safety laws, regardless of whether they meet OSHA's minimum requirements.

On at least two occasions OSHA issued hazard warnings related to hydraulic systems.

In 1991 OSHA had issued OSHA Hazard Information Bulletin - Hydraulic Systems Modifications[11]. The 1991 OSHA bulletin noted that any of the following conditions should be sufficient to consider the replacement of a component:

a. Any evidence of hydraulic oil leakage at the surface of a flexible hose or its junction with the metal and couplings;

b. Any blistering or abnormal deformation to the outer covering of a hydraulic hose;

c. Hydraulic oil leakage at any threaded or clamped joint that cannot be eliminated by normal tightening or recommended procedures; and/or

d. Evidence of excessive abrasion or scrubbing on the outer surface of a hose, rigid tube, or hydraulic fitting. Modification must be made to eliminate the interference of the elements in contact, or otherwise protect the components.[2]

On November 20, 2024 OSHA published an article "Hydraulic System Hazards: Prevention and Response"[12]. This article enumerates a number of possible hazards posed by hydraulic systems including injury risk, system failure (pressure loss and over-pressure), high pressure fluid exposure. As part of the 2024 OSHA article's emergency response planning recommendations, OSHA notes that in case of fire,

[11] https://www.osha.gov/publications/hib19910711

[12] https://blog.oshaonlinecenter.com/hydraulic-system-hazards-safety/

workers should "Know the location of fire suppression equipment and have procedures in place to evacuate the area safely."

CONCLUSIONS AND RECOMMENDATIONS

This investigation determined with a high level of confidence that the fire was due to the release of flammable hydraulic fluid mist that came in contact with a hot surface when a hose connection to the power pack failed. The hose was found separated from its crimp fitting. The hydraulic oil that began flowing onto the deck fueled the fire. Since the fire was not extinguished, the heat output increased, the luffing rope failed, and the boom collapsed. Due to the deterioration of the hose after the fire, the investigation could not determine whether the leak or other signs of deterioration had preceded the hose separation.

In terms of compliance with regulations, GMS concluded that the construction operations at this site failed to meet the intent of the provisions of Chapter 33 of the 2014 New York City Building Code (NYCBC) on Safeguards During Construction or Demolition. The operation did not meet the requirements of 2014 NYCBC Section 3301.5 (Unsafe conditions and equipment) which states that "Any structure, temporary construction, operation, or equipment found to be defective or unsafe, and posing a risk to the public and property, shall be immediately secured and corrected, or removed from the site."

Crane related inspections intended to verify the safe condition of equipment stipulated in Section 3319 of the 2014 NYCBC and 1-RCNY§3319-01 were only partially met. The investigation found that:

- There was no documentation proving that all inspections required by the manufacturer (FF) in the FF Manual were executed.
    - As previously noted, the daily, weekly, and monthly inspection forms/checklists provided by CCC and the 100-hour (monthly), 250-hour (three month) and six month Service Work Order (SWO) checklists provided by NYCE differ slightly from the daily, weekly (40-hour), monthly (100-hour), and three month (250-hour) maintenance logs/checklists included in the FF Manual. See Exhibit 15 (Inspection Forms) of CTS's report and APPENDIX 4: SECTION 3.5 (CHECK LISTS) OF FF MANUAL on page 41 of this report.
- Written records attesting to leak inspections could be found only in the three-month (250-hour) SWO checklists used by NYCE. See Exhibit 15 (Inspection Forms) of CTS's report.
- The FF-required weekly (40-hour) inspections did not take place.

While fires in cranes are an unusual occurrence (DOB datasets in NYC Open Data show there are no violations for a previous crane fire), below is a list of issues to consider to avoid a similar accident in the future:

- The DOB should reiterate to all crane manufacturers that they are required to notify the DOB of all mandatory and voluntary bulletins.

- Crane owners should inform equipment users of all the bulletins, including bulletins indicating voluntary prevention, so they can take appropriate measures.

- Due to the rarity of a fire, it is not clear that the crane personnel were aware of the inherent risk posed by a damp, or leaking hose. Operators and owners should all be trained to inspect hydraulic hoses and all hose fittings to ensure that they are in safe, working condition.

- Extinguishers of adequate capacity should be provided on every diesel-powered tower crane and on any other crane where extinguishers are required by the manufacturers.

- After the incident, the DOB modified the Required Protocol for Third Party Certification to include the requirements of Bulletin FFCA-EB-030. This protocol includes the installation of a fire suppression kit on diesel cranes. To add this requirement to the Building Code, the DOB should work in conjunction with crane owners, operators and fire protection specialists.

APPENDIX 1: RISKS ASSOCIATED WITH HYDRAULIC FLUIDS AND HOSE FAILURES

Use of Power Hoses

GMS has reviewed technical literature related to risks related to use of hoses carrying hydraulic fluids. ***SAE J1273-2021 Recommended Practices for Hydraulic Hose Assemblies*** "provides guidelines for selection, routing, fabrication, installation, replacement, maintenance, and storage of hose and hose assemblies for hydraulic fluid-power systems."

The SAE guideline enumerates various risks related to use of such hoses. Among those it mentions:

> *"4.4 Fire and Explosions from Conveyed Fluids*
>
> *Most fluid-power media, including fire-resistant hydraulic fluids, will burn under certain conditions. Fluids which escape from pressurized systems may form a mist or fine spray that can flash or explode upon contact with an ignition source."*

An almost identical warning can be found in the ***ISO/TS 17165-2 Hydraulic fluid power - Hose assemblies Part 2 Practices for hydraulic hose assemblies***.

In ***SAE J1273-2021*** Table 1 *(*Items related to visual inspection of hose and hose fittings), the SAE identifies several types of leaks that that should be observed during a visual inspection of the hose and the fitting: leakage from threaded connection, leakage from flange connection and leakage from hose/connecting assembly, house fitting slippage on hose. The last type of leakage may be the result of deterioration of the hose (due to heat, oil, long use). See Figure 1 on page 30 of this report for a copy of ***SAE J1273-2021*** Table 1.

The Favco 3.5.1 Daily check lists require that prior to engine start a visual check for oil leakage around the power pack as well as in the air. An additional oil leakage check is to be performed during the warmup period (prior to operation). Similar visual checks around the power pack are to be performed monthly.

Table 1 - Items related to visual inspection of hose and hose fittings

Item		Main Cause	Corrective Actions to be Taken
Leakage from threaded connector		Defective connector seat due to presence of flaw, dirt, or other foreign objects	Clean connector seat
		Loose connector or O-ring wear	Tighten the connector or replace O-ring
		Mismatching of seat surface	Replace the connector as necessary
Leakage from flange connection		Loose fixture bolt or deterioration of O-rings/seals	Tighten the bolt or replace O-rings/seals
Leakage from hose/fitting interface hose fitting slippage on hose		Deterioration of hose (due to heat, oil, long use, etc.)	Replace the hose
		Improper routing	Avoid sharp bending at the assembly part
Deformation	(Kink or dent)	External impact	Impact prevention (protection), replace the defective hose
	(Swell, bulge)	Oil spillage (leak)	
Visible defect (damaged, cut or abraided cover; exposed reinforcement; kinked, crushed, flattened, or twisted hose; blistered, soft, degraded, or loose cover; cracked, damaged, or badly corroded hose fittings; wear flaws; scratch etc.)		Component interference External shocks	Impact prevention (protection), replacement
Visible external cracks		Ozone, radiation, paint, other fluids	Exterior protection, replacement
Unusual hose movement at starting of operation		Improper hose length	Replace the hose
		Improper routing	Correct routing or use of adaptive devices
Hardening/softening, heat cracked, or charred hose		Deterioration due to fluid or temperature mismatch.	Replacement as necessary
Unusual noise, odor, heat		Improper circuitry	Check the circuit
Rusting of joints		Sand dust, water, air salinity	Use of protective paint (but not on the exterior surface of the hose)
Product lifetime (useful service life has been reached)		Deterioration and wear	Replace hose and/or hose assembly based on criteria defined in Section 8

8.3 Visual Inspection (All Other Components)

When visually inspecting hose and fittings, inspect for related items including:

a. Leaking ports

b. Damaged or missing hose clamps, guards, or shields

c. Excessive dirt and debris around hose

d. System fluid: level, type, contamination, condition, and air entrainment

If any of these are found, address them appropriately.

Figure 1 SAE J1273-2021 Table 1

Appendix A of ***SAE J1273*** provides examples of hose failures, including failures of steel wire reinforced rubber hose assemblies. An excerpt of ***SAE J1273*** Appendix A is included on page 31 of this report as Figure 2. The failure examples include leakage or disconnection of hose fitting end as well as leakage from the hose fitting connection. The causes listed for these failures are mainly related to the original installation. The CTS investigation found marks on some of the hoses indicating the year 2008, the same year the crane was manufactured. It is supposed that these hoses were original to the crane. In an

interview with CTS and Russo, one NYCE mechanic stated that NYCE replaced the failed hose in 2011, however no written record was found that indicated a hose replacement. The failed hose may have been original to the crane. In GMS's opinion, it would be unlikely that a deficient mounting would show its effect after many years in operation at multiple different construction sites.

4	Leakage or disconnection at hose fitting end	Hardening and cracks on the outside layer	Cracks on the internal and/or external layer due to high internal/external temperature		
		Breakage of external rubber surface at the end	Severe bending at the hose fitting end arising from deformation of adjacent connections	Negligence	
		Bending or falling of hose fitting neck	Deformation due to twisted mounting or stress from tension	Improper mounting	
		Large leaks from hose fitting end	Internal and external layers become fragile due to low temperature, causing cracks	Insufficient resistance to low temperature	
5	Leakage from hose fitting connection	Leakage from screw threads	Improper matching of seat surface and damaged threads	Improper mounting	
		Leakage from the flange	Degradation or extrusion of O-rings	Incompatibility of O-ring with the fluid or temperature	

a. If this occurs after a long use, the hose life is likely to be over.
b. Use of protective cover or sealing of the hose assembly.
c. This occurs often as a result of a combination of high temperature and high water content.

Figure A1 - Examples of actual failure resulting from improper use of steel-wire reinforced rubber hose assembly

Figure 2 Excerpt from Appendix A of SAE J1273

A possible cause that is not listed in Appendix A of SAE J1273 would be the wear and tear of the hydraulic hose.

According to SAE J1273 hose service life can be affected by a variety of interacting factors (pressure, temperature, hose movement, etc.). Because the combined effects of these factors on service life are often unpredictable, SAE considers it improper to provide generic guidelines; each system should be evaluated separately.

> *"5. HOSE SELECTION AND ROUTING*
> *A wide variety of interacting factors influence hose service life and the ability of each hydraulic fluid-power system to operate satisfactorily, and the combined effects of these factors on service life are often unpredictable. Therefore, hydraulic hose specification documents should not be construed as design standards."*

SAE J1176 JUN2012 External Leakage Classifications for Hydraulic Systems provides characteristics to describe the size or type of leak. See Figure 3 below.

3. *Dust-free Classifications*

3.1 Class 0—No indication of moisture.

3.2 Class 1—Nonrecurring fluid.

3.3 Class 2—Recurring fluid that does not result in the formation of a droplet.

3.4 Class 3—Recurring fluid that results in the formation of a nonfalling droplet.

3.5 Class 4—Recurring fluid where a droplet forms and falls.

3.6 Class 5—Recurring fluid where the frequency of droplets makes a measurable stream.

Figure 3 Extract from SAE J1176 JUN2012 External Leakage Classifications for Hydraulic Systems

According to the CTS report the operator's answers varied when questioned about leaks and the use of diapers (pads). The responses included various terms such seeps and drips.

The NYCE mechanic that serviced the crane and performed the monthly maintenance check said that when he operated the crane in the shop there were no leaks in the power pack area. He said that the crane operated for a day or two and he would have seen them. His definition of a leak was if he touched the fitting and it felt damp – this was a leak, and he would have replaced the hose.

SAE J1176 JUN2012 notes that "Permeation, or effusion, is seepage of fluid through the hose."

Literature on fire risk of hydraulic oil mists

GMS surveyed several technical papers discussing the risk of fire associated with sprays and mists and extracted some passages it considers relevant to the present investigation.

Yuan, L. (2006). Ignition of hydraulic fluid sprays by open flames and hot surfaces. *Journal of loss prevention in the process industries*, *19*(4), 353-361.

Prepared by an author affiliated with National Institute for Occupational Safety and Health (NIOSH) the technical paper discusses fires that were associated with an external source of ignition - flame or hot surface.

> *"Most hydraulic fluids are combustible and are used under high pressure to transmit power or motion. Pressurized oil in hydraulic systems presents a considerable fire hazard, particularly where ignition sources are present. When hydraulic oil is released under pressure, it often results in an atomized spray or mist of oil droplets that may extend as far as 10 m from the break (Bowen & Shirvill, 1994). The oil spray can be ignited readily by hot surfaces, such as heated or molten metal, electric heaters, open flames or welding arcs. The resulting fire usually is torch-like, with a very high heat release rate, and can cause significant property damage, even loss of human lives. The frequency of fires involving hydraulic fluids has prompted the introduction of fire-resistant fluids in hydraulic systems*.

> *The ignition event was found to depend on the temperature of the hot surface, the geometry of the arrangement of the carrier gas at room temperature, the physical properties of the fuel and the fuel concentration."*

The NIOSH paper presents a study of non-fire-resistant hydraulic fluid sprays. Mobil H belongs to this category. The study discusses external source ignition like open flame or hot surfaces. For certain cases it determined minimum hot surface ignition.

IEC 60079-10-1 International Standard - Explosive atmospheres

IEC 60079-10-1 International Standard - Explosive atmospheres published by the International Electrotechnical Commission (IEC) states that "mists which form through leaks of pressurized liquid can be flammable even though the liquid temperature is below the flash point."

Puttick, S. (2008). Liquid mists and sprays flammable below the flash point: the problem of preventative bases of safety. In *Institution of Chemical Engineers Symposium Series* (Vol. 154, p. 825). Institution of Chemical Engineers; 1999.

In the paper's "Relationship to Material Flash Point" section, Puttick discusses and cites several technical reports that show that the mist flammability can be below the material flashpoint. There is no established methodology to determine how much lower they can be.

Babrauskas, V. (2022). Ignition of gases, vapors, and liquids by hot surfaces. *Fire technology*, *58*(1), 281-310.

> *"In both motor vehicles and industrial environments, it is quite possible that the fuel, instead of being already vaporized, will be discharged against the hot surface in a still-liquid form. This can range from simple droplet being dribbled onto to a surface, to sprays, streams, and aerosols. The U.S. armed forces have been especially interested in studying this type of hazard. Since the most common scenario may involve a hot engine manifold, it is appropriate to devote some specific attention to this particular hot surface. It is also useful to know that exhaust manifold temperatures in passenger cars can vary over a large range, and one study reports a range 200° – 600°C [7]. It is often considered that a dull-red-hot temperature of 600°C (or higher) will only be reached if there is a serious engine problem."*

AXA XL Risk Consulting Property Risk Consulting Guidelines – Fire Hazards of Hydraulic Systems[13]

A clear assessment about risks of hydraulic systems and methods of mitigating can be found in ***Property Risk Consulting Guidelines***, a Publication of AXA XL Risk Consulting.

> *"All commonly used hydraulic fluids except water are combustible or can become combustible. Petroleum-based fluids present the most serious hazard. Their flash points range from 300°F to 600°F (149°C to 316°C) and auto ignition temperatures range from 500°F to 750°F (260°C to 399°C). When these fluids discharge under pressure in a fine mist, they ignite easily, burn rapidly,*

[13] https://axaxl.com/-/media/axaxl/files/pdfs/prc-guidelines/prc-9/prc924firehazardsofhydraulicsystemsv1.pdf

and emit large quantities of heat. In fact, their heats of combustion, which are over 18,000 Btu/lb (2327 kJ/kg), are comparable to fuel oil….Provide automatic sprinklers in all areas containing hydraulically operated equipment, hydraulic systems, or hydraulic piping."

While the AXA XL Risk Consulting guideline is intended for buildings, several points raised are relevant for tower cranes as well.

"Special Extinguishing Systems: Water spray and/or carbon dioxide protection may be warranted for high hazard, high value machinery. Design these systems in accordance with applicable NFPA and AXA XL Risk Consulting Guidelines. Extra fire protection may also be needed where hydraulic system components are shielded from the ceiling sprinklers and when equipment surfaces are near or above the hydraulic fluid flash point."

APPENDIX 2: FAILURE TEMPERATURE OF THE LUFFING ROPE

GMS has performed an approximate study of the fire temperature that might have acted on the luffing rope. To determine the temperature of the rope, we interpolate between the flame's temperature at the base and the tip of the flame, considering that the rope is around 15 feet above the base of the fire.

From photographs, GMS determined the height of the flame. Comparing the height of the flame to the horizontal width of the platform, GMS found that the height of the flame is approximately 39 feet.

The aluminum pan melted at the base, indicating a temperature above 600°C-700°C. The actual temperature depends on the type of aluminum and the alloy.

Based on Babrauskas, V. (2006). *Temperatures in flames and fires. Fire Science and Technology Inc, 18, 369-374*. that researched open-air turbulent diffusion fires, GMS assumed that the temperature at the base of the fire is around 900°C, and the tip is around 320°C to 400°C. The base temperature can grow to 1200°C for large hydrocarbon pool fires.

Temperature at luffing rope.

Neglecting the continuous flame region and assuming, for simplicity, a linear variation of the temperature in the flame, considering that the height of the luffing cable above the fire is around 15 feet, linear interpolation gives a rope temperature of 675°C to 700°C.

Steel loses strength and stiffness at higher temperatures. For comparison, at 700°C mild steel has lost 80 percent of its strength.

For failure of wire ropes exposed to fires see literature review starting on page 37.

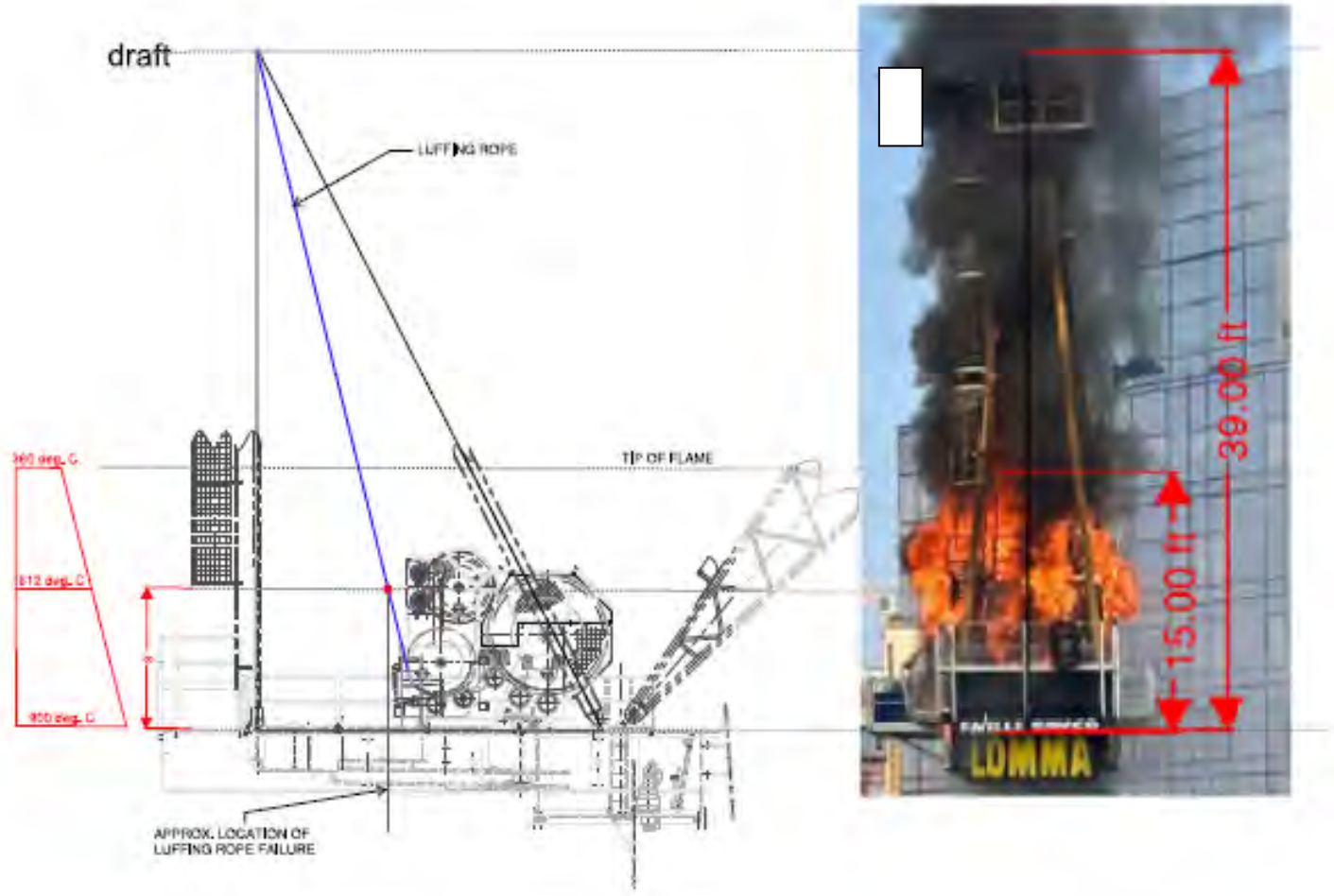


Figure 4 Approximate temperature at luffing cable.

Technical Literature Review

Once we establish the luffing rope temperature, we must determine if the rope broke under the load. At 700 Celsius, mild steel has lost 80 percent of its strength, but the rope is a high-strength steel cable that deteriorates more at higher temperatures than mild steel. Please see the articles referenced below. The rope to support the load needs factors of safety higher than 5. A factor of safety of 5 is not common in design, as the luffing cable is supposed to have a 3.5 factor of safety under the design loads.

Kotsovinos, P., Judge, R., Walker, G., & Woodburn, P. (). Fire performance of structural cables: Current understanding, knowledge gaps, and proposed research agenda. Journal of Structural Engineering, 146(8), 03120002.

In a 2020 state-of-the-art article reviewing the fire performance of structural cables, P. Kotsovinos et al. qualify this performance as a "knowledge gap." The article observes that "fire-resistance requirements for cable-supported structures are not explicitly covered by national building regulations or health and safety legislation or, typically, by specific owner/operator requirements." The issue of the effect of fire on cables is concisely described. "Their high tensile strength is attributed to the wire-drawing (i.e., cold-working) and heat treatment processes and the inclusion of small amounts of chromium, silicon, and vanadium. The cold drawing process produces important microstructural changes that influence the strength of the material. At high temperatures, cold-worked high-strength steel will lose its material properties faster than typical mild steel because the strength introduced by the cold-drawing process is gradually lost." The review found that there is only limited industry guidance with respect to the fire performance of cables, with only one recommendation existing (by the Post-Tensioning Institute).

V. Fontanari, M. Benedetti, B.D. Monelli, F. Degasperi, Fire behavior of steel wire ropes: Experimental investigation and numerical analysis, Engineering Structures Volume 84,2015,

Fontanari et al. indicate "that the rope exposure to high temperatures is particularly critical since it rapidly degrades the wires' mechanical properties. (…) The wire exposition to temperatures above 300°C (572°F) activates the dislocation movements responsible for the annealing, thus producing an irreversible loss of the beneficial effect of work-hardening on the mechanical properties. (…) The high carbon content and the wire drawing process produce fine pearlitic microstructures and a high level of work hardening, thus combining a significant increase in tensile strength with a worsening of material ductility."

(Wistreich [2], Fontanari et al. [3], Ray et al. [4], Phelippeau et al. [5]). "The wire exposition to temperatures above 300°C activates the dislocation movements responsible for the annealing, thus producing an irreversible loss of the beneficial effect of work-hardening on the mechanical properties. A further increase in the temperature up to 600°C activates the recrystallization process, which is responsible for the nucleation and growth of a new crystalline structure. The resulting detrimental effects on the strength characteristics are well known in the literature (Dieter [6]),"

Moon Ok Kim, Kyuwon Kim, Jung Hyun Yun, Moon Kyum Kim, Fire risk assessment of cable bridges for installation of firefighting facilities, Fire Safety Journal, Volume 115, 2020,

Moon Ok Kim, in a study of fire risk assessment of cable bridges, provides the following reductions:

"When the cables in cable bridges, such as cable-stayed bridges and suspension bridges, are exposed to fire long enough to raise their temperature to 200°C, the cables start to weaken. When their temperature exceeds 500°C, their strength drops to less than 50% of the original strength."

APPENDIX 3: REVIEW OF TOWER CRANE FIRES

GMS review of fires on tower cranes found that these are rare events. However, a risk assessment needs to consider the enormous costs of a tower crane collapse.

A word analysis of the NYC Open Data listing of DOB-ECB violations since 1988 found 4,516 entries that include the word “crane” in their description. 50 entries mention spill, leak or malfunctioning of diesel or hydraulic oil systems. This list covers all types of cranes. 438 violations in this list refer to the words “tower crane.” The search was carried out for violations up to September 2023, and the only violation found refers to this incident.

An overview (Beavers et al. 2006) of 125 cases of fatal accidents that occurred between 1997 and 2003 classifies accidents by type (crushed, tip over, etc.) and associated contributing factors. There is no mention of fire.

A 2009 study by the Center for Construction Research and Training (CPWR) covers 323 crane related deaths during about the same period (1992-2006) using OSHA accident categories (struck by, caught in between, etc.). It does not contain any mention of fire.

Milazzo (2017) analyzed 937 of worldwide (46% in North America) accident data records over 5 years. The analysis found that 22% of accidents were associated with tower cranes. For tower cranes only 1% of analyzed accidents were due to fire/explosions. Using the Milazzo database of accidents, Lingard produced the table illustrating incident types.

GMS reviewed several other studies that discuss crane accidents without mentioning fires.

Almost all the papers reviewed cover serious accidents both of mobile and tower cranes. The exceedingly rare mention of fire indicates that such events may be very uncommon or if a fire occurred it was so minimal that the accident was not included in lists. Cranes are basically steel frame installations, and with the exception of the fuel for the engines, they have a limited amount of combustibles to feed a catastrophic fire.

In 2016, in Prahran, Melbourne, Australia a tower crane boom collapsed due to a fire that destroyed the luff rope. The cause was a fire due to a short in the battery terminal.

In 2024, a tower crane collapsed in Vancouver, Canada due to a fire that started on the construction site at the base of the tower crane.

The website Vertikal.net counted a number of fires on all terrain cranes. In one web post, the website notes that “All Terrain crane fires are relatively common and devastating when they occur sometimes writing off the entire crane when the boom is damaged along with all the running gear.”[14]

[14] https://vertikal.net/en/news/story/8571/another-crane-fire

The Favco 2012 Fire

The November 27, 2012 Sydney tower crane fire, is the only event that has been covered in some detail in technical literature. It was followed by a coroner's inquiry into cause/origin of fire.[15]

Following the incident, in 2016 Favco issued an Engineering Bulletin (FFCA-EB-030) for all Favelle Favco diesel/hydraulic tower cranes operating outside Australia. On July 1, 2016, the bulletin was sent on to Lomma, which later became NYCE.

Bibliography

Beavers, James E., et al. "Crane-related fatalities in the construction industry." *Journal of construction engineering and management* 132.9 (2006): 901-910.

Gabriel Raviv, Barak Fishbain, Aviad Shapira, Analyzing risk factors in crane-related near-miss and accident reports, Safety Science, Volume 91, 2017,

Milazzo, Maria Francesca & Ancione, Giuseppa & Spasojević-Brkić, Vesna & Valis, David. (2016). Investigation of crane operation safety by analyzing main accident causes.

CPWR - The Center for Construction Research and Training Crane-Related Deaths in Construction and Recommendations for Their Prevention https://www.elcosh.org/document/1781/d000823/Crane-Related+Deaths+in+Construction+%2526+Recommendations+for+Their+Prevention.html

[15] The State Coroner's Court of New South Wales, File no. 2012/383995, (Aug. 2015).

APPENDIX 4: SECTION 3.5 (CHECK LISTS) OF FF MANUAL

On the following pages are excerpts from Section 3.5 (Check Lists) of Favelle Favco's *Installation, Operations, Maintenance Manual, Crane Serial Number 1475.* These check lists should be reviewed together with the various inspection forms presented in Exhibit 15 (Inspection Forms) of CTS's report.

3.5 Check Lists

3.5.1 DAILY

According to the usage of this crane, "daily check list" means inspection either by the crane operator or the maintenance personnel whenever the crane is to be operated.

It is imperative that the crane operator is informed by the previous operator or the person responsible for the crane of any shut down or problem.

It must be noted, that the following daily checks do not include all specific direction given for the diesel engine.

A Check prior to engine start:

Item	Check Prior to Engine Start	Check
1.	Check for sufficient fuel oil to avoid untimely engine shut down during operation.	
2.	Check radiator water level (Check for leaks).	
3.	Check pump drive gearbox and/or gearbox oil level (Check for leaks). ATTENTION **Do not overfill.**	
4.	Check hydraulic oil level tank level. ATTENTION **Do not overfill.**	
5.	Visually check for oil leakage around the powerpack and the winch.	
6.	Visually check for leakage or damage in the air and non-mechanical systems.	
7.	Check hoist, luff and fly ropes for defects. Refer to Section 0 for more details on rope inspection. Ensure that ropes are laying in all sheaves and correctly on their drums. The ropes shall be free of kinks, loose strands or rust.	

B Engine Start:

Warm up diesel engine as recommended in the engine manual supplied, then continue with checks. Drive all motions at half speed only while checking, as the hydraulic system needs warming up. Refer to table 4-1 page4.17 for hydraulic oil operational temperature limits.

ATTENTION ***Do not lift any loads while the hydraulic system is warmed.***

Items	Start Instruction	Check
1	Reset circuit breakers, if disengaged, to supply electric power to the engine and crane safety system (if applicable).	
2	Reset emergency stop button if latch down type is used.	
3	Shift throttle control to low idle and then turn start key and push start button. Allow the engine 5 minute to warm up	
4	Should the engine fail to start, rectify possible cause.	

C **Checks during the warm up period (prior to operation):**

Items	Checks During Warm Up	Check
	Check filter visual indicators. Replace elements if required.	
	Check hydraulic pipework for leakage.	
	Check oil levels (Engine, hydraulic drive units)	
	Drain water from air tank and filter	
	Check engine tachometer.	
	Check safe load indicator and run a comparison with the mechanical radius indicator on the boom.	
	Release slew brake.	
	Check main 'hoist up' limit function	
	Check boom buffer positions. Both buffers must be of equal length when the boom is away from them.	
	Check 'luff in' deceleration and motion cease limit.	
	Check horn.	
	Check 'dead man' controls. Ensure that all controls return to zero position by themselves.	
	Check that there is absolutely no motion creep with brakes applied. If any motion is detected, immediately shut down the crane and contact a qualified maintenance personnel. **ATTENTION** ***With brakes released, creep up in both hoists and luff is possible, as the pumps can be set slightly off centre to avoid the load or boom drop with heavy loads.***	
	Check engine throttle control and tachometer when oil is sufficiently warmed up.	
	Check oil tank temperature before any heavy work is required. The minimum temperature shall not be less than 25-35 degrees Celsius, depending on the oil type. Refer to the Maintenance section of this manual for further information.	
	Check engine oil level (dipstick).	
	Check 'annunciator' panel to ensure visual and audible alarm is working.	
	Check the fuel gauge (if fitted) in cabin.	
	Check the operation of the luff drum pawl.	
	Check that load chart for applicable boom length is installed in the cabin.	
	Check hoist brake.	

	Check emergency stop is working.	
	Check 'luff down' limit	
	Check emergency lowering needle valve(s) is present and tightly closed.	
	Ensure windows are clean.	
	Determine that wind is not excessive for crane use and type of lift.	
	Check aviation warning light(s) are working.	
	Visually check for loose, missing, or corroded bolts, pins, keepers or cotter pins.	
	Visually check loose gear to be used, such as slings, sling hooks and shackles (if applicable).	

3.5.2 MONTHLY

NOTE ***1. Items 2 to 8 are to carried out with engine running.***
2. Items 9 to 19 are be carried out with all crane motions

Items	Monthly Checks	Check
1	Check main hoist, fly hoist and luff ropes for defects. Ensure that ropes are laying in all sheaves and correctly on their drums.	
2	Check engine oil level (dipstick).	
3	Check radiator water level (cap and dip stick).	
4	Check pump drive gearbox oil level.	
5	Check hydraulic oil level indicator on the hydraulic oil tank.	
6	Check safe load indicator and run a comparison with mechanical boom radius indicator.	
7	Check the 'annunciator' panel to ensure visual and audible alarms are working.	
8	Check the fuel gauge in cabin.	
9	Check the operation of the luff drum pawl.	
10	Check that load chart for applicable boom length is installed in the cabin.	
11	Check hoist brake	
12	Check 'hoist up' limit.	
13	Check emergency stop is working	
14	Check throttle control.	
15	Check 'luff in' deceleration and motion cease limit.	
16	Check 'luff down' limit.	
17	Check 'dead man' controls.	
18	Check emergency lowering needle valve(s) is present and tightly closed.	
19	Check needle valve on slew pump is closed.	
20	Ensure windows are clean.	
21	Check aviation warning light(s) are working.	
22	Visually check for oil leakage around the powerpack and the winch.	
23	Visually check for leakage or damage in the air and non-mechanical systems.	
24	Visually check for loose, missing, or corroded bolts, pins, keepers or cotter pins.	

25	Visually check loose gear to be used, such as slings, sling hooks and shackles (if applicable).	
26	Further check all control mechanisms for proper adjustment, excessive wear of components, and contamination by foreign matter.	

3.6 Operating Instruction

Prior to starting the diesel engine and during the warm up period, the operator is required to check the crane according to the daily checklist.

When the crane is assembled for the first time, circuit breakers in the electric cubicle must be engaged to provide power. Ignition is switched on and the annunciator shows low oil and boost pressure until engine is started. The safe load indicator is also switched on through the ignition switch and shows boom radius, load in tonnes and permitted load in tonnes.

NOTE ***When the crane is started with cold and thick hydraulic oil in the system, the filter bypass may indicate on the annunciator until the hydraulic oil warms up.***

Motion control valves are of the 'dead man' type and motion speeds are in direct proportion to the deflection of the lever from the neutral position.

Care must be taken at all times to ensure that all motion controls are operated smoothly and progressively and not 'plugged' or 'counter switched' before the load stops.

EXAMPLE *Pull the lever from zero to approximately half stroke and a pressure between 5 and 18 bar actuates the pump from zero to full displacement. The rest of the valve stroke, giving a pressure from 18 to 28 bar destrokes the hydraulic motor towards its minimum displacement if the load on the hook allows. Adjustment within the motor is automatic towards faster speed, if the torque required is satisfied. This only applies to the main hoist and luff motions.*

The safe load indicator(SLI), which continually shows the radius, actual and permitted load at any specific radius must be observed at all times. This is to avoid tripping the motion cutout while luffing out. When overload condition occurs, the operator should immediately luff in or lower the load to the ground.

Further information on using the SLI can be found in Section 8 of this manual and the SLI operator' manual (if supplied).

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File: FR-4694-23

DATE: March 4, 2025

LOSS ADDRESS: 550 10th Avenue
Manhattan, New York

CLAIM/FILE NO: Not provided

INSURED: New York City Department of Buildings

Vicki Arbitrio
GILSANZ, MURRAY, STEFICEK, LLP
129 West 27th Street, 5th Floor
New York, New York, 10001

Dear Ms. Arbitrio,

In accordance with your instructions, we have prepared an "Origin and Cause Determination Report" pertaining to the fire involving a crane that occurred at 550 10th Avenue, Manhattan, New York. If, in the future, you should require a more comprehensive report, kindly advise and one will be prepared and submitted with original photographs.

Please note, Russo Consultants reserves the right to amend/supplement this report if additional information, documentation, and/or evidence is presented.

Very truly yours,

Daniel Seeley

Daniel Seeley, CFEI, CVFI
Fire Investigator

DS:pjr
Enc.

T.J. Russo Consultants
Fire Investigation and Analysis Services

FIRE INVESTIGATION
"ORIGIN AND CAUSE REPORT"



INCIDENT LOCATION: 550 10th Avenue, Manhattan, New York

INCIDENT DAY AND DATE: Wednesday, July 26, 2023

TIME OF OCCURRENCE: 7:25 am
APPROXIMATE TIME DISCOVERED

ASSIGNED RUSSO INVESTIGATOR: Daniel Seeley

OFFICIAL INVESTIGATIVE AGENCY: Fire Department New York; NYC Department of Buildings; Department of Investigations
AUTHORITY HAVING JURISDICTION

DAY AND DATE OF ASSIGNMENT: Tuesday, August 29, 2023

DAY AND DATE OF INITIAL EXAM: Friday, September 8, 2023

DAY AND DATE OF RE-EXAM: Monday, September 25, 2023
Wednesday, September 27, 2023
Tuesday, October 24, 2023 (at Newark storage yard)

ORIGIN AND CAUSE CONCLUSION

Origin – Power pack (engine compartment) of crane

Most Probable Cause– Hydraulic hose failure

FIRE INVESTIGATION

A. Introduction

The New York City Department of Buildings, through Gilsanz, Murray, Steficek LLP, retained Russo Consultants to investigate a fire loss that damaged a tower crane that resulted in a failure of the crane boom. The incident occurred at 550 10th Avenue in Manhattan, New York on July 26, 2023. The crane in question was inspected by the investigation team on three separate occasions: once while still assembled and erected at the job site, once when the crane was disassembled and lowered to a lower roof setback and transport trailer, and a third time at the Newark, New Jersey storage yard. Additional information has also been reviewed and researched since the incident was assigned. The following are the results of our investigation.

B. Background Information

The incident occurred at a construction job site in Manhattan, New York on 10th Avenue, between West 40th Street and West 41st Street. The building erected on this property is to be a 45-story, multi-use building, divided into several studio, one bedroom, and two-bedroom luxury apartments. Construction began in early 2023, and the crane was delivered to the site in February 2023. When the incident occurred on July 26, 2023, the concrete structure for the building was nearing completion. The tower crane was erected on the northern side of the building footprint.

Around 7:30 am, on July 23, 2023, while the crane was in the process of hoisting a conical bucket filled with nearly 16,000 pounds of concrete, a fire originated and developed on the machinery deck of the crane. Smoke and fluid were first observed by the “signal man” observing the crane movements from the top floor of the building. The “signal man” notified the crane operator. The crane operator exited the cab and noticed fluid on the machinery deck and a fire in the Power Pack of the crane. Efforts to suppress or extinguish the fire were unsuccessful by the crane operator, and he had to abandon the crane. Due to the location and height of the crane, firefighting efforts and tactics were hindered. At some point after the fire developed and continued to burn combustible materials, fluids, and other items on the machinery deck, the luffing rope

failed, and the boom dropped and collapsed. The boom impacted another building across the street before falling onto 10th Avenue.

The crane was owned by *New York Crane & Equipment*. It was leased to *Cross Country Construction LLC* for this job. *Cross Country Construction LLC* was the designated sole operator of the crane while it was at this job site.

C. Crane Description

The subject crane was manufactured by Favelle-Favco. It was identified as a tower crane with a model number of 440D. The serial number for the crane was 1475. The crane was manufactured in 2008. It was delivered to the job site at 550 10th Avenue, Manhattan, in February 2023.

The crane is a split deck crane, meaning the machine deck was comprised of two sections, pinned and bolted together to form a larger one-piece deck. The front deck contains the slew mount, cabin, and is the section where the boom assembly attaches. The rear deck contains the counterweights, Power Pack (diesel engine), mast assembly, luff and hoist winches. The crane decks are transported separately and assembled on the job site. After a job is completed, the crane is then disassembled and placed on trailers and transported off the site.

The tower was positioned to the north of the building. Access to the tower was provided by assembled walkways between the building and the tower. Three such walkways existed at the time of the incident, with the highest at the 42nd story.

D. Origin and Cause Analysis

1. Initial Scene Examination

On September 8, 2023, the crane was examined at the job site. It had not been removed from the tower and was initially examined as it was at the time of the incident. Overall examinations of the crane revealed significant fire damage with scorching and oxidation to the back of the platform, specifically around the Power Pack region or engine compartment. No fire damage to the crane cab was noted. The boom failed and collapsed following the failure of the luffing rope. The boom had been removed from the job site before the initial scene examination was scheduled. The cab remained intact with no evidence of fire spread or significant damage in the control area.

Documentation within the Power Pack revealed extensive damage throughout this area. Most of the combustible materials had been consumed during the fire. Partial melting

to some metal components had occurred. The oil pan was partially consumed during the fire and most of the lubricating fluids eventually drained or leaked from the engine block. Closer examinations revealed no evidence of a catastrophic mechanical failure to the engine block. The observed damage to the engine was determined to be a result of the fire and not the cause.

Continued examinations within the Power Pack revealed a braided metal reinforced hose separated at a crimp fitting. The crimp fitting was at the bottom of the slew pump. The hose was determined to be a hydraulic hose. Several other hydraulic hoses with crimp fittings were observed within the Power Pack, some of which were connected to the same slew pump. These adjacent hoses were not separated from their respective crimp fittings.



1. Crimp fitting



2. Separated hydraulic hose



3. Another view of the crimp fitting

Note: The adjacent hoses in the Power Pack sustained significant damage from the incident. The steel braided webbing was severely oxidized and deteriorated, but the hoses remained attached to their respective crimp fittings. During the follow up examinations on the crane, cracks, fractures, and failures of the reinforced webbing on numerous hydraulic hoses were visible. Many of these hoses were subjected and exposed to fire conditions that weakened and compromised the integrity of the hose material and reinforcement webbing. These subsequent failures occurred because the

materials were brittle from the fire exposure, as well as the disassembly, movement, and transportation of the crane from the loss location.

The crimp fitting for the slew pump did not appear physically damaged or deformed. No denting of the crimp fitting was observed, and the attached metal tubing exhibited no evidence of impact damage. Further examinations revealed the end of the reinforced hose did not remain in the crimp fitting.

The hydraulic hose originally attached to this crimp fitting was found resting on one of the access panels for the Power Pack. Spiral delamination and separation of the braided metal webbing at the end of the hose was documented.



4. *Delamination of the braided metal webbing on the hydraulic hose*



5. Another view of the terminating end of the hydraulic hose

The engine batteries were mounted below the engine block on a small metal rack or shelf. Due to the incident and loss of integrity to the oil pan, the batteries were significantly damaged and/or consumed during the fire. One section of the primary cabling was observed on the machinery deck. No evidence of adverse electrical activity was documented on the recovered section of the primary cabling.

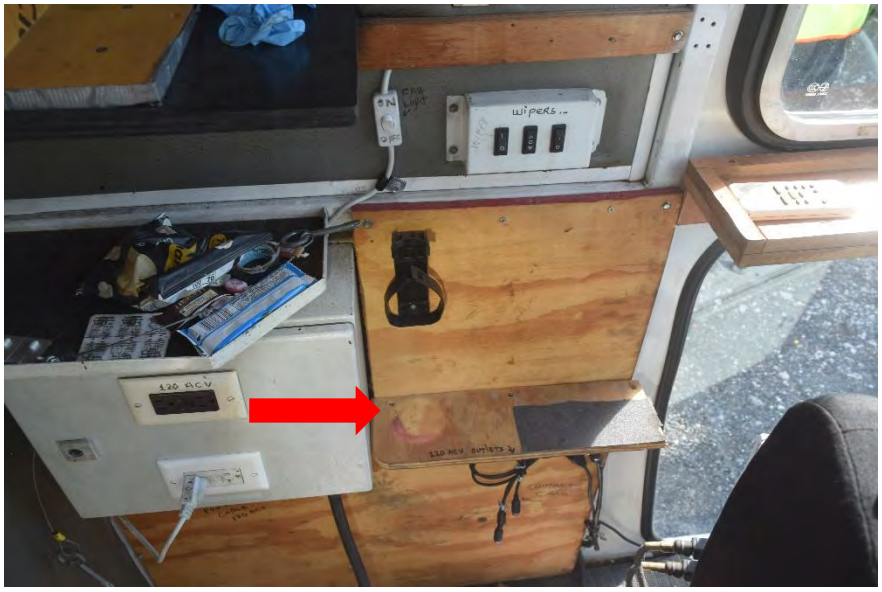
The starter for the engine had sustained significant damage as well. Due to its location within the Power Pack, the starter motor was affected by the extreme fire and heat conditions which partially melted the metal housing for the starter motor as more flammable and combustible fluids ignited. The starter motor was determined to be a victim of the fire spread and not the fire cause.

The control panel for the crane was at the back of the machine deck. The control panel sustained significant damage from the fire, and it was determined the fire communicated to, and did not originate in, the control panel.

A handheld fire extinguisher (total weight between 3 and 4 lbs.) was recovered under the hoist cable at the front of the machinery deck. This was the only fire extinguisher found or recovered on the crane. The pin was pulled, and the handle mounted gauge indicated no extinguishing agent remained in the cylinder. A second fire extinguisher was not observed or found in any of the work boxes on the machinery deck.

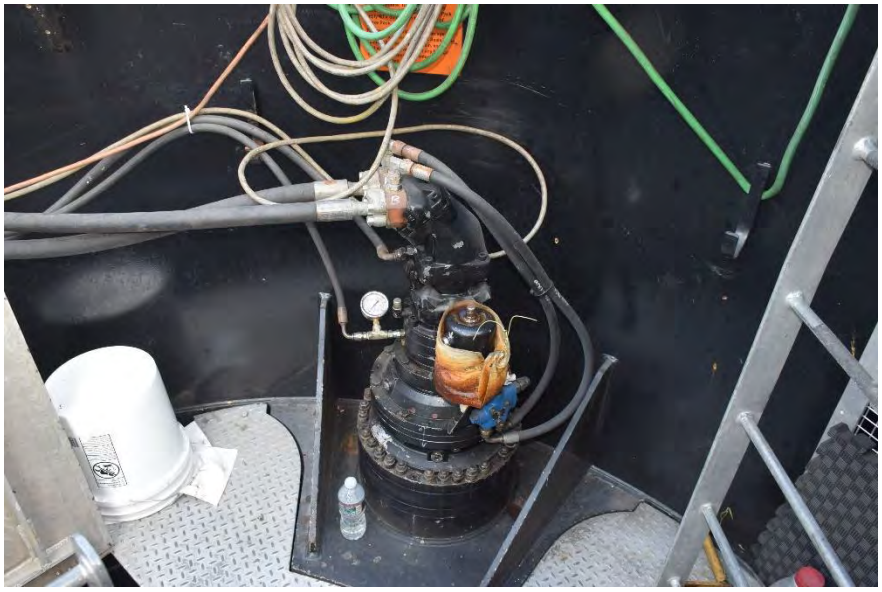


6. Fire extinguisher found on the machinery deck



7. Extinguisher bracket and protected area on shelf demonstrating the location of the fire extinguisher in the cabin

Continued examinations on the machinery deck revealed several areas where oil absorbing pads, commonly referred to as “diapers”, were placed around various pumps and hoses presumably to absorb fluid leaking from these locations. Extra oil absorbing pads were observed in various work boxes on the crane platform.



8. Fluid leakage from the main swing pump



9. Extra oil absorbing pads (aka "diapers") found in a workbox on the machinery deck

2. Examination of Crane During Disassembly

On September 25, 2023, and September 27, 2023, the crane was disassembled and lowered from the tower. The sections were placed on transport trailers and removed from the property to be held in storage in a yard in Newark, New Jersey, owned by *New York Crane & Equipment*. Prior to the dismantling of the platform of the crane, artifacts

were recovered from the crane by Frank Hegan of *Crane Tech Solutions* to prevent further destruction and/or additional damage of these items during the disassembly process. The items were secured by the New York City Department of Investigations, under the custody of Chief Investigator.

After the rear deck of the crane was removed from the tower and secured to the transport trailer on the ground, the suspect hydraulic hose connected to the slew pump was further traced out to the front of the platform.

The crimp fitting was removed from the slew pump as was the separated hose. Additionally, an exemplar hydraulic hose and associated crimp fitting were removed from the slew pump to compare with the suspect hose and fitting.



10. Crimp fitting removed from slew pump



11. End of crimp fitting



12. Delamination of the webbing on the failed hydraulic hose



13. Spiral delamination of the webbing

Note: The failed hydraulic hose and crimp fitting remain in the custody of the Department of Investigations if further testing and/or analysis is requested from any interested or involved party. The party requesting further analysis of these artifacts should provide a protocol for said examination.

Additional observations of the disassembled crane revealed the support beams below the rear machinery deck sustained significant damage from the fire. The support rails or beams for the rear deck had deflected approximately 5 inches due to the intensity of the fire. Buckling and damage to the steel deck directly below the diesel engine had also occurred.

The fire extinguisher from the crane deck was removed and secured. It was a dry chemical extinguisher with a classification of 1-A:10B-C. It was manufactured by Kidde. The weight of the extinguisher, fully charged, should range between 3 lbs. 5 oz., and 3 lbs. 12 oz. The safety pin was pulled and the gauge on the handle indicated the fire extinguisher was empty.

Note: The information on the fire extinguisher indicated it could be used on ordinary combustibles (category "A" fires), flammable/combustible liquids (category "B" fires) and electrical equipment (category "C" fires).[1] The number preceding the letter "A" is equivalent to 1.25-gallons of water. Therefore 1 = 1.25 gallons of water. The number two in front of the letter "A" would equal 2.5 gallons of water. The number preceding

[1] National Fire Protection Association 10, *Standard for Portable Fire Extinguishers;* Occupational Safety and Health Administration 1910.157, *Portable Fire Extinguishers*

the letter "B" indicates the square foot coverage for a flammable/combustible liquid. The number 10 equals 10 square feet of coverage. It does not relate to the actual weight of the extinguisher.[2]

Note: The original instruction manual for the crane provided by the manufacturer recommends "a portable fire extinguisher with a minimal rating of 10BC shall be installed in the cabin at all times."[3]

3. Joint Examination of Disassembled Crane

On Tuesday, October 24, 2023, a joint examination with multiple parties was completed at the *New York Crane & Equipment* storage yard at 86 Doremus Avenue, Newark, New Jersey. This examination provided all interested parties the opportunity to inspect the crane. The items and artifacts that were removed from the crane prior to the crane disassembly were not provided during this examination but all parties were notified of what was removed for their records.

Several hydraulic hoses were examined near the front of the crane platform. The hoses appeared to have been original manufacturer's equipment as they had a tag with "Favelle-Favco" name printed on the tag. Some tags had a date of May 2, 2008, written in permanent marker, while others had a date of August 2, 2008 written on the tag. This would suggest these hoses were the original hoses for the crane. No failures with these hoses were found. No abrasions to the outer jacket of the hoses were observed. The hoses were not manipulated, bent, or kinked in any unusual manner and no physical damage to the crimp fittings was visible.

[2] www.guardianfireprotection.com/blog/numbers-fire-extinguisher/#:~:text=The%20letter%20on%20a%20fire,C%20puts%20out%20electrical%20fires
[3] IOM1475 REV A OCT 2008



14. Tag from Favelle-Favco with the date of 5-2-08 written in permanent marker on one of the hydraulic hoses



15. Tag from Favelle-Favco with the date of 8-2-08 written in permanent marker on one of the hydraulic hoses

Unfortunately, due to the damage sustained to the subject hydraulic hose and the adjacent hoses in the Power Pack no determination could be made as to whether these hoses were original to the crane or if they had been replaced.

INTERVIEWS CONDUCTED

As part of the investigation, formal interviews with several individuals were completed to understand the circumstances leading up to the incident. The list of individuals interviewed included:

- Lift Director (LD), *Cross Country Construction*, taken December 19, 2023
- Crane Operator (HMO 1), *Cross Country Construction*, taken December 19, 2023
- Crane Operator (HMO 2), *Cross Country Construction*, taken December 20, 2023 (HMO 2)
- Maintenance Engineer, Oiler (HMO 3), *Cross Country Construction*, taken December 20, 2023 (HMO 3)
- Mechanic 1, *New York Crane & Equipment*, taken January 3, 2024
- Mechanic 2, *New York Crane & Equipment*, taken January 4, 2024 (Mechanic 2)
- General Manager (GM), *New York Crane & Equipment,* January 31, 2024

Note: This investigator was not present during the interview of GM.

From the interviews, it was disclosed the typical day would begin with a meeting between the Lift Director (LD) and the Crane Operator, Maintenance Engineer, "signal men", and other construction workers outlining the daily operation. This meeting would be held between 6:00 AM and 6:30 AM, and the crane operator would immediately go to the crane cabin.

Note: Present at the "Lift Director Daily Meeting Log (Tower Crane)" meeting on the date of the incident were HMO 2 and HMO 3.[4]

Note: The crane operations on that date were to "pour 44 [44th story] with buckets/load material to 44 slab after pour/misc. picks off preston boxes".[5]

LD recalled the "operators meeting" was held between 5:30 AM and 5:45 AM. HMO 2 was the designated Crane Operator and HMO 3 was the Maintenance Engineer or "oiler". LD believed the crane was started around 6:30 AM, and operations began around 6:50 AM to 7:00 AM. He received a call from his signalman, around 7:15 AM, informing LD that "there was smoke from the back of the crane." He left the construction shanty and entered the maintenance elevator when he received a second call from the signal man informing LD there was a fire at the back of the crane. When

[4] Cross County Construction LLC *Lift Director Daily Meeting Log (Tower Crane)*, dated 7/26/23
[5] Cross County Construction LLC *Lift Director Daily Meeting Log (Tower Crane)*, dated 7/26/23

LD arrived on the 40th floor, he met HMO 3, who was operating the crane when the incident occurred, and HMO 3 informed LD that "I really tried" to extinguish the fire.

LD recalled mechanics from *New York Crane & Equipment* had been called to the site on 5 to 6 occasions, but he could not recall the purpose for these calls. The mechanics that came to the site were either Mechanic 1 or Mechanic 2.

According to HMO 2, HMO 3 was operating the crane on the date of the incident. HMO 3 was scheduled to operate the crane for a four-hour shift, before relinquishing those duties to HMO 2 for the final four hours. HMO 1 was not present on the loss date, and was last on the job site on July 17, 2023, nine days before the incident occurred. HMO 3 was on the job site every day, whereas HMO 1 and HMO 2 would alternate days on the site. It was not uncommon for HMO 3 to share the crane operator duties with the HMO1 and HMO 2 on any given day. Depending on their schedules, the three would agree on how the crane operation duties would be divided on any given day.

The only assigned Maintenance Engineer or "oiler" was HMO 3. When HMO 3 would operate the crane, the other assigned Crane Operator would remain in the "construction shanty" in the lower level of the building under construction.

The "daily maintenance log" would be filled out by the Crane Operator on the morning of every day. On July 26, 2023, HMO 3 completed the morning inspection. No issues or problems were reported.[6]

On the morning of July 26, 2023, HMO 3 was "in the seat" and operating the crane; the operation of the day was to hoist and lift concrete to the upper floors to pour. He was using a three-yard bucket filled with concrete and raising it to the 44th floor. He believed he was on his fifth load of concrete when the incident occurred. HMO 3 received a call from his signal man indicating fluid was leaking from the crane, and almost simultaneously a hydraulic fluid indicator light illuminated on his screen. This was a low fluid light signaling the fluid level in the hydraulic tank dropped to an unsatisfactory level. HMO 3 could not recall if he turned the ignition key "off" or hit the "emergency stop" button. (Either of these two options "would cease all motion operations, applies all brakes, and shuts down the engine"[7]). He turned to the back of the crane (where the Power Pack, winches, and counterweights are found), and observed smoke from this area. He exited the cab and noticed fluid from the Power Pack area. HMO 3 returned to the cab, grabbed a fire extinguisher mounted behind the seat, and attempted to suppress or extinguish the fire. He observed flames between the engine/motor and the winch. After discharging the extinguisher, HMO 3 traveled

[6] Daily inspection information completed and submitted
[7] Favelle-Favco IOM 1475 Rev A Oct 2008, p.81

around the front of the crane and realized the fire was not extinguished. He had no other options to suppress the fire, as there was only one fire extinguisher in the cab and none on the crane platform. He immediately contacted LD to notify him to stop the traffic flow on the streets below and exited the crane.

HMO 3 indicated *New York Crane & Equipment* was contacted on at least two occasions prior to the incident for issues with the crane operation. The crane mechanic came to the site and corrected the issues. He further disclosed the mechanic was working on the pump pressures and hydraulic pumps to correct the issues.

All three of the crane operators indicated they encountered "fluid seepage" from pumps and hoses, but these issues did not rise to what they would consider a "leak". They would be concerned if they observed a puddle of fluid on the deck, but they did not observe such a condition prior to the incident. HMO 2 even indicated it is common to have seepage leaks or drips on a crane.

HMO 3 was the oiler and would complete a morning or daily check of the crane and indicated at no time did he observe a significant leak or hydraulic hose failure. None of the three crane operators noticed or observed a leak in the Power Pack region of the crane while on site.

HMO 3 did not observe or notice a separated or failed hydraulic hose when the incident occurred.

The information obtained during the interviews of HMO 1, HMO 2, and HMO 3 disclosed they were not informed of a similar event that occurred in New South Wales, Australia in 2012 prior to the incident with this crane. They have since been presented with an article about this incident. All three were also not aware of a "service bulletin" issued by *Favelle-Favco* in 2016 outlining recommendations to limit or prevent similar instances from occurring.

Commentary: HMO 1 and HMO 2 were the crane operators on the job site. HMO 3 was the designated Maintenance Engineer or "oiler". All three agreed that HMO 3 would operate the crane on numerous days and would take a four-hour shift. When HMO 3 was operating the crane, he was both the crane operator and Maintenance Engineer or "oiler" officially on duty.

HMO 1 and HMO 2 both stated there were two fire extinguishers on the crane platform when the incident occurred. One was mounted in the cab and a second was reportedly outside the cab or around the cab. This second extinguisher was a larger fire extinguisher than the one mounted in cab. In his interview, HMO 3, who was operating

the crane when the incident occurred, stated only a single handheld fire extinguisher mounted in the cab was present and available when the incident was first detected. The fire extinguisher was insufficient to extinguish or suppress the fire in the Power Pack when it was discovered by HMO 3.

While operating the crane and completing the morning maintenance inspections, all three individuals did not report any leaks from hoses on the crane or specifically within the Power Pack region of the crane. In his interview, HMO 3 disclosed he observed "seepage" from various hoses, but his determination was that it was not severe and did not require notification to his superiors or the crane owner. HMO 2 further indicated that it is normal for any crane to have some "leakage or seepage" from the hoses, connections, or fittings. All agreed if they noticed a "puddle of fluid" on the platform that they would consider that an issue which required remediation.

The two crane mechanics from *New York Crane & Equipment* that were involved with the subject crane. Mechanic 1 was on site when the crane was first assembled and returned to the site on April 4 and April 5 to replace the "encoder coupler". All other maintenance work on the crane, including the "off-line" maintenance (when the crane is not in use and is between rental contracts) and on-site maintenance at the loss location was completed by Mechanic 2. Mechanic 2 was called to the site and serviced/repaired the crane on May 5, May 10, May 15, June 5, and July 3, 2023. During these visits, Machanic 2 stated he did not observe any excessive leakage from the hoses, pumps, or fittings on the crane or in the Power Pack area. He further disclosed that for each occasion he would drive to the job site in Manhattan from the Newark, New Jersey office in a work truck which had an "EZ-Pass" tag mounted in the windshield.

Note: We have not confirmed if a vehicle was taken to the Manhattan job site on the days mentioned above. The information from the interview indicated Mechanic 2 used the same work truck vehicle.

The crane was returned from a previous rental to *New York Crane & Equipment* on May 16, 2022. The crane was completely torn down and re-assembled by Mechanic 2, starting in September 2022, and running through December 2022. The hydraulic pumps were sent out to be rebuilt and tested at a plant in Woodstock, OH. The hydraulic hoses were visually examined but found to be satisfactory. Mechanic 2 did not replace any of the "bigger" hydraulic hoses on this crane.

Note: Undamaged hoses remaining with the crane had labels from the manufacturer, indicating they were manufactured in 2008, and most probably, original to the crane assembly.

While at the Manhattan job site on those several occasions, Mechanic 2 disclosed the crane was never shut down or taken out of operation for repairs during working hours.

Both crane mechanics stated they were not alerted or advised of a service bulletin issued by the crane manufacturer, *Favelle-Favco*, prior to the incident. They received a copy of the bulletin, issued in 2016, after the incident in July 2023. Mechanic 1 disclosed he received the bulletin from his employer, GM. Mechanic 2 stated he was provided a copy of the bulletin from a "guy at the shop". Both men further stated that the recommendations in the service bulletin have been implemented in several other cranes owned by *New York Crane & Equipment* since the fire in 2023. This would include relocating the batteries, replacing any rubber hoses in the Power Pack area of the crane, installing an aftermarket fire suppression system, and installing a fire detection system.

Commentary: *New York Crane & Equipment* has two dedicated mechanics for their tower cranes. The crane involved in this incident, serial number 1475, was overhauled by Mechanic 2. He was assigned to tear down the crane and rebuild it when it was returned to the owner from its previous rental. In his interview, Mechanic 2 indicated the hydraulic pumps were removed and sent to an authorized company for a complete rebuild. The hydraulic hoses were visually inspected but never replaced. Other hydraulic hoses on the crane had tags or labels from the manufacturer with a date code of 2008. It is quite possible the failed hose was part of the original manufacturer's equipment.

Neither of the two dedicated crane mechanics were provided a copy of the service bulletin issued by the *Favelle-Favco* in 2016, prior to the incident of this crane in 2023. This service bulletin was in response to a similar incident in Australia with a *Favco* crane. The mechanics were only provided a copy of the service bulletin after the July 2023 incident. Since this incident occurred, *New York Crane & Equipment* has begun to implement the recommendations offered in the service bulletin. One of the primary recommendations is for an aftermarket fire suppression system to be installed in the Power Pack area. Additional recommendations included having 2-20 LB fire extinguishers available for the crane operator and a fire detection monitoring system, to notify the crane operator of a potential fire. This system is to alert the operator both visually and audibly.

ADDITIONAL MATERIALS REVIEWED

Additional materials and/or documents were also reviewed and are highlighted below.

A. News Articles and Video Images

The incident was captured on video and was a major news story in New York City. Many of the videos and stories were posted on the internet via *YouTube* or other social media outlets. All the photos clearly show a fire at the back of the crane around the Power Pack before the boom drops and collapses. The fire burns for several minutes before the boom eventually fails. As the boom drops, it impacts a building across the street and falls directly onto 10th Avenue.

B. Crane History

The history of the crane was outlined in a letter dated January 3, 2023, from Sal Isola, general manager, *New York Crane & Equipment Corporation* to the New York City Department of Buildings, Cranes and Derricks unit. The timeline provided the following dates the crane was rented, the job locations, and the names of the companies that rented the crane:

- December 16, 2017 - January 28, 2019 - Crane was rented to *Cornell & Company Inc.* and was operating at 74 Trinity Place, New York City.
- January 2019 – May 30, 2019 – Crane returned to a storage yard at 9 Albert Avenue, Newark, New Jersey
- May 31, 2019 - November 9, 2019 - Crane was rented to *High Rise Safety* and was on a job site at 202 Broome Street, New York City.
- November 2019 – November 13, 2020 – Crane returned to the storage yard at 9 Albert Avenue, Newark, New Jersey
- November 14, 2020 - May 15, 2022 - Crane was rented to *Sorbara Construction*, and operated at a job site at 1568 Broadway, New York City.
- May 16, 2022 – Returned to storage yard at 9 Albert Avenue, Newark, New Jersey.[8]

No reported issues with the crane were documented at these previous sites.

C. Crane Service and Maintenance

The crane underwent service and maintenance repairs as it was in storage between May 16, 2022, and January 3, 2023. The maintenance records reviewed indicated the same individual was handling the maintenance and servicing for *New York Crane & Equipment*. This individual was identified as Mechanic 2. The maintenance/servicing included:

[8] New York Crane letter dated January 3, 2023 to NYC Department of Buildings, Cranes and Derricks Unit

- September 15, 2022: Installed all hydraulic pressure hoses on boom hoist and swing pumps

Note: The "swing" pump is another name for the "slew" pump

- September 20, 2022: Replaced a boost pressure hose from boom hoist pump (it was cracked and leaking)
- September 21, 2022: Refill hydraulic oil tank with NUTO-46 hydraulic oil (5 barrels – 275 gallons)
- December 19, 2022: 1. Checked all tower crane components for 3rd party inspection.
  2. Replace pump drive gearbox Lube hose (was leaking)
- January 19, 2023: Reset and tighten all hydraulic pressure hoses on climber and shipping to NYC job site.

Note: There were several other invoices presented and reviewed, but the highlighted invoices involved the hydraulic pumps and hoses

The crane manufacturer outlines or recommends routine maintenance while the crane is in operation and use. This includes daily maintenance checks, monthly maintenance checks, annual maintenance checks, and maintenance checks every 100 hours. The daily maintenance checks are for the crane operator or onsite maintenance personnel. The provided checklist is divided into three sections: "prior to engine start", engine start" and "during warm-up". Before the engine is started, the operator should check for any leakage of fluid (oil) around the Powerpack or winch.[9] After the engine has started and it is warming up, the hydraulic piping and hoses should be checked for leakage as well, and the oil levels (including engine oil and hydraulic drive units) should be checked.[10]

After 100 hours of operation, the "general service" of the crane includes, draining one liter of hydraulic fluid from the tank to remove any condensed water that has collected in the tank, comparing the tank oil with a sample of "new" oil, checking for external leaks, and visually inspecting the hoses for chafing or physical damage.[11] Any leaks should be remedied immediately.

Note: No records were provided demonstrating fluid was drained from the hydraulic tank at any time while the crane was at 10th Avenue job site.

[9] Favelle-Favco IOM 1475 Rev D, Section 3.5.1, A
[10] Favelle-Favco IOM 1475 Rev D, Section 3.5.1, C
[11] Favelle-Favco IOM 1475 Rev A, Oct 2008 (original manual)

Note: During their respective interviews, the mechanics from New York Crane & Equipment, were not familiar with this recommendation.

The crane operator experienced and reported issues with the hydraulic system while the crane was in operation on at least five separate occasions: May 5, May 10, May 15, June 5, and July 3. The incident occurred on July 26. Based on the received paperwork, the diagnosis and repairs to the crane was completed by the same mechanic from *New York Crane & Equipment* that serviced the crane while it was in the Newark storage yard.

The first issue with the crane occurred on May 5, 2023. The problem reported was the "main hoist surging sometimes on the way up while concrete bucket is on hook." The mechanic checked the hydraulic pressure settings on the main hoist motors and reset the override pressure from 1500 PSI to 2000 PSI. He also readjusted the boost pressure on the main and auxiliary boom hoists to 35 bar on the pressure gauge from 29 bar. After the repairs, the crane was tested, and the hoist was able to lift 15,000 pounds.[12]

Note: One bar of pressure equals 14.5 pounds per square inch. Therefore 29 bar equals 420.5 pounds per square inch (psi) (29 x 14.5); 35 bar equals 507.5 psi.

Note: The invoice indicated the crane had 18,468 hours of service. It was delivered to the job site with 17,847 hours of service. Therefore, between the start date on this job, February 8, 2023 and May 2023, the crane operated approximately 621 hours. No records demonstrate the hydraulic fluid was drained or sampled during this time.

The second issue was recorded on May 10, 2023. The service call was for the "tower crane [has] low speed while cabling up on the main hoist with concrete bucket on it." The hydraulic pressure setting on the main and auxiliary pumps was tested and readjusted. The mechanic also performed a visual inspection on the tower crane components prior to leaving the site.[13]

Note: The service hours on the crane were not recorded by the mechanic.

On May 15, 2023, the crane was experiencing a similar issue. The mechanic described the issue as "tower crane main hoist with slow speed while lifting 15,000 pounds on hook." The mechanic installed a hydraulic pressure gauge on the main hoist motors to collect data on the system which was then forwarded to the manufacturer. A *Favco* representative evaluated the data and instructed the mechanic how to remedy the

[12] New York Crane work invoice dated 5/5/23
[13] New York Crane work invoice dated 5/10/23

problem. The hydraulic pressure was raised from 300 bar to 350 bar (4,350 PSI to 5,075 PSI) in the system and the hydraulic boost was elevated 10 bar (145 PSI). The hydraulic pressure to the motors was elevated from 1500 PSI to 2000 PSI. After these repairs were completed, the crane was again tested and found to function with the proper torque and speed.[14]

Note: The service hours for the crane on this date were 18,525. The crane only operated 57 hours between May 5 and May 15.

On June 5, 2023, the crane operator reported another issue while the crane was in operation. The issue was recorded by the mechanic that "from time to time while tower crane pouring concrete with 14,000 concrete bucket on hook hydraulic oil temperature alarm came on display." The mechanic reset and adjusted the hydraulic input pressure to the hydraulic cooler motor from 35 bar pressure to 50 bar pressure (507 PSI to 725 PSI). The temperature of the oil and reportedly dropped as the pressure was raised.[15]

Note: The crane had 18,661 service hours recorded on this date. The crane operated 136 hours between May 15 and June 5.

The final service call was on July 3, 2023. The issue recorded was the "main hoist (low line) surging while cabling up full concrete bucket (16,000 lbs., pouring concrete) and the hydraulic oil temperature build up." The mechanic checked the pressure settings on the main hoist motor and monitored the main hoist while the crane was in use pouring concrete. The speed for the main hoist motors were reset.[16]

Note: The recorded service hours on this date were 18,840. The crane operated 179 hours between June 5 and July 3.

Commentary: The crane was experiencing several issues between May 5 and July 26 while hoisting or lifting a bucket filled with concrete. Over 11 weeks, at least five occasions were recorded by the crane operator to *New York Crane & Equipment* involving speed control and surging while the crane was lifting concrete. On each occasion, the mechanic from *New York Crane & Equipment* examined the hydraulic systems and equipment and altered or adjusted the pressure in the hydraulic system for the main hoist and auxiliary pumps. On two occasions, the May 15 service call, and the June 5 service call, the mechanic either forwarded information to a representative from the manufacturer or consulted with a representative for the manufacturer. The

[14] New York Crane work invoice dated 5/15/23
[15] New York Crane work invoice dated 6/5/23
[16] New York Crane work invoice dated 7/3/23

manufacturer representative provided his analysis and thoughts on how to repair or remedy the reported issue.

It does not appear any issues were reported with the operation of the slew pump or the operational pressures.

Information on the incident date indicated the crane was hoisting or lifting a full load of concrete when the crane operator was alerted by a warning light on the crane monitor while almost simultaneously receiving a call from his signal man of smoke from the rear of the crane. The crane operator observed smoke and fire around or at the Power Pack of the crane. The crane operator noticed fluid on the machinery deck and noticed the site glass for the hydraulic tank was empty before he had to evacuate the machine deck.

The service records indicated the crane was equipped with a 275-gallon capacity hydraulic fluid tank. Before it was delivered to the job site, the crane owner filled the tank with Exxon/Mobil NUTO 46 hydraulic fluid.[17] The provided service records do not demonstrate the hydraulic fluid was removed and analyzed as per the crane manufacturer's recommendations.

The Safety Data Sheet (SDS) specifies the hydraulic fluid has a flash point greater than 414º Fahrenheit with the flammable limits between .9 and 7.0 percent per volume of air. There is no determinable auto ignition temperature (AIT). Unusual fire characteristics or hazards listed on the SDS sheet states "pressurized mists may form a flammable mixture."[18]

Commentary: The flash point of a liquid is "lowest temperature, as determined by specific laboratory tests, at which the liquid gives off vapors at a sufficient rate to support a momentary flame across its surface."[19] However, the laboratory test does not replicate the conditions or factors involved in this fire incident. The hydraulic fluid in this case was under significant pressure and not stationary in a container or reservoir. The SDS sheet for this product warns that the fluid can achieve a flammable mixture in a mist form and under pressure.

The National Fire Protection Association 921, *Guide for Fire and Explosion Investigations* state "atomized liquids or mists (those having a high surface area to mass ratio) can be more easily ignited than the same liquid in the bulk form. In the case of sprays or mists, piloted ignition can occur at temperatures below the published

[17] This information was obtained from the New York Crane & Equipment service invoice dated September 21, 2022
[18] ExxonMobil Safety Data Sheet for product NUTO H 46, June 11, 2021
[19] National Fire Protection Association 921, *Guide for Fire and Explosion Investigations,* Chapter 3.3.92, 2021 ed.

flashpoint of the bulk liquid, and even very high flashpoint liquids (several hundred degrees °C) have been shown to be ignitable when in the form of spray."[20]

Furthermore, the Power Pack has elevated temperatures present while in operation. This would include the exhaust manifold and the turbocharger. In fact, NFPA 921 outlines that "the turbocharger housing and exhaust manifold feeding the turbocharger are the hottest external points on an engine. These high temperature surfaces can ignite fuels and other combustible materials under certain conditions."[21]

A failure or rupture of a fluid carrying hose results in an atomized spray of the fluid which can easily ignite off a hot surface or component within the Power Pack. The hot surfaces in the Power Pack would include the exhaust system, exhaust manifold, and/or the turbocharger.

D. Fire Safety

A similar incident occurred to a *Favelle-Favco* tower crane in Australia. The incident was investigated, and the final findings were issued on August 25, 2015, by Magistrate Helen Barry of the State Coroner's Court of New South Wales. The circumstances of the incident recorded on November 27, 2012, indicates that a fire originated and developed within the Power Pack of the crane which subsequently led to a secondary failure of the boom. The cause of the fire was not determined conclusively but potential fire causes included a leak in the hydraulic system, a leak with the turbocharger feed oil tube, or a failure in the pressurized diesel fuel lines. The escaping fluid from one of these three sources contacted a competent ignition source such as a live spark or a hot part (hot surface) of the mechanism (i.e. turbocharger).[22]

Because the fire originated within the Power Pack as it intensified, the support "luffing cables" were affected by the heat of the fire and failed, leading to the collapse of the "jib" or boom.

In response to the investigation, *Favelle-Favco* issued an "Engineering Bulletin", FFCA-EB-030, effective for "all *Favelle-Favco* diesel/hydraulic tower cranes operating outside Australia". The effective date of this bulletin is January 7, 2016. The three-page document outlines "immediate actions" to be taken by crane owners, and "longer term actions" that can be addressed when a crane is in storage or undergoing an "in-yard" service.[23]

[20] National Fire Protection Association 921, *Guide for Fire and Explosion Investigations,* Chapter 5.7.3.3, 2021 ed.
[21] National Fire Protection Association 921, *Guide for Fire and Explosion Investigations,* Chapter 26.5.1.6, 2021 ed.
[22] State Coroner's Court of New South Wales, Inquiry UTS Fire 27 November 2012, file number 2012/383995
[23] Favelle-Favco Engineering Bulletin, reference number FFCA-EB-030

The immediate actions to be undertaken by the crane owner involve their daily maintenance regimen including removing extraneous materials left within the Power Pack area, inspecting battery cables connections, and looking at hoses and fittings for leaks. The bulletin further requests the owners and/or operators to inspect the fluid carrying hoses in use and if necessary, wrap the hose with a fire blanket or replace it with a hose that has a proper fire-rating. The manufacturer further recommends "owners/operators to have at least two 9kg Class "B" fire extinguishers available on the machinery deck of the crane."[24]

The longer-term actions offered by the manufacturer include relocating the batteries, providing better protection for electrical connections, installing battery isolators, use of threaded sealants on piping, installation of a fire detection system in the Power Pack of the crane, and the installation of a plumbed fire suppression system in the Power Pack of the crane, with the nozzles directed toward areas where fluids could potentially pool if leaking from a hose or component. The fire detection system should also have audible and visual devices or alarms to notify the crane operator as they are usually not facing the direction of the Power Pack.[25]

The New York City Fire Code does mandate an operational fire extinguisher on tower cranes. The extinguisher is to be "a carbon dioxide, dry chemical or equivalent fire extinguisher [that] must be kept in the cab or vicinity of the crane or derrick".[26]

Commentary: The recommendations offered by the crane manufacturer stem from a similar event that occurred in Australia in 2012, where a fire developed in the Power Pack and could not be suppressed by the crane operator. The fire led to the failure of the "luffing cables", causing the "jib" or boom to drop and collapse. Recommendations were offered to prevent repeat incidents.

The incident at 550 10th Avenue, Manhattan, also had the fire originate within the Power Pack while the crane was in operation. The crane operator unsuccessfully attempted to suppress the fire. As the fire intensified, the boom failed and collapsed.

Note: An independent engineering analysis of the boom failure will be addressed by Frank Hegan, Crane Tech Solutions.

Our examination of the crane revealed a fire detection system or fire suppression system were not installed in the Power Pack area as recommended by the manufacturer in 2016. The disregard of the manufacturer's recommendations provided this incident in

[24] Favelle-Favco Engineering Bulletin, reference number FFCA-EB-030
[25] Favelle-Favco Engineering Bulletin, reference number FFCA-EB-030
[26] 1 RCNY Chapter 3300, Section 3319-01 – Cranes and Derricks, (s) – Miscellaneous, (10) – Fire extinguishers

Manhattan, in 2023, to mirror the incident in Australia in 2012. No audible or visual alarms or detectors were in the crane operator cabin. The operator of the crane, HMO 3, was alerted to the incident when he received a call from his "signal man" and when a sensor monitoring the hydraulic fluid level in the tank activated. According to the information obtained from the crane owner, this crane has been in storage for extended periods of time from 2017 to 2023 (5 months in 2019, 12 months between November 2019 to November 2020, and seven months between May 2022 to January 2023). The installation of a fire detection system and/or fire suppression system could have been completed in the time the crane remained in storage.

Aftermarket fire suppression systems are available and are marketed for heavy machinery equipment. These systems include automatic and manual activation devices. The systems usually include several manual activation buttons, both in the cab and at remote locations from the cab. The systems also include alarms sensors and devices to notify the operator of a system activation. The location of the suppression nozzles is engineered specific to the style of equipment and are designed for optimal coverage, as well as immediate and automatic shutting down the engine operation. These systems are designed to prevent fire growth and spread from its origin.

Although the fire detection and fire suppression systems were longer term remedies offered by the manufacturer to follow, even the "immediate action" recommendations were not followed, especially in the "fire extinguishing" department. The crane operator only had a single, handheld fire extinguisher at his disposal when the incident occurred. The manufacturer recommends at least two 9kg, Class "B" fire extinguishers be available on the crane deck to suppress and limit the spread of a fire that may develop on the platform.

Note: In Australia, a 9kg extinguisher represents the capacity of the fire extinguisher. The nominal weight of an extinguisher of this size is approximately 13.5 kg or nearly 30 pounds. The handheld fire extinguisher on the subject crane was well below the size recommended by the manufacturer, weighing less than four pounds. During the examination, we recovered only one extinguisher on the crane deck. The manufacturer recommends two 9kg class "B" fire extinguishers.

E. Independent Testing Results

The hydraulic fluid samples removed from the crane by Frank Hegan, *Crane Tech Solutions*, were submitted for testing at *Analytical Testing Services Inc.* Of the five

samples submitted, the Autoignition Temperature[27] (AIT) ranged between 360° C (680° F) to 369° C (696.2° F). The Flash Point[28] ranged from 240° C (464° F) to 244° C (471.2° F).[29]

Commentary: The submitted samples of the hydraulic fluid recovered from the crane and its components have an auto ignition temperature that ranged 9°C to 16°F while the flashpoint had a range of 4°C to 7°F. The hydraulic fluid was stated to be *Exxon/Mobil NUTO H46.* The manufacturer does not provide an Autoignition Temperature in the *Safety Data Sheet* but lists the Flash Point above 212°C (414°F), which is consistent with the testing results.

AUTHORITIES RESEARCH

The fire alarm call was recorded at 7:25 AM. The box number was 0782. The initial call was for a "crane on fire on top of 47 story building." At 7:33 AM, the fire department issued an "urgent" call due to "a collapse of the crane onto 10th Avenue." At 8:42 AM, the incident was a "five alarm" fire call.[30]

Preliminary information from the Bureau of Fire Investigations has disclosed the assigned Fire Marshal on this incident is Robert Alphonse. The BFI file number is 10440. We have not received a copy of his findings to date.

ANALYSIS AND CONCLUSION

Based on the examinations of the crane, evaluations of the fire, heat, and smoke patterns, review of documentation forwarded, research completed, and information to date, the following are the opinions of this organization regarding the fire that damaged a construction crane at 550 10th Avenue, Manhattan, New York, on July 26, 2023:

- While the crane was lifting mixed concrete in a large bucket, the fire originated on the machinery deck of the crane.
- The fire was determined to have originated in the Power Pack/engine compartment.

[27] National Fire Protection Association 921, *Guide for Fire and Explosion Investigations* defines Autoignition Temperature as "the lowest temperature at which a combustible material ignites without a spark or flame." Chapter 3.3.17, 2021 ed

[28] NFPA 921 defines Flash Point (of a Liquid) as "the lowest temperature of a liquid, as determined by specific laboratory tests, as which the liquid gives off vapors at a sufficient rate to support a momentary flame across its surface." Chapter 3.3.92, 2021 ed

[29] *Analytical Testing Services, Inc*, ATS Lab ID 115916-115920

[30] Information was obtained from unofficial FDNY website, *NYC FireNet.*

- Physical evidence of a separation or failure to a hydraulic hose was observed in the Power Pack.
- A separation or failure of a high-pressure hydraulic hose would introduce atomized fluid into the Power Pack. A hot surface on the engine is a competent ignition source for the atomized fluid.
- The rapid growth of the fire is consistent with a dispersed fuel package, such as atomized fluid from a ruptured or failed hose.

Note: The age of the hydraulic hose that failed has not been confirmed. The hydraulic hose was not recently replaced. Statements provided by the crane ownership and mechanics suggest the failed hose may date back to 2011 or may be original to the age of the crane (2008). Other hydraulic hoses on the crane had tags that dated back to the year 2008.

- The fire burned long enough to compromise the luffing cable and resulted in a failure and collapse of the boom.

Our examination and analysis have identified factors that allowed greater fire propagation, damage, and spread to include:

- The Power Pack/engine compartment had not been retrofitted with an automatic suppression system, as recommended by the manufacturer of the crane, via their Engineering Bulletin FFCA-EB-030, issued in January 2016
- No fire detection system was installed on the crane. No audible devices or visual devices were found on the crane.
- Only a single handheld fire extinguisher was supplied to the crane operator, which was insufficient to suppress the fire.

Note: The manufacturer recommended a fire detection system should be installed on older cranes as well as a fire suppression system in the Power Pack in 2016. These recommendations were primarily based on an investigation of a similar incident in 2012. The manufacturer also recommended that at least two 9kg, class "B" fire extinguishers are available on the crane deck or platform. The only extinguisher found in this case was a small handheld extinguisher, which was undersized per the recommendations by the manufacturer in 2016.

Russo Consultants reserves the right to amend and/or supplement this report if additional information, documentation, or evidence becomes available.

Respectfully submitted,

T J RUSSO CONSULTANTS, LLC

Daniel Seeley

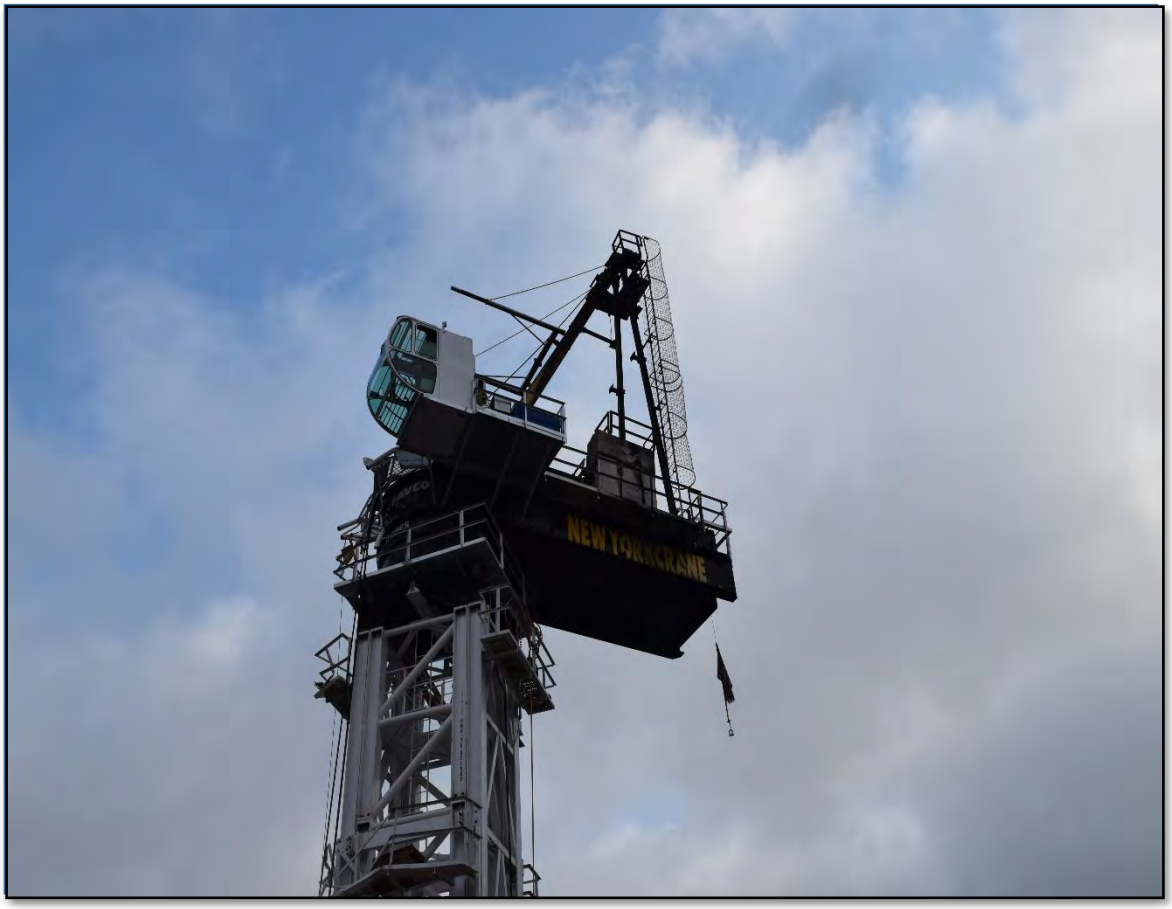
CFEI, CVFI, CFII
Fire Investigator

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PHOTOGRAPH 1

DESCRIPTION

Crane above top floor of building



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PHOTOGRAPH 2

DESCRIPTION

Fire damage to the crane

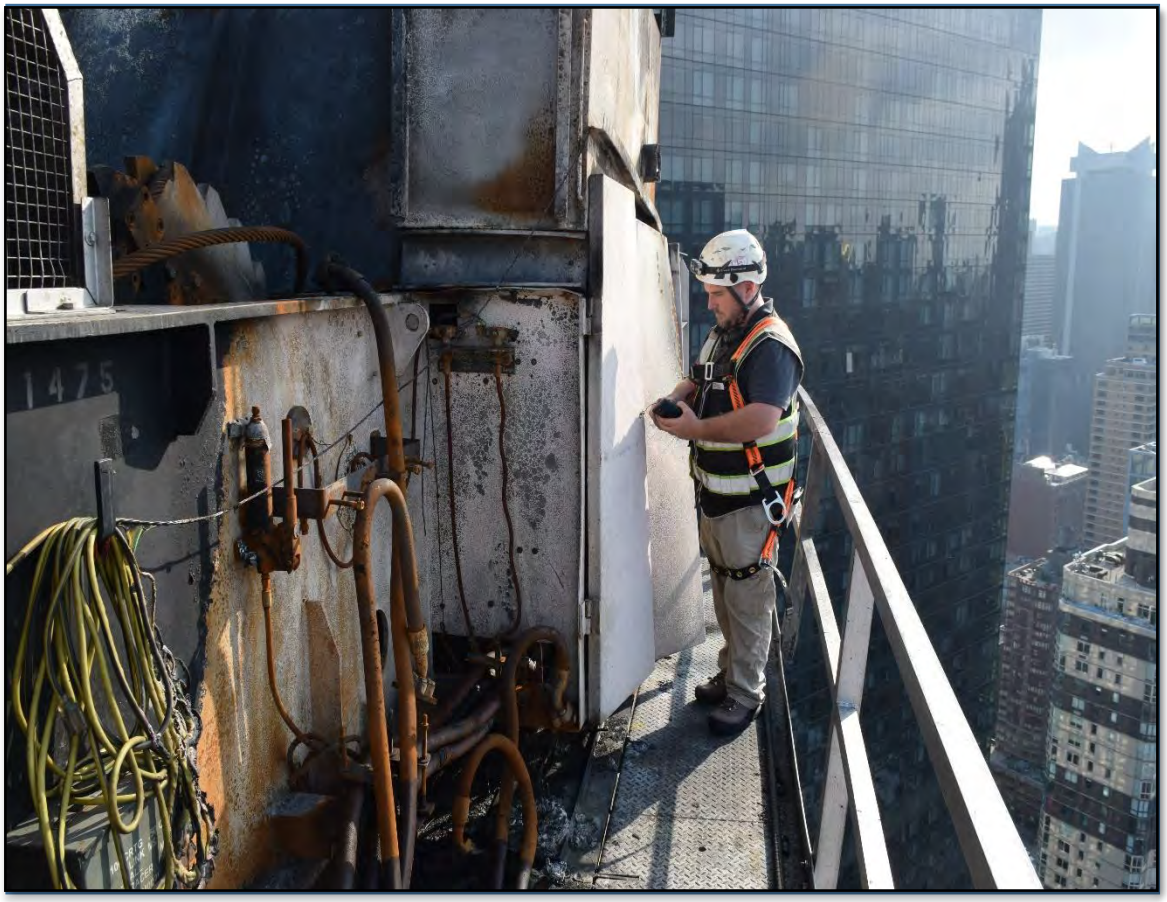


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PHOTOGRAPH 3

DESCRIPTION

Scorching to the crane at Power Pack



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PHOTOGRAPH 4

DESCRIPTION

Fire patterns from the Power Pack to the front of the crane



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PHOTOGRAPH 5

DESCRIPTION

Interior of the access panel for the Power Pack



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PHOTOGRAPH 6

DESCRIPTION

Separated hydraulic hose



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PHOTOGRAPH 7

DESCRIPTION

Closer view of the delamination of the steel webbing



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PHOTOGRAPH 8

DESCRIPTION

Crimp connection to the slew pump



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PHOTOGRAPH 9

DESCRIPTION

Arrow highlighting the crimp connection from the access panel

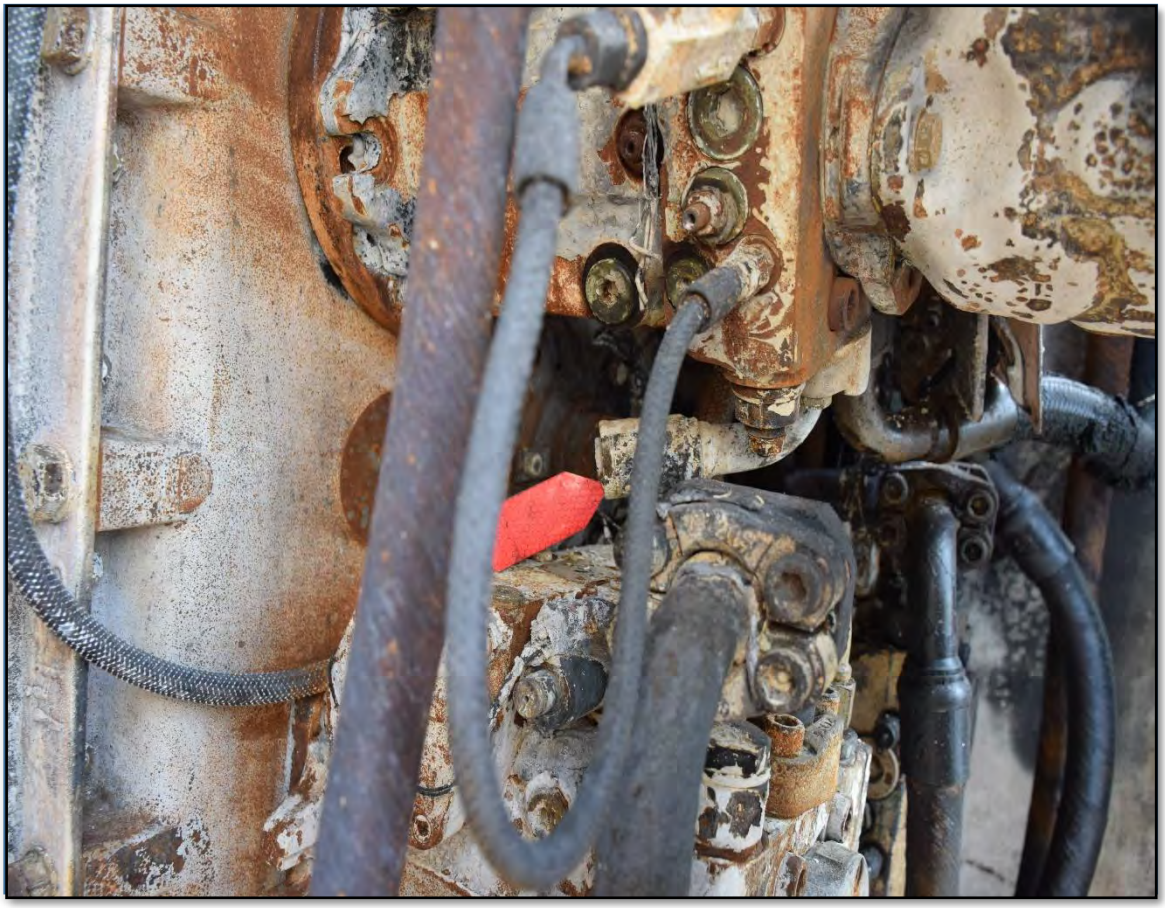


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PHOTOGRAPH 10

DESCRIPTION

Another view of the crimp connection



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PHOTOGRAPH 11

DESCRIPTION

Tracing the separated hose

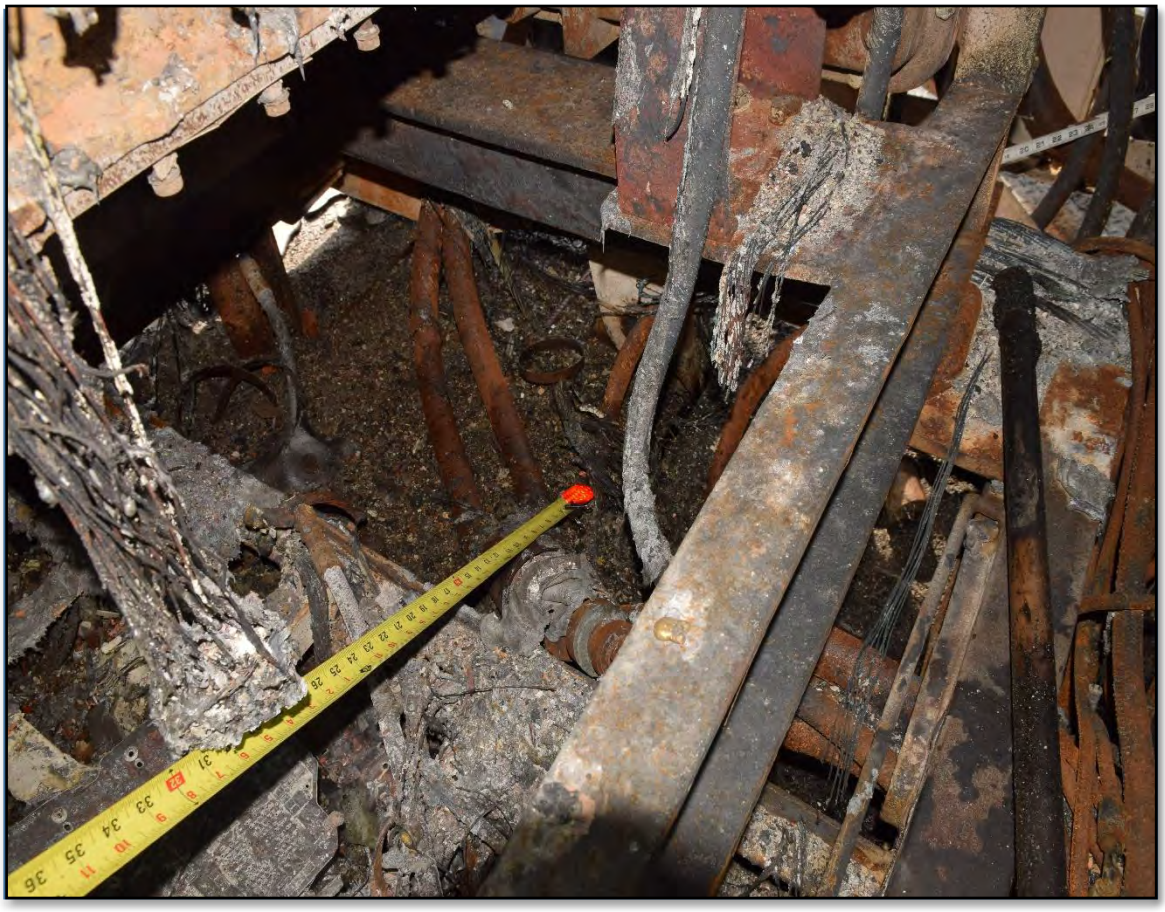


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PHOTOGRAPH 12

DESCRIPTION

Highlighting the separated hose as it ran below the diesel engine



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PHOTOGRAPH 13

DESCRIPTION

Red arrow highlights starter motor; yellow arrow highlights primary battery cable



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PHOTOGRAPH 14

DESCRIPTION

Another view of the separated hydraulic hose. Yellow arrow highlighting the damage to the oil pan



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PHOTOGRAPH 15

DESCRIPTION

Components recovered from the crane before it was disassembled



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PHOTOGRAPH 16

DESCRIPTION

Hydraulic hose and fitting from slew pump



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PHOTOGRAPH 17

DESCRIPTION

Crimp connection on the fitting



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PHOTOGRAPH 18

DESCRIPTION

Crimp connection exhibiting no physical damage or bending



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PHOTOGRAPH 19

DESCRIPTION

Another view of the crimp connection



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PHOTOGRAPH 20

DESCRIPTION

Delamination of the webbing for the hydraulic hose



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PHOTOGRAPH 21

DESCRIPTION

Recovered fire extinguisher

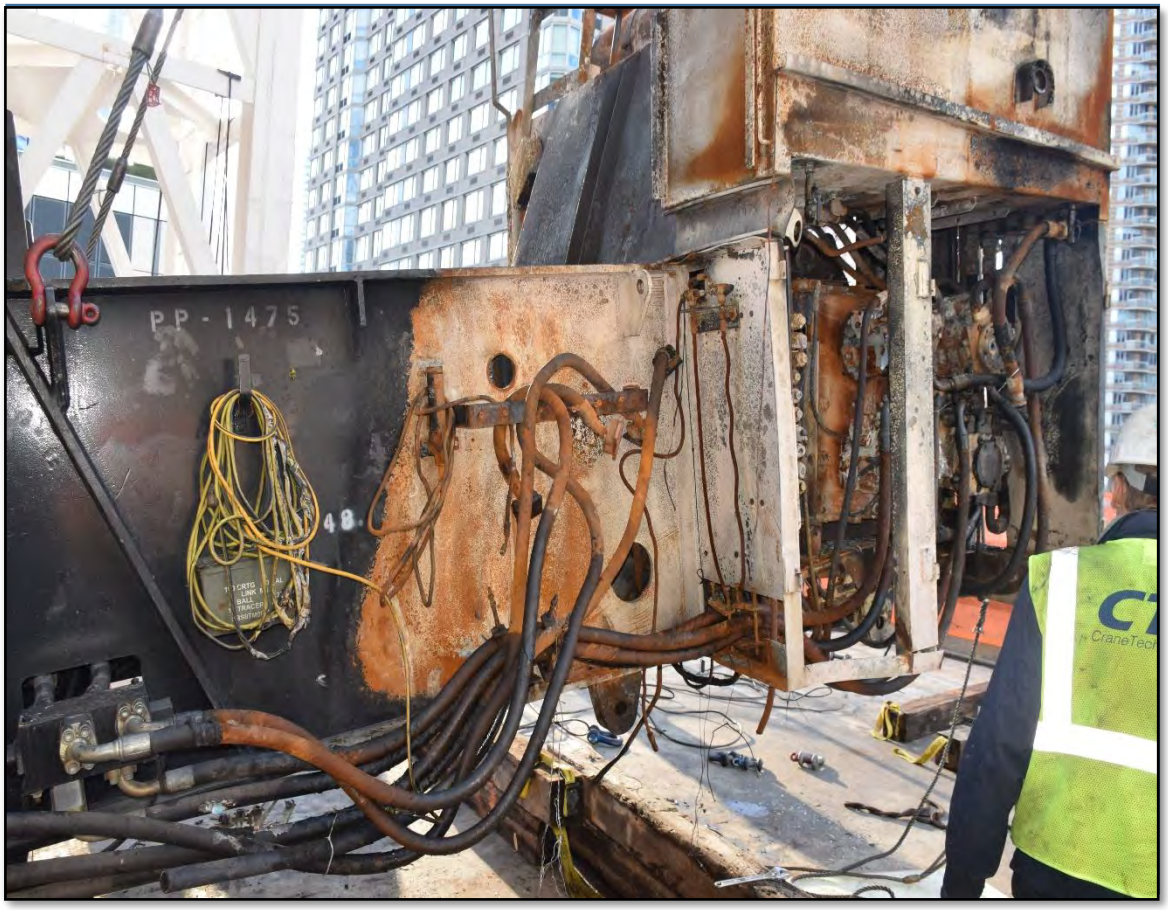


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PHOTOGRAPH 22

DESCRIPTION

Damage to the rear crane section and Power Pack region



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PHOTOGRAPH 23

DESCRIPTION

Further detailing the damage to the Power Pack region of the crane



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PHOTOGRAPH 24

DESCRIPTION

Crane sections loaded on transport trailer



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PHOTOGRAPH 25

DESCRIPTION

Opposite side of the crane on transport trailer



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PHOTOGRAPH 26

DESCRIPTION

Directional fire pattern on crane section demonstrating the fire spread from the Power Pack to the front of the crane



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PHOTOGRAPH 27

DESCRIPTION

Further detailing the separation of the hydraulic hose from the crimp connection

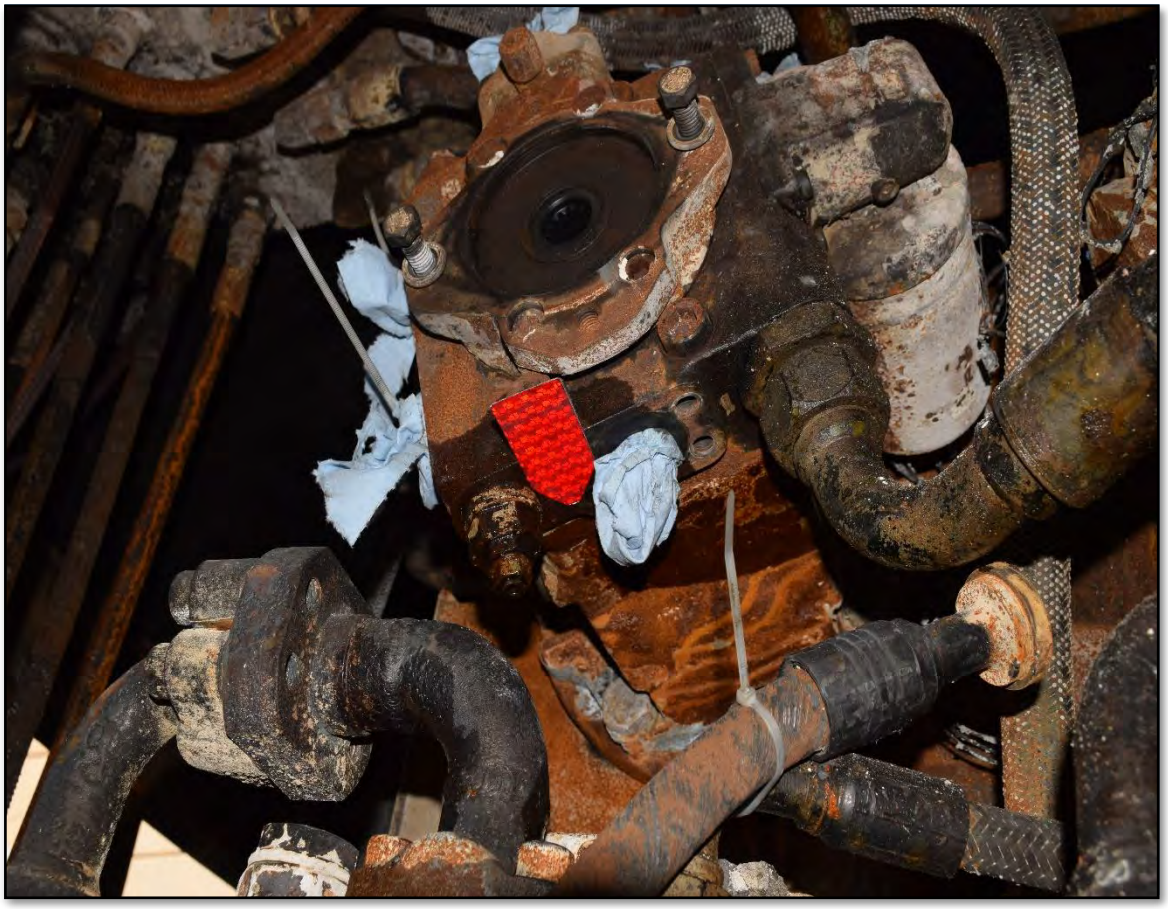


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PHOTOGRAPH 28

DESCRIPTION

Original location of the fitting on the slew pump



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PHOTOGRAPH 29

DESCRIPTION

Hydraulic hose marked after failed section recovered



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PHOTOGRAPH 30

DESCRIPTION

Tracing the failed hose



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PHOTOGRAPH 31

DESCRIPTION

Damage within the Power Park. Arrows highlighting damage to the oil pan



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PHOTOGRAPH 32

DESCRIPTION

Slew pump. Note the other hydraulic hoses that are not separated

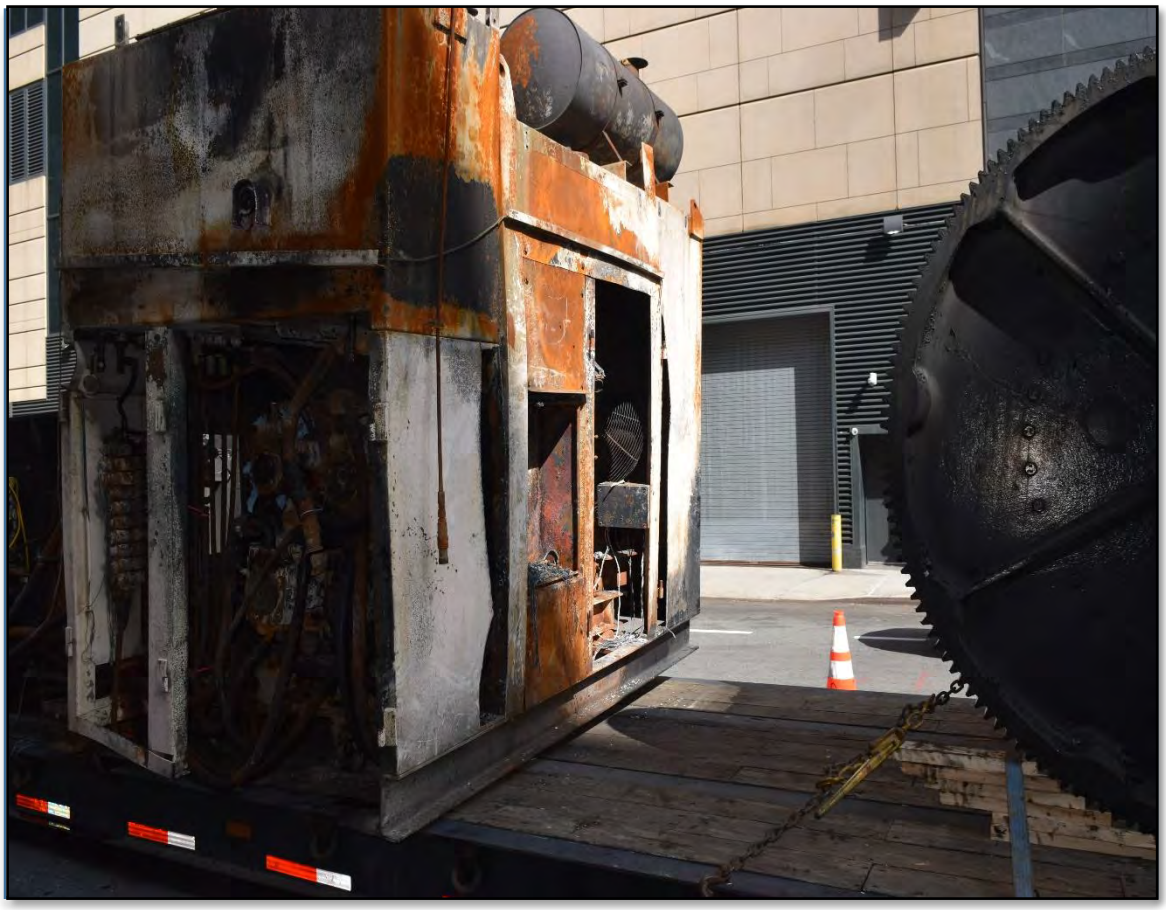


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PHOTOGRAPH 33

DESCRIPTION

Back of the Power Pack enclosure



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PHOTOGRAPH 34

DESCRIPTION

Location of the main electrical panel



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PHOTOGRAPH 35

DESCRIPTION

Damage within the main electrical panel



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PHOTOGRAPH 36

DESCRIPTION

Turbo charger



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PHOTOGRAPH 37

DESCRIPTION

Another view of the turbo charger



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Origin and Cause Determination Report - Is a summary reports designed to communicate our findings, cover the file in a timely manner and to save the expense associated with full narrative style reporting. The findings do not include all the data collection and/ or analysis conducted during the course of our investigation. All data, notes and digital documentation obtained during the course of our analysis will be maintained at our offices and can be compiled into a more detailed report "at any time" in the future.

REPORTS - In the event that you require a more detailed written report of our findings, we offer a Full Narrative Report. Our Full Narrative Report is a compilation of the data collection, examination narratives, statements, scene sketches, exhibits, photographs in sequence with narratives and expanded conclusions.

CAUSE CLASSIFICATIONS - Undetermined and Apparent Classifications include possible and probable levels of certainty. If either classification is opined and new information or evidence is developed or received by the undersigned, the aforementioned will be reviewed in order to ascertain whether or not the data impacts the opinions or conclusions. The determinations, conclusions and opinions contained in this summary are based upon the evidence developed during the course of our investigation and to the date of these findings. In the event that "new evidence" is developed or received, we reserve our right to amend our findings.



PHOTOGRAPHS - All additional photographs and digital documentation taken during the course of our investigation are retained in our offices, backed up remotely on secure servers and available to you "at any time." In the event you need pictures at this juncture for any reason, just reply to this correspondence and our office will link you to them for download (or send by any means you request).

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EVIDENCE STORAGE SERVICES

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VOLUME III



CRANE INVESTIGATION REPORT

Fire and Subsequent Boom Collapse – July 26, 2023

Crane Tech Solutions, LLC

March 19, 2025

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1.0 Executive Summary

A Favco M440E tower crane partially collapsed at 550 10th Avenue at approximately 7:30 am on July 26, 2023. The scope of this report is to investigate the crane and, if possible, determine the fire causation and subsequent boom collapse, and make recommendations to lessen the possibility of such an occurrence from happening again.

The crane had been operating for between ½ hour and 1 hour when a fire started in the power pack (near the diesel engine). The operator attempted to extinguish the fire with the on-board fire extinguisher but was unable to control the fire. He left the crane when he realized he would not be able to put the fire out.

The Lift Director and the Hoisting Machine Operator (HMO) met at the uppermost tie-in location (40th floor) and decided to stop the traffic on 10th Avenue and 41st Street. This proved insightful because there was no vehicle or pedestrian traffic on the street when the boom hoist rope failed, and the boom fell to the ground.

The evidence shows that a hydraulic hose on the slewing pump failed when the hose separated from its fitting. The slewing system is a pressurized system with a pressure setting between 3,000 psi to 4,000 psi (per Mechanic1). The investigators' opinion is that the failed hose created a hydraulic oil mist which has a flash (ignition) point around 240°C. The detached hose sprayed the hydraulic mist toward the hot engine and the mist ignited. According to the maintenance records there were approximately 275 gallons of hydraulic fuel in the reservoir tank. In addition to hydraulic fluid, there are other petroleum-based fuel sources to feed the fire (i.e., diesel fuel, engine oil and gear oil).

The fire continued unabated and grew in intensity. The luffing boom rope path goes from the bottom of the drum to the top of the "A" frame, travels around a sheave, through a bridal and pinned (fixed end) to the top of the "A" frame (Exhibit 1). This path placed the rope in flames / heat (Exhibit 2). Wire rope under stress, when exposed to extreme heat, will eventually fail. There are engineering studies covering the effects of extreme heat on wire rope. Engineering Structures published one such article. One point this article noted was: *"… The external wire layers, subjected to the highest temperatures, undergo an extensive plastic deformation at a nearly constant, or even decreasing stress. The applied load is therefore progressively transferred to the internal wires. Since all wires experience the same axial elongation, it is reasonable to assume that failure will occur at the internal wires, as for the estimated time to rupture their temperature is between 350° and 450°C, corresponding to the lowest rupture strain*". [1]

There was no evidence that the failed hose was leaking the day of the fire, but there was evidence of hydraulic leaks (unknown severity) at various locations in and around the machine deck. The Crane Tech Solutions (CTS) investigation team saw oil absorption pads in several places (see photograph section) indicating leakage.

[1] Fire behavior of steel ropes: Experimental investigation and numerical analysis, V. Fotanarie, M. Benedetti, B.D. Monelli, F. Degasperi, Engineering Structures, Elsevier, Ltd., 2014, pages 346 -347.

Cross Country Construction, LLC's (CCC) HMO3/Oiler informed the investigating team that he performed all the required maintenance from the Favelle Favco Cranes Installation, Operations, and Maintenance Manual (Favco Manual), but HMO3/Oiler did not keep a separate maintenance log listing the tasks performed. Exhibit 14 contains the manufacturer's list of required maintenance tasks.

HMO3/Oiler said that he changed the engine oil every 300 hours, but he noted this task only once in the daily inspection log. CTS requested a list of all parts purchased during the job and CCC supplied a list of 8 fuel filters and diesel fuel. HMO3/Oiler mentioned that CCC may have had parts from previous projects.

There was a similar tower crane fire in Australia (November 2012) where there was a fire in the engine compartment, the operator was unable to extinguish it, and he exited the crane. This fire continued and the luffing rope failed causing the boom to collapse. As a result of the Australian fire, the manufacturer (Favco Favelle) issued a service bulletin addressing the fire potential and made several recommendations (Exhibit 3)[2].

The evidence shows that the owner did not incorporate the items listed in the bulletin into the subject crane. The adherence to these recommendations may have prevented the catastrophic crane failure.

[2] Favelle Favco, Engineering Bulletin titled Fire that occurred on a Favelle Favco Tower crane, dated July 1, 2016, Page 1-4

2.0 Background

2.1 Crane Tech Solutions Role

GMS engaged Crane Tech Solutions, LLC (CTS) to provide an analysis regarding the tower crane collapse at 550 10th Avenue, New York City, provide an evaluation or opinion on the cause of the catastrophic boom failure, investigate the maintenance and inspection requirements of the crane, and provide recommendations for additional regulations that may prevent a similar occurrence. CTS made three trips to New York City to inspect the partially collapsed crane, reviewed many documents produced by the crane's owner (New York Crane & Equipment Corp. – NYCE), the manufacturer (Favco Favelle - Favco), and the user (Cross Country Construction, LLC - CCC) and interviewed seven (7) individuals.

2.2 CTS Team

CTS engaged Analytical Testing Services, Inc. to analyze five (5) hydraulic oil samples to determine the flash point, auto ignition temperature, and viscosity of the samples removed from the crane.

2.3 Project Description

The provided information showed that the developer of the site / building was Gotham. The Gotham website described the planned building as "*a luxury rental tower that will consist of up to 453 mixed-income residential homes. The 47-story, mixed-use tower with inclusionary housing will include over 20,000 sf of indoor and outdoor amenity space, as well as neighborhood retail on the ground floor*"[3]. Handel architects designed the building[4].

Gotham contracted with Monadnock Construction, Inc. (General Constructor) who, in turn, executed a subcontract with Cross Country Construction, LLC ("CCC") as the concrete subcontractor and Crane User to construct the building at 550 10th Avenue in New York City.

CCC contracted with New York Crane & Equipment Corp. (NYCE) to provide a Favco M440E tower crane to assist with the building construction on February 1, 2023, with a noted duration of six months. CCC engaged Valjato Engineering, P.C. (VE) as the crane engineer of record. VE submitted the required documents to New York City's Department of Buildings (DOB) and DOB approved the crane's application by issuing a Certificate of On-Site Inspection (also known as the Crane Notice) number CN00045622.

Certified Testing & Inspections, Inc. (CTI) performed the required third-party tower crane inspection. CTI performed a variety of inspections and stated "*The unassembled crane components are in acceptable condition for permitted erection*"[5] (Exhibit 4). The crane

[3] https://www.gothamorg.com/property/550-10th-avenue , December 29, 2023
[4] https://www.gothamorg.com/property/550-10th-avenue , December 29, 2023
[5] Certified Testing and Inspections, Inc report dated January 10, 2023, p. 7 of 193 (blue highlighted area)

inspected had the manufacturer's serial number 1475 and DOB issued the crane a Certificate of Operation (referred to as a CD) number CD00004052.

Documents provided by CCC indicated the roles for the various companies.

Crane User – Cross Country Construction, LLC
Crane Applicant – Valjato Engineering, PC
Device Installer – XLO Consultants LLC
Lift Director – Referred to as the Lift Director
HMO/Operators – Referred to as HMO 1, HMO 2, and HMO 3
Disassembly – referred to as Disassembly Master Rigger.

The report refers to the CCC mechanic as HMO3/Oiler. During the interview, HMO3/oiler said he performed the required crane maintenance and served as an operator (see below).

2.4 Investigation Outline

CTS started its investigation on September 8, 2023, with its initial examination of the crane. T.J. Russo Consultants (Russo) provided a representative that climbed the crippled crane with CTS. Russo is the fire expert responsible for assisting with determining the cause of the fire. CTS and Russo took photographs, documented the status of the crane, and discovered a failed hydraulic hose (pulled out of its fitting). Photograph 2.4.1 below shows the failed hose and fitting.



Photograph 2.4.1

CTS went back to the site from September 25th to September 27th to preserve evidence prior to the crane's return to its owner. CTS removed assorted items, and DOI took possession of such and logged them into evidence.

DOB offered concerned parties the ability to inspect the crane on October 24, 2023, at the crane owner's New Jersey yard. CTS was present and explained to the attendees the evidence / components removed from the crane. The attendees were free to take pictures and ask questions.

DOI sent the hydraulic oil samples removed on September 25th and 27th to Analytical Testing Services, Inc. for analysis. A summation of the analysis results is below, and the full lab report is Exhibit 5.

CTS considered using a laboratory to evaluate the failed hose and fitting but determined that the results would not provide conclusive causational evidence of why the failure occurred.

CTS interviewed four employees from CCC (2 Hoisting Machine Operators (HMO), the HMO/Oiler, and Lift Director) and NYCE (2 Mechanics and the General Manager).

3.0 Applicable Law and Regulations

3.1 NYC Building Code Requirements for Tower Cranes

The applicable code requirements for this incident are crane approval, crane site plans, crane operation, inspection, lift director, and HMO licensing. A detailed examination of the various tower crane regulations was not in the scope of the CTS. However, the report addresses the primary code sections.

3.2 Certificate of Approval

DOB issued the crane approval for this model in December 1998 and issued the number P331. The placard on the crane indicated that Favco manufactured the crane 2008.

In 2016, DOB modified the crane approval process that required manufacturers to supply safety bulletins and recall notices (RCNY §3319-01(d)(6)). A notable bulletin not provided to DOB prior to the fire was the Engineering Bulletin titled "Fire that occurred on a Favelle Favco Tower Cranes." This bulletin describes recommended actions due to the tower crane fire in Australia (Exhibit 3).

3.3 Certificate of Operation

The NYC registration number for the affected tower crane was CD 0004052 and the crane's serial number was 1475. RCNY §3319-01(f) outlines the inspection requirements to obtain a valid Certificate of Operation (CD). In line with these requirements, DOB issued a Service Update titled "*Erecting Tower Cranes: Required Protocol for Third-Party Certifications*." This Service Update requires the Engineer of Record, the third-party inspector, and the owner approve various documents with the intent that all three parties agree that the crane is ready to assemble on site (Exhibit 6). DOB produced the "revised" protocol to CTS (includes last paragraph related to this incident).

3.4 Certificate of On-Site Inspection

DOB approved the assembly and operation of this crane and issued Certificate of On-Site inspection number CN 000456-22. The third-party tower crane inspection performed by Certified Testing and Inspections, Inc. (CTI) located in Florence, NJ was part of the documentation to authorize the assembly (Exhibit 4). CTI sent a letter to DOB on January 10, 2023, summarizing the inspection by writing "*The unassembled crane components are in acceptable conditions for permitted erection*.[6]" Further the crane engineer of record, Valjato Engineering, P.C., sent a letter dated January 10, 2023, to DOB and wrote, "*we have reviewed the enclosed inspection certification*

[6] Certified Testing and Inspections, Inc report dated January 10, 2023, p. 7 of 193 (blue highlighted area)

package, including all relevant documents of the inspection. We have found it to be complete. I do not object to the crane's erection.[7]"

The analysis did not entail a detailed review of all the required submittals but focused on the readiness of the crane to operate at the site.

3.5 Licensure Requirements

The regulations require a tower crane operator to possess a current "A" or "B" HMO license for the crane that is subject to this investigation. During the interview process, each operator showed their valid NYC issued license as well as the required National Commission for the Certification of Crane Operators (NCCCO) certificate indicating they have passed the written and practical tests for a tower crane.

The project required a Lift Director according to the regulations. During his interview, the Lift Director said that he had not read and appeared to not know the specific requirement of this position as outlined in regulation 1 RCNY §3319-02. The regulations require the Lift Director to be Competent and Qualified to perform the required duties outlined in the regulations. Although the Lift Director did not the specific requirements of a Lift Director pursuant to the regulations, he appeared to have met the requirements.

He maintained the required Crane and Derrick Log and held daily meetings that discussed the daily operation, weather, traffic control and area the crane would service. He said he held the meetings prior to the initiation of the crane work and that the meetings were in person. He further said that sometimes he would discuss the work with the operator alone and then the remainder of the crew prior to starting the work. He provided a certificate of completion of a 32-hour Lift Director class issued by Competent Safety Consultants.

There were two people on the crew that had the Rigging Supervisor certification, the Lift Director and one other person. There were two crew members with the 16 hour Rigging Worker certification. In NYC, the Rigging Supervisor and Rigging Person certificate includes signal person training according to the DOB requirements for such courses.

The work planned for the day of the accident did not require a Master Rigger so there was none on site. The load on the hook at the time of the incident was not a critical pick pursuant to the DOB regulations and code definitions.

3.6 DOB Actions after the fire

DOB requested proposals from the industry to provide Forensic Engineering Services for 550 10th Avenue Crane Collapse. More specifically, to prepare interim and final reports concerning the determination of the cause and origin of the crane failure at 550 10th Avenue on July 26, 2023.

Once DOB selected an engineering team, DOB required the manufacturer to provide a letter certifying the standing crane was safe for personnel to view the damage and during the period to design a safe manner to remove the crane from the site.

[7] Certified Testing and Inspections, Inc report dated January 10, 2023, p. 3 of 193 (blue highlighted area)

DOB issued a "Order of the Commissioner" to all diesel hydraulic tower crane (manufactured by Favco) on August 1, 2023. DOB sent this order to seven (7) active (erected) tower cranes and required the equipment user / owner to hire a New York State licensed professional engineer (PE) to *inspect the engine compartment/power pack area, winch systems, and related systems for compliance with manufacturer manuals*… DOB also required the PE to provide a report documenting the results of the inspection and an action plan, acceptable to the Commissioner, to implement to safeguard the engine compartment/power pack.

DOB updated its third-party inspection protocol titled "*Erecting Tower Cranes: Required Protocol for Third-Party Certifications*" that required "*Favco: All Diesel Crane Models fire protection Service Bulletin FFCA-EB_030- Rev A - All long-term recommendations in the above Favco Bulletin are required enhancements for use in NYC. This includes but not limited to Fire rated Hydraulic hose's, steel suction lines with approved check valves. Fire detection and automatic fire suppression system, Battey [sic] box relocation and electrical connection protection. Luffing rope fire wall, etc. Owner to provide A [sic] separate 3rd party report to verify all bulletin items have been addressed and submitted with the full 3rd party report"*[8]*. (Exhibit 6)*

DOB issued various subpoenas to the crane owner, user, and manufacturer requesting a variety of documentations that each may have in their possession.

DOB issued a letter to all the manufacturers reminding them of their obligations pursuant to City of New York, 1 RCNY 3319-01(d)(5) & (6) to update the Certificate of Approval for Contact information, updates to the manuals, updated inspection and maintenance checklists, and all safety bulletins and recall notices (letter dated May 24, 2024). In addition, DOB provided three other documents to assist manufacturers in viewing their respective approved crane models and the methodology to submit the updated material.

4.0 Field Work and Background

4.1 Crane Investigation

The crane investigation was a multifaceted examination of the available evidence. The field work included inspecting the crane on three separate occasions, requesting and reviewing documents from the appropriate parties, interviewing seven people (4 from CCC and 3 from NYCE), and engaging a lab to analyze hydraulic oil samples removed from the crane.

Site Visit on September 8, 2023

CTS started its investigation on September 8, 2023, with its initial examination of the crane. A representative of T.J. Russo Consultants (Russo) climbed the crippled crane with CTS. T.J. Russo is the fire expert responsible for assisting with determining the cause of the fire. CTS and Russo took photographs, documented the status of the crane, and discovered a failed hydraulic hose where the hose separated from its fitting.

[8] New York City Department of Buildings, Erecting Tower Cranes: Required Protocol for Third-Party Certifications, August 2023, p. 5 of 5.

The purpose of this work was to create a base line of photographs prior to other interested parties visiting the crane to make their own assessments.

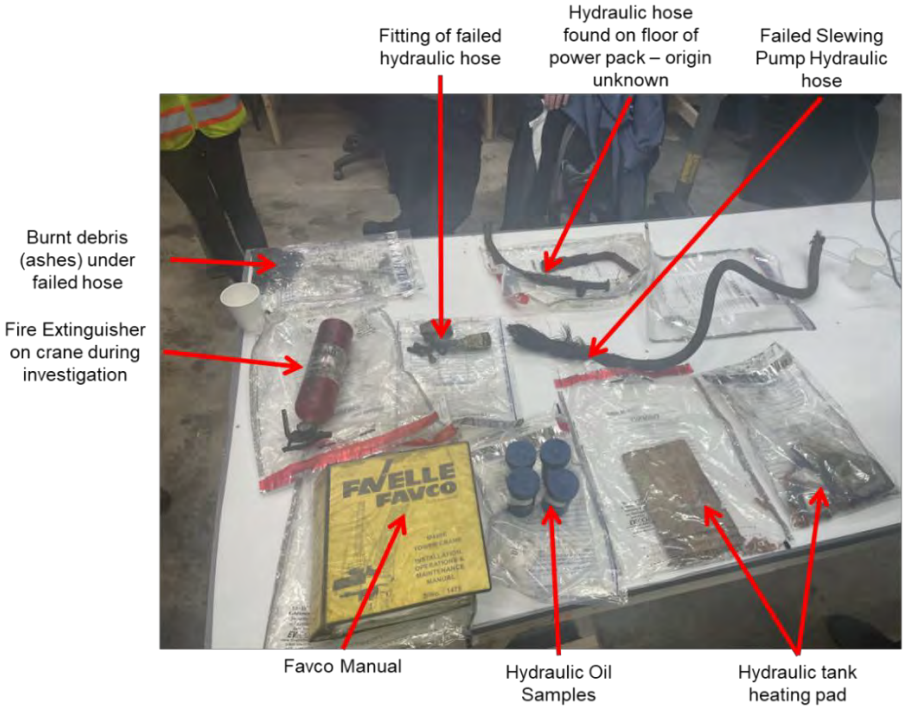
Later that day, the CTS investigator traveled to New Jersey to photograph the items removed from the site after the accident that the disassembly team placed into two dumpsters. He also photographed the boom sections placed onto the ground next to the dumpsters.

Site Visit from September 25 to September 27

CTS returned to the site from September 25 to September 27 to remove / preserve evidence prior to the crane's return to its owner.

September 25, 2023 – The day started with the Master Rigger in charge of dismantling the damaged crane outlining the duties and responsibilities of the crew. During the meeting, the Master Rigger introduced the investigator so the crew understood that he would be on the machine deck to remove various components. The weather was cold and rainy and CCC assigned a person to assist the investigator. The investigator removed the following items from the crane (see photograph 4.1.1):

- One expended fire extinguisher located under the hoist rope drum.
- The failed slewing pump hydraulic hose and its fitting
- The operator's manual was in a toolbox near the operator's cabin.
- A hydraulic hose laying on the machine deck. The purpose of hose was unknown.
- A sample of the ashes on the machine deck under the failed hydraulic hose.
- Remnants from the hydraulic tank heating system.
- Four oil samples: two from the climbing system, and two from the slewing motor.



Photograph 4.1.1

The investigator measured the length of the luffing rope from the bottom of the drum to the failed end. The approximate length was eight (8') feet. It was difficult to get the exact measurement due to access and the rope had been damaged when it failed. The investigator then tied the failed end to the luffing drum and sprayed two lines across the drum.

After the investigator left the crane, DOI held a meeting with the on-site interested parties and the investigator described the evidence collected above. Meanwhile, the disassembly crew continued to dismantle the crane.

The dismantle crew lowered the luffing and hoist ropes that were hanging from the crane, the remainder of the boom, two counterweights, the "A" frame, and the luffing boom winch to the offset (part of the existing building).

September 26, 2023 – The dismantlement continued which included lowering the items on the offset to flat beds on 41st street. The investigators performed work on the offset and removed the three bullet items listed below (Photograph 4.1.2).

- The failed end of the luffing rope (approximately 3') from the drum.
- A two-foot section of the rope immediately after the failed end.
- A four-foot section of luffing rope from the luffing rope that remained hanging. CTS removed this from the dumpster that the disassembly team placed all removed ropes.



Photograph 4.1.2

A wire rope expert arrived and inspected the failed end of the luffing rope and mentioned that the fire affected the ends because the wires were more pliable than wires not subjected to the heat and fire. The wire rope expert also requested the 4' section of the luffing rope noted above.

September 27, 2023 – The dismantling continued with the machine deck lowered to the offset and CTS removed the following items (Photographs 4.1.3 through Photograph 4.1.6).

- The corresponding hydraulic hose on top of slewing pump, which remained intact (appeared to suffer only heat damage) (Photograph 4.1.3)

- A hydraulic oil sample from a hose near the front of the machine deck that did not show signs of fire damage (Photograph 4.1.4).
- The end of the hydraulic hose from which the last oil sample was removed and taken into evidence by DOI (Photograph 4.1.5).
- The climbing cooler pump (bolted to the slewing pump) (Photograph 4.1.6).



Photograph 4.1.3



Photograph 4.1.4



Photograph 4.1.5



Photograph 4.1.6

When the disassembly team lowered the power pack to the street, the CTS investigator and a representative from Russo traced the failed hose from the pump to the front of the power pack and confirmed that the hose was part of the slewing system. They also traced the top hose attached to the slewing pump to the front of the power pack and marked both with colored zip ties (photographs 4.1.7 and 4.1.8).



Photograph 4.1.7



Photograph 4.1.8

The dismantlement continued throughout the day and the next few days. CTS left the site after tracing the two slewing system hoses.

October 24, 2023

DOB offered all interested parties the ability to inspect the crane at the crane owner's yard in New Jersey. DOI coordinated this visit on October 24, 2023. The investigator explained to the attendees the evidence / components removed from the crane. The attendees were free to take pictures and ask questions.

CTS removed the other failed end of the luffing rope from a dumpster that the owner removed from the site immediately after the boom collapse. In addition, the investigator removed another 3' section from another part of the luffing rope. DOI took possession of the ropes.

CTS removed a camera (Photographs 4.1.9 and 4.1.10) positioned so the operator could view both the luffing and hoist rope drums. The fire had destroyed it. CTS removed the monitor for the camera and determined that the monitor had no taping capabilities (live feed only). The investigator left the monitor inside the operator's cabin.



Photograph 4.1.9



Photograph 4.1.10



Photograph 4.1.11

CTS planned to retrieve the event recorder and discussed such with Favco personnel in the owner's yard. Favco showed CTS the location of the recorder (Photograph 4.1.11). The photo depicts the rear electrical box directly behind the engine compartment. Unfortunately, the fire burned the recorder beyond recognition. The lighter coloration

(red circle) was the location of the recorder. According to Favco personnel, all data collected via the “black box” system resided in this electrical cabinet.

4.2 Information Requests

CTS requested documentation from the Manufacturer (Favelle Favco Cranes Pty Ltd), crane owner (New York Crane & Equipment Corp.), the Crane User (Cross Country Construction LLC) and the Department of Buildings. The documents provided essential information.

Manufacturer

Favco delivered the crane to NYCE in 2008 and assigned the crane serial number 1475. Favco provided a copy of the serialized manual, and copies of engineering bulletins. The purpose of the bulletins is to notify the owners of potential and real safety issues that the owners should address as well as information Favco believes complements the material contained in the original manual. Ideally, the owners would include copies of these bulletins in the manual kept on the crane so the operators would have access to them.

One engineering bulletin addressed a fire that occurred in Australia (2012), which had similarities to the NYC fire. As a result of the Australian fire, Favco issued a service bulletin that addressed fire potential and made recommendations (Exhibit 3 contains the complete bulletin) to reduce the risk of a similar from fire occurring. The bulletin had “Immediate Action” and “Longer Term Actions.[9] ” categories. Below includes a few of the items from each section.

Immediate Action

- *Any leaking hoses or fittings should be attended to immediately.*
- *Owners/operators are requested to ensure that no extraneous materials are left within the power pack area that could potentially initiate or accelerate a fire (cleaning agents, greases, rags, etc.)*
- *Ensure the sludge tank is emptied regularly.*
- *Install any suitable fire detection device (which could possibly be a small camera) system within the power pack.*
- *Recommended owners/operators to have at least two (2) 9kg Class B fire extinguishers available on the machinery deck of the crane.*

Longer Term Action

- *Install a fire detection system within the power pack. The system should deliver an audible and visual alarm to the crane operator’s cabin.*
- *The manufacturer included the Work Safe (NSW) (Australian government entity) recommendation for the inclusion of a plumbed fire extinguishing system that would be directed to the areas where flammable fluids might pool in the event of leakage within the power pack. The manufacturer required the*

[9] Favelle Favco, Engineering Bulletin titled Fire that occurred on a Favelle Favco Tower crane, dated July 1, 2016, Page 1-4

customer to contact them for further information on fixed fire extinguishing systems.

- *Replace all pump suction hoses with flexible metal hoses. Favco noted the owner could contact them for further information with respect to these products.*
- *Install an extended wall (sheet metal) between the luff winch and the power pack to function as a further barrier to shield the luff rope.*

Crane Owner

The crane owner is New York Crane & Equipment Corp. (NYCE), and NYCE signed a rental contract with CCC dated February 4, 2023. NYCE provided a copy of the contract, a digital version of the manual, an Engineering Bulletin issued by Favco, copies of an invoice for a hoist rope, an invoice for a fire extinguisher, copies of the required 3rd party inspection for 550 10th Avenue project, and their maintenance history from September 2022 through July 26, 2023.

A contract clause reads that NYCE was responsible for "*all maintenance and lubrication on the crane after delivery, such as Department of Buildings requirements and the manufacturers 250-hour service, is to be performed by New York Crane and billed to the customer*.[10] (Exhibit 7)" When asked about this point, the NYCE General Manager (GM) responded that this language stemmed from NYC DOB requiring the owners to perform the monthly inspection versus a true bare rental. NYCE started performing the inspections several years ago, but the mechanics were waiting around all day to perform the inspection and eventually stopped doing them. Further, the GM said that CCC had the responsibility to maintain the crane since the contract was a "bare rental" (NYCE only provided the crane).

NYCE did not produce the Engineering Bulletin that covered the tower crane fire in Australia, but Favco produced an email addressed to NYCE (Exhibit 8) showing that the owner of NYCE received such bulletin in 2016. Further, when interviewing the mechanics (Mechanic1 and Mechanic 2) neither remembers seeing this document prior to the fire.

The GM remembers discussing the document in 2016 because a customer had two Favco's on a NYC project. He remembers NYCE wrapping hoses with fire retardant material and no other items in the bulletin.

The maintenance records indicated that NYCE traveled to the site seven times. Below is a summary of the Service Work Orders (SWO) with comments provided during the interviews.

April 5, 2023

Mechanic1 traveled to the site due to a slow hoist speed issue. He adjusted the IVG_min on the hoist motor and attained a desirable speed (per the SWO). In addition, the operator mentioned the boom up limit changed. He changed the encoder with one that HMO3/Oiler had on site. However, according to the Mechanic1, the main issue was

[10] Contract between NYCE and CCC dated 1 February 2023, page 9, Exhibit B, item 5.

a coupling that had failed and required replacement. Mechanic1 noted on the SWO that he had to return to replace the coupling. He mentioned that the crane should not work without this part and did not know if the operator continued working the crane.

April 6, 2023

Mechanic1 arrived early in the morning and installed the coupling and exiting the crane. He said it took about 30 minutes to perform this task.

May 5, 2023

Mechanic2 traveled to the site due to a complaint regarding the main hoist surging (Mechanic2 said during interview this is the same as the hoist being slow). He checked all three motors, and the pressure was about 1,500 psi. Mechanic2 increased the pressure to 2,000 psi. This increased the hydraulic torque of the motors. Mechanic2 also readjusted the boost pressure on the main, auxiliary and boom hoist from 29 bar (420.5 psi) to 35 bar (507.5 psi). One bar is equal to approximately 14.5 psi. Mechanic2 called the Favco engineer, and Mechanic2 said that the engineer agreed to this action. Mechanic2 assessed the machine with 15,000 pounds on the hook and the crane appeared to be functioning normally.

May 10, 2023

Mechanic2 travelled to the site due to low speed while hoisting up with a full bucket of concrete. This time Mechanic2 said that he focused on the pumps (May 5th he focused on the motors), and the pressure setting on the motors was still 2,000psi. The pressure setting on the main and auxiliary pumps was 300 bar (4,350 psi). He increased settings for the main and auxiliary pumps to 350 bar (5,075 psi). According to the Mechanic2, the Favco engineer agreed to this increase. Mechanic2 also performed a 100-hour visual inspection, and he noted that "*Performed a visual inspection on the tower crane components and everything looks on the safety factor at this time [sic*]".

During this inspection, Mechanic2 did not draw 1 liter of hydraulic fluid as required by the manual, but rather turned the two ½" ball values slightly to see if water was in the hydraulic tank and he said he did not see any. He said the inspection took approximately 2½ hours.

May 15, 2023

Mechanic2 travelled to the site due to the main hoist being slow while lifting approximately 15,000 pounds. The SWO included a summary of the previous two visits as well as the work he performed on this date. He said he fined tuned the Load Moment Indicator (LMI), installed a pressure gauge on the main hoist motors, proceeded to check and monitor the activity and collect data (information). He sent this information to Favco. He noted on the SWO that the main hoist now is ok on torque and speed while lifting the load.

June 5, 2023

Mechanic2 travelled to site due to "*from time to time while tower crane pouring concrete with 14,000 [sic] concrete bucket on hook hydraulic oil temperature alarm come on*

display." He started by monitoring the oil temperature from the hydraulic cooling system and noted a temperature of 160°F. Favco instructed Mechanic2 to increase the input pressure to the hydraulic cooling motor for the oil cooler from 35 bar (507 psi) to 50 bar (725 psi). The hydraulic oil temperature was 140°F after this adjustment.

July 3, 2023

Mechanic2 traveled to the site due to the hoist surging while hoisting up with a full concrete bucket, and the hydraulic oil temperature increased as well. Mechanic2 said he worked primarily in the operator's cab and needed a password to enter the system. He reset the "*PV speed for the main hoist from the LMI parameters at 23 bar at 160°F oil temperature for better tower crane functionally to the main hoist (low line)*." He said this repair took about 5 minutes.

Crane User

The Crane User was Cross Country Construction, LLC (CCC) and they produced documents filed with the Department of Building outlining the responsibilities of various companies and individuals (see above). The NYC licensed Hoisting Machine Operators, HMO3/Oiler, and Lift Director were employees of CCC, and the Lift Director said that his crew were the ones assigned to operate the crane for the project. The crane crew assisted other trades with lifts, but CCC remained the official Crane User throughout the time the crane was on site.

The various documents provided by CCC were, among others, the rental contract, Lift Director Daily Meeting Log, the daily and monthly inspection log, the Crane Weekly Weathervane Log, the operator's manual, and qualifications of the crane crew.

CCC provided copies of the Lift Director's Daily Meeting Log that used the same form for each meeting. The log noted weather conditions (time not noted), flag and pedestrian control personnel, summary of the picks to be made that day, radios have been tested and the system ready, underlined various topics discussed (tag lines, hours, check slings for tags, check slings for broken strands), and crane crew individually signed the form.

The crew consisted of the following personnel: Three HMO's, a Rigging supervisor, two Signal Persons, and Flagger Supervisor. Another person joined the team on February 22, 2023, but the Lift Director did not disclose his function. Other personnel joined and left the crew during the crane's tenure on site. The crew was similar from mid-February 2023 throughout the project.

CCC had the maintenance responsibilities while the crane was on site, and as such CTS requested all maintenance records. CCC noted the daily and monthly inspection logs, and these showed one motor oil change. They also produced records indicating the diesel fuel purchase and eight fuel filters. This was the extent of the produced maintenance records.

4.3 Tests Performed

Hydraulic Oil Analysis

DOI sent the five (5) hydraulic oil samples collected to Analytical Testing Services, Inc. for analysis (Destructive Protocol – Exhibit 9). The two samples from the climbing system marked with the number 3 (391 and 302), the two samples from the slewing system marked number 4 (491 and 492), and the sample from the single hose marked 103. CTS requested the lab to perform the following tests. However, the lab did not perform all the tests on each sample.

- Standard test for flash and fire points, ASTM D92 attempted to determine the flash point of the sample provided. The lab used sample numbers 391, 302, 491, and 492 to perform this test. The test resulted in flash points ranging from 240°C and 244°C.
- Standard test for Auto Ignition, ASTM E659 attempted to confirm when a hot surface would ignite the hydraulic oil. The lab used all the samples to perform this test. The lab determined the heat range between 360°C and 369°C.
- The laboratory evaluated the viscosity of the oil using the ASTM D445 - 11a Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity). The lab performed this test on all the samples. The analysis shows the viscosity was within specifications for an ISO VG46 product.
- To assess water content, the lab used ASTM E1064-05 - Standard Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration. The results indicated that there was free water in three samples (numbers 391, 491, and 492). An explanation for this occurrence is due to the weather conditions when CTS collected the samples (rainy and cold).
- The laboratory used the ASTM D5185 - 09 Standard Test Method for Determination of Additive Elements, Wear Metals, and Contaminants in Used Lubricating Oils and Determination of Selected Elements in Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) testing standard. See Exhibit 5 for the results.

Hydraulic Hose Destructive Testing

CTS collected the failed hose and its fitting, the top hydraulic hose on the slewing motor, and one other near the front of the crane that did not show signs of fire damage. CTS initially planned to destructively test these hoses to try to determine the reason(s) for lower hose failure. However, CTS's opinion is that such testing would not provide conclusive causational data why the hose failed, and therefore no testing performed.

4.4 Interviews

Below is a summary of the interviews with commentary from the interviewer. Each interview contained detailed questions. Below is a summary of the key points discussed during the interview. The summary below does not include all the questions and responses from the interview. The non-interviewee attendees were OSHA, DOB, DOI, CTS, and T.J. Russo Consultants.

The Lift Director appears to have met the NYC requirements to perform the duties of the Lift Director[11]. The Hoisting Machine Operators (HMO) all produced valid NYC issued HMO B licenses along with the required NCCCO certificates[12]. To operate the damaged crane, an HMO must have either an A or B license.

Lift Director- December 19, 2023, at 8:00am

There was only one Lift Director on this project, and he had his 32 hour (and 16-hour refresher) and 16-hour signalperson card. Although, when asked, he was not familiar with 1 RCNY §3319-02 outlining the Lift Director's duties and responsibilities.

The Lift Director said he maintained a "Rigging or Pre-Task Log," which conforms to the requirements pursuant to 1 RCNY §3319-02(j) – Pre-Shift Meeting. The individual pages of the log contained a list of projected lifts, weather conditions, a list of personnel involved in crane activities, rigging required for that day, and each attendee signed the log daily. The meeting was in-person, and he sometimes offered the meeting twice – once for the operator (so he could climb the crane) and once for the other personnel (riggers, signal persons, and flag persons). The Lift Director said he held these meetings prior to crane operation.

He outlined the procedure to have NYCE travel to site should the crane experience a mechanical or electrical issue. HMO3/Oiler or other Hoisting Machine Operator would call/radio him and outline the issue, he would then call his boss, and his boss would call NYCE and request a mechanic to travel to the site. He remembers NYCE coming to the site 5 or 6 times but did not remember the reasons. He said that he remembered one instance when HMO3/Oiler saw oil in the pan, and they needed NYCE to come out.

On the day of the fire, he arrived around 5:30 am and had a meeting with HMO 3 around 6:00am. He believed he started the crane around 6:50 am. Around 7:00 am, the signal person radioed him that smoke was coming from the back of the crane. He went up to the 40th floor and met HMO 3 and the rigger at the walkway and they discussed taking additional fire extinguishers up, but the fire was too severe. He said he saw flaming items falling and was worried about them hitting cars, so he radioed the flaggers to close 10th Avenue and 41st Street. When the boom fell, the streets were clear of automobile and pedestrian traffic.

The NYC Fire Chief asked him who shut down the streets and the LD said he had issued that instruction, and the Fire Chief told him that he saved lives. He believed there was 16,000 pounds on the hook at the time of boom failure (3 yards of concrete).

Crane Operator – HMO 1 – December 19, 2023, at 10:00 am

Started the interview by saying his last day operating the crane was July 17th and the fire occurred on July 26th. HMO 1 presented the appropriate credentials to operate the crane located at 550 10th Avenue.

[11] New York City Regulation 1 RCNY §3319-02(c) (2), dated April 14, 2017, p.3.
[12] New York City Regulation 1 RCNY §104-09

He typically worked two days per week and would split the weekends if there was weekend work. The three operators would discuss the weekly schedule. He would split each day with HMO 3 where he would work half and HMO 3 the other half.

He confirmed that the Lift Director held a daily meeting prior to him climbing the crane to go to work. He said that he needed to sign the log after the meeting.

He remembered three times NYCE came out due to the hoist being slow. He said that NYCE came out monthly to perform monthly maintenance. However, there is no documentary evidence proving this statement. He said he did not see any hydraulic leaks, but when he showed a photograph of the slew motor (photograph 4.5.2 below) he said that he notified NYCE and NYCE wanted to wait to repair it when the crane came down.

He said there were two fire extinguishers on the crane – one behind the operator's seat and one just outside the door. The latter was larger than the former. However, the investigating team only found one extinguisher after the fire.

Crane Operator – HMO 2 – December 20, 2023, at 8:00am

HMO 2 was on site the day of the fire, but HMO3/Oiler wanted to take the first shift, so he went to the shanty and was there when the fire started. He presented the appropriate credentials to operate the crane located at 550 10th Avenue.

He typically worked three days per week and would split the weekend work. He would split the daily activities with HMO 3.

He confirmed that the Lift Director held a daily meeting prior to him climbing the crane to go to work. He said that he needed to sign the log after the meeting.

He said that NYCE came out 4 or 5 times to address various issues. When asked about leaking hoses, he said, "to be honest, all cranes have seeps and leaks," and they used absorbent pads (diapers) to absorb the leaking fluid. He said that there may have been diapers around the hydraulic motors in the back near the engine. He did not report these because he considered this normal.

The only maintenance he did was to clean the windows.

At the time of the fire, he was in the operator's shanty when HMO 3 called him, and he ran into the street. He heard a loud noise, saw the boom falling, and started running north. Items flew by him, and he jumped into Yodel Hotel entrance way, and then came out to see the boom had fallen. He remembers streams of fire prior to the collapse. They did not make it to the street. He said it was approximately 10 minutes from the time HMO 3 called him and the boom collapsed.

Crane Operator – HMO 3/Oiler – December 20, 2023, at 10:00am

HMO 3/Oiler was the operator at the time of the fire. He asked HMO 2 if he could take the first shift and HMO 2 agreed. He presented the appropriate credentials to operate the crane located at 550 10th Avenue. His NYC license was set to expire on August 31, 2023, and HMO 3 said that he had submitted his renewal paperwork. He had a dual role on the project as he was also the Oiler (mechanic).

He typically worked five days per week and worked the weekend as required. He would split the daily activities with HMO 1 and HMO 2. He worked either the morning or afternoon shift depending upon the site's work schedule.

He confirmed that the Lift Director held a daily meeting prior to him climbing the crane to go to work. He said that he needed to sign the log after the meeting.

He said that NYCE came out two times to address a fan and slow hoist issue. He said that he would talk to a NYCE mechanic if an issue arose and would try to repair it. If he could not, he would call the Lift Director and CCC Management would request that a NYCE mechanic come to the site.

When asked about leaking hoses, he said there may have been a few drips and did not remember any diapers around the hydraulic pumps near the engine. He oversaw maintaining the crane and he said he performed various tasks that included changing the motor oil every 300 hours. He did not keep a written record of this work. The CTS investigator requested CCC to produce purchasing records of oil and filters and CCC said there were none.

The day of the fire he said he arrived on site between 600 and 630am and met with HMO 2 and asked if he could take the morning shift. He met with the Lift Director and climbed the crane. He said that during his inspection he did not see anything out of the ordinary. He completed the functional test and started lifting around 700am. He was on the second concrete truck, and he believed it was the second pick. There were three lifts per truck so this would be the fifth pick of the day. He said the crane was operating about 30 minutes before the fire started.

The hydraulic system light (low oil level) came on about the same time that the signal person radioed and said there was smoke coming from the crane. He hit the emergency stop or turned the key off (same effect) and he came out of the cabin and the oil was everywhere. He slipped but did not fall. He heard someone say fire and went back in crane to get the fire extinguisher. The fire was between the motor and the boom hoist drum. The door to the power pack was already open, and he started to extinguish the fire and thought he was getting the fire under control. However, he could not reach the middle, so he went back towards the cab, passed through the turntable, and arrived on the other side and the fire had grown, he emptied the fire extinguisher and then decided to leave the crane. He noticed that the hydraulic tank sight glass indicated the tank was empty when he was trying to put the fire out. By the time he reached the 40th floor landing, the fire had grown. He met LD at the walkway, and he said he told LD to shut down the streets.

He said there was only one fire extinguisher – it was a small one that was behind the operator's seat. He said that he thought he could have put the fire out if he had a larger fire extinguisher.

He was inside the building when it shook and heard something – it was the boom falling. The safety guy said to leave the building and he and the safety guy were the last people out of the building.

As the oiler/mechanic, HMO3/Oiler said he performed all the maintenance on the crane but did not maintain a log of the tasks completed. He said that he may have noted them in the daily inspection log. When asked where the site obtained (procured) the filters and oil, he provided vague answers.

He performed the monthly inspections, and these are in the monthly inspection log. He did not drain one liter of hydraulic oil monthly as required by the Favco manual. He said he would try to assist the NYCE mechanics when they were on the crane by providing tools. He said he wanted to learn more about the crane.

Mechanic1 – January 3, 2024, at 3:00pm

Mechanic1 is a tower crane mechanic for NYCE. He had limited involvement with the crane involved in the fire. He has been a tower crane mechanic for NYCE for approximately 5 years and has an additional 15 years of experience with other employers. He received Favco factory training twice in Harlingen Texas. The latest was between 8 and 9 years prior to the interview.

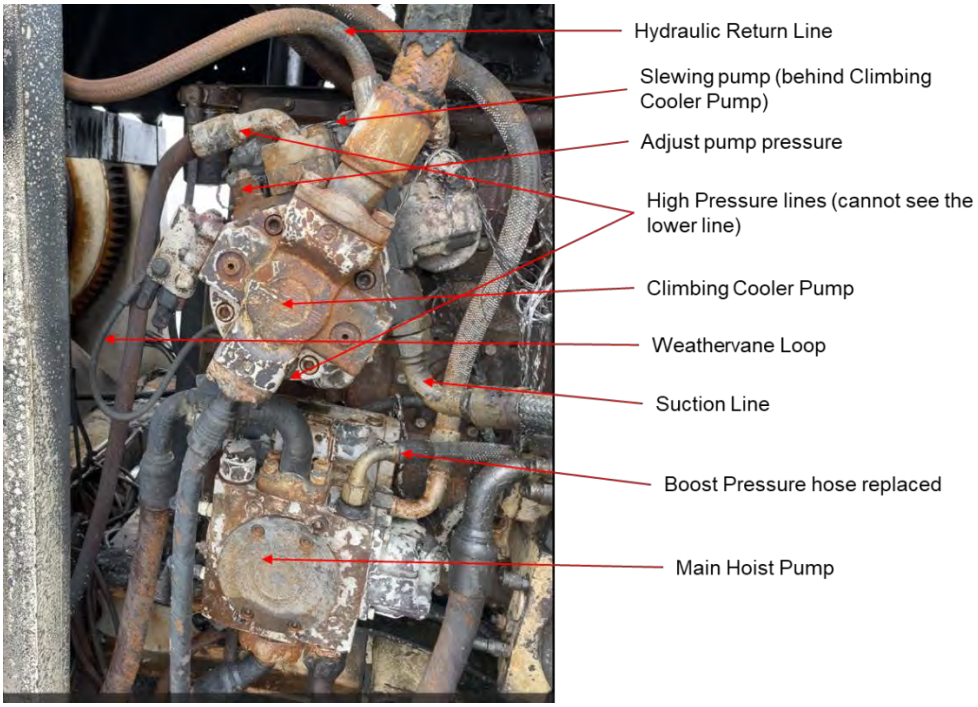
He mentioned that NYCE follows a policy that they assign a mechanic to a tower crane when the crane has an upcoming rental. This mechanic has the responsibility to inspect and prepare the crane for rental. Other personnel may help if he needs assistance such as lifting a heavy component. He was not the mechanic assigned to the crane sent to 550 10th Avenue and so he had minimal input readying this crane for the eventual operation.

He was onsite four times during the project. The first time he was the mechanic that provided support for the assembly of the crane at 550 10th Avenue. He said it took approximately 17 hours (same day) to assemble the crane. The next day he went out and set up the crane and ensured its functionality. He was not sure if he oversaw the required load test.

The third time he traveled (4/5/23) to the site was in response to an operator’s complaint that the hoist was slow. He adjusted the speed using 15,000 pounds of rebar to adjust the IVG Min on the hoist. The operator said the boom up limit changed. He initially thought the issue was an encoder, but it was the coupling that failed. He was on-site between 3 and 4 hours for this repair. He returned the next day and installed a new coupling (30 to 40 minutes).

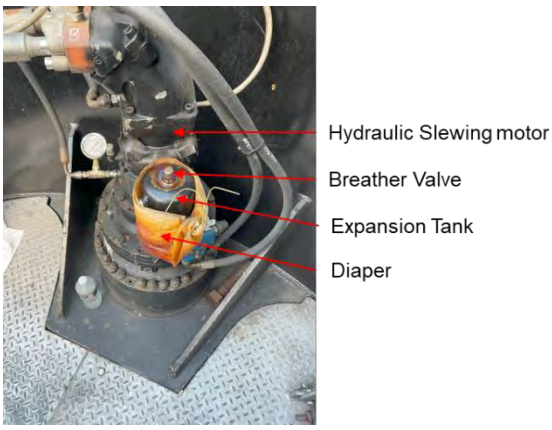
To better understand the failed hose and its function, the interviewer presented Photograph 4.5.1 (below). Mechanic1 pointed out the various hoses and components. The hydraulic hose that failed was one of the two high pressure lines in the slewing system (rotating). It was the one on the bottom of the pump.

He said that he does not typically replace the hydraulic pressure hoses unless they are leaking, they have gouges, or they show abrasion. He said that NYCE replaced the failed hose in 2011 making the hose 12 years old at the time of failure. He said the pressure in the slew system was between 3,000 psi and 4,000 psi.



Photograph 4.5.1

He said that he did not see any leaks in the power pack compartment either time he was on the crane. He also said that HMO3/Oiler called him twice during the project. They were for the coupling issue and one time when the crane did not start. He addressed the last one over the phone and did not need to travel to the site.



Photograph 4.5.2

The interviewer showed him Photograph 4.5.2 depicting a white absorbent pad ("diaper") wrapped around the expansion tank. CCC personnel wrapped a diaper around the expansion tank and if pressure in the system exceeds a certain value, then the breather valve (see arrow) will vent an oil vapor, and his thoughts were HMO3/Oiler put the diaper there to catch the vapor. If the breather valve fails, the pressure could not be released, and this would create a situation where the lower seals could fail. He did not see the diaper during his 4/5 and 4/6 site visits.

The parties discussed Favco's Engineering Bulletin dated July 1, 2016. He said he had not seen it until after the fire when his supervisor gave him a copy. He said that NYCE told him to "hit" every point going forward. Specifically, he said they were replacing the suction lines with fire resistant hoses (all hoses must have MSHA stamp), installed a fire suppression system that had an audible and visual detection system (behind operator), they moved the batteries from under the engine and installed them between the luffing and hoist winch near walkway, a battery kill switch is attached near battery box, crane now has two 20 pounds fire extinguishers mounted to the operator's cabin outside the door, and a steel wall between the power pack compartment and the luffing rope. He could not remember the steel thickness – it was 1/8" or ¼".

Mechanic2 – January 4, 2024, at 10:00am

Mechanic2 is a tower crane mechanic for Lomma Crane and Rigging (LCR) but assigned to NYCE to ready the crane scheduled for 550 10th Avenue. He has worked for LCR for 18 to 19 years. He started as a truck mechanic and has been a tower crane mechanic for approximately 16 years. He received Favco factory training once in Harlingen, Texas 14 to 15 years ago.

He said that NYCE assigned him to perform the necessary maintenance to ready the crane for rent. The work orders for these tasks started on 9/12/22. During the interview, he said that he started inspecting the crane to determine the required parts and he gave the list to a NYCE employee.

The interview went through various work orders provided by NYCE. Some notable items were replaced the hydraulic fluid (275 gallons of Nuto H 46), changed planetary gear oil, removed the hydraulic pumps and sent them to a rebuilding company in Ohio, pulled the slewing motors, replaced the hoist rope, inspected the luffing rope (no issues) among other tasks. It appears from his interview that NYCE follows a rigorous process prior to sending a crane out on rent. The records show that Mechanic2 performed a 100-hour and 250-hour inspection prior to the crane going to the site.

Mechanic2 confirmed the information above regarding Photograph 4.5.1. Although, he added that the upper slewing pressure hose allows the crane to swing left and the bottom slewing pressure hose allows the crane to swing right (hose that failed). He did not replace either hose during the reassembly. When asked, he said he replaced a hose if he sees a crack in the skin, slow leak, or sees wire through the skin. Further, he said all the main hoses looked good and said that he does not remember changing any of the main hydraulic hoses (slew, hoist, or luffing).

He said that the pressure setting for the slew pumps should be 150 bar (2,176 psi). He did not see a leak in the power pack after the test run in the shop. When asked to define a leak, he said if you touch a hose, and you feel wetness then he would consider this a leak.

The interview went through the work orders that required him to travel to site. He said that to go to the site CCC would need to request his services from the NYCE management and management would instruct him to go to the site. He went to the site five (5) times and four (4) of these addressed a similar issue as the one Mechanic1

addressed, and that being a slow (surging) hoist when the crane lifted a heavy load (3-yard concrete bucket – approximately 14,000 pounds). Below is a summary of the five trips:

- 5/5/23: He adjusted the pressures at the hydraulic motors.
- 5/10/23: He focused on the pump's pressure.
- 5/15/23: He adjusted the hydraulic PV motors from 30 bar to 50 bar. The work order provided includes a summary of the first two trips plus the work he performed on 5/15/23.,.
- 6/5/23: The operator requested a mechanic because he noticed a high hydraulic oil temperature reading. The corrective action the mechanic performed increased the input hydraulic pressure to the Cooling Motor for the oil cooler.
- 7/3/23: He monitored the hoist speed and fine-tuned the speed using the controller located in the operator's cab.

All these issues relate to the hydraulic systems of the crane. Mechanic2 mentioned that he talked to Favco's engineer during each of these visits and the Favco engineer authorized him to increase the respective pressures.

On the second trip (5/10/23) he also performed a 100-hour inspection and used a form for such inspection. One of the items on the list requires the inspector to remove one (1) liter of hydraulic fluid to check for water. Mechanic2 said he did not take the required sample but rather "cracked" both ½" hydraulic valves (bottom of tank) and did not see water so he closed the valves.

He did not receive a call from either CCC or NYCE GM regarding an issue on the day of the fire.

The interviewer presented the interviewee with Photograph 4.5.2. He said he was not sure why HMO3/Oiler wrapped the diaper around the tank, but assumed it was because the hot weather may have created more pressure. When asked, he said that an Oiler should not add oil to the tank. The oil level was correct when the crane left NYCE. He did not remember seeing the diaper during his visits to the crane.

After the fire, NYCE provided him with a copy of the Favco Engineering Bulletin dated July 7, 2016, and prior to this copy he had not seen it. He said that he has now installed new hoses, check valves, moved the batteries, installed the fire wall, and installed two (2) fire extinguishers (not sure of the size). He said he has not installed or helped install the fire suppression system.

NYCE General Manager – GM – January 31, 2024, at 10:00 am

The General Manager (GM) of NYCE works in the Long Island City office. His self-described responsibilities are finding work, renting equipment, trucking, dispatching mechanics, and getting paid. The mechanic that worked on the subject tower crane did not report to him. The GM said that he was not a mechanic nor had any training as such.

When asked about the process of preparing a crane to go out on rent, the GM said that there were no written check lists that the mechanics use. He said the mechanic

collaborated with the third-party inspectors (selected by renter) and used the manual provided by the manufacturer to ensure the crane is ready. He also said that the mechanics have experience preparing cranes for rent and they know the required steps. Lastly, he said the process takes months to complete.

The interviewer asked him about the process whereby a mechanic travels to site to repair the crane. The customer typically calls him to request a mechanic. He said that we would normally have the customer discuss the issue with a mechanic and then determine if the mechanic would travel to the site. The mechanic completes a Service Work Order (SWO) for each trip outlining the hours worked, tasks performed, and the outcome. He said neither he nor Mechanic 2's supervisor would typically approve the SWO's but rather entered directly into their system.

The CTS investigator asked the GM if he had seen the 2016 Favco bulletin outlining recommendations due to the Australian tower crane fire. He did not remember if he reviewed the document in 2016 but remembered discussing it with a customer that had two Favco cranes on a project at that time (2016). The only item he remembered doing was wrapping various hoses in fire retardant cloth. He received a copy of the 2016 bulletin from a Favco engineer after the fire. He said that either he or his manager sent the bulletin to the mechanics to implement. He went further and said the third-party inspectors now require the items before agreeing that the crane is ready for service.

NYCE could not produce documentation proving that NYCE had replaced the failed hose. When asked if the hose could be an original hose, the GM said that it was a possibility. The mechanics use visual inspection to determine whether he should replace a hose – age is not a determining factor.

When asked about calls he received on the day of the fire, The GM said that he received a call at 7:20am from the Lift director that the crane blew a hose, and 5 minutes later he received a call that the crane was on fire.

4.5 Rope Analysis

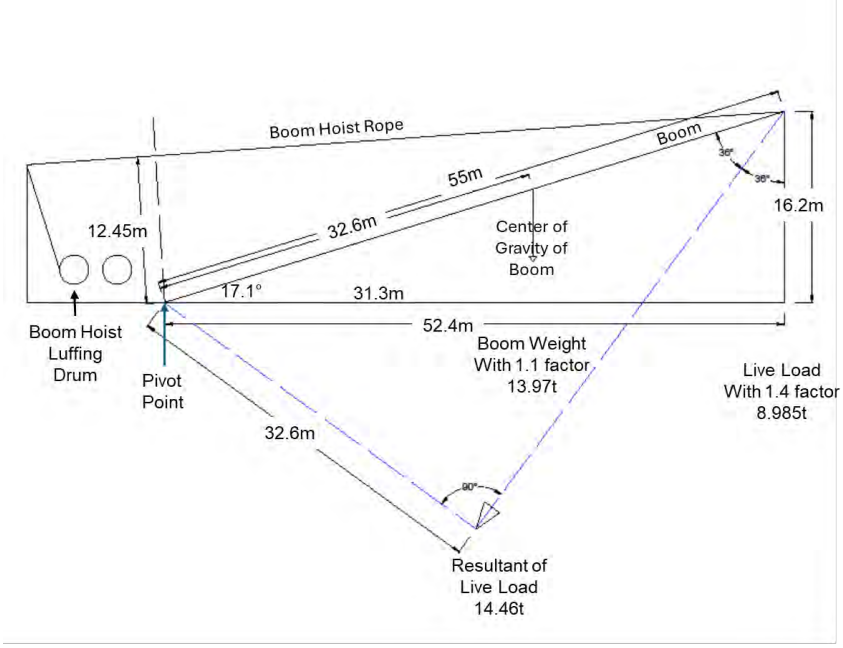
CTS performed three rope calculations, and Table 4.5.2 lists the results showing the safety factor on each scenario. The scenarios are:

- Assumed the estimated weight (approximately 7 Tons) on the hook when the fire started at the approximate radius (39') (HMO 2 provided the radius during his interview).
- Assumed maximum radius (172') with the approximate weight (7 Tons) on the hook when the fire started.
- Assumed maximum capacity (8.8 Tons) at the maximum boom radius (172'), which is the worst case for this crane's configuration.

CTS used the second scenario to describe the calculations below because it is the worst case (highest force) on the rope with the approximate weight on the hook at the time of the incident. Drawing 4.5.1 depicts this scenario.

The third-party inspection package included the rope details (Exhibit 10). NYCE attached this same data sheet to an invoice. The rope manufacturer was Westfälische

Drahtindustrie GmbH and the documentation provided listed the rope had a minimum breaking strength of 943 kN.



Drawing 4.5.1

The pertinent data for the rope force calculation follows. The crane dimensions were from the Favco manual. The Crane Notice showed a boom length of 180' (55m), and the Favco manual showed the maximum radius of 172' (52.4m) for this boom length (Exhibit 11). The height of the boom tip above the horizontal plane of the pivot point is 53' (16.2m). The weight of the boom (including bridal and pendants) is 12.7t (14T) (Exhibit 11). The drawing also shows a Center of Gravity of 32.6m (107') (see arrow) for this boom length (Exhibit 11). The radius for the boom's Center of Gravity at maximum radius is 31.3m (102.8'). The perpendicular distance from the boom hoist rope to the pivot point is 12.45m (41').

The drawing in Exhibit 11 indicates the fly jib as part of the weight and Center of Gravity (COG). The existence of the fly jib increased the weight and COG which would produce a lower safety factor. CTS used the data provided because the result would result in a more conservative safety factor (actual safety factor would be marginally higher).

HMO 3 said during his interview that the crane had a three-yard bucket full of concrete. Concrete weighs approximately 4,050 pounds per cubic yard plus the weight of the bucket of 2,000 pounds (provided by CCC) equals 14,150 pounds (approximately 7 Tons).

The resultant force from the Live Load is 14.46t[13] and the perpendicular dimension from the resultant to the pivot point is 32.6m (107') (scenario 2).

[13] https://www.omnicalculator.com/math/right-triangle-side-angle with inputs of Side B = 8.99 and an angle of 36.425

The calculation includes an acceleration / deceleration and friction factor of 1.4 for the load and 1.1 for the weight of the boom. The analysis does not impute the friction caused by the sheeves, which CTS opines as insignificant. The analysis converts Imperial dimensions/weights to metric.

Below is the formula used:

$$\frac{(Factor\ weight\ of\ boom * \ the\ radius\ of\ the\ CoG\ of\ boom) + (Resultant\ force * \ perpendicular\ dimension\ from\ resultant\ to\ pivot\ point)}{Perpendicular\ distance\ from\ the\ boom\ hoist\ to\ to\ the\ \ pivot\ point}$$

$$\frac{(13.97t * 31.3m) + (14.46t * 32.6m)}{12.45m} = 72.98t$$

The luffing rope was in four-part line, and the calculation divides the total force by four to obtain the force on each part of line. Therefore, the force on each part equaled 18.25t. The minimum breaking strength of the rope provided by the Owner is 943kN (96.2t). The safety factor for the second scenario was 5.3.

CTS performed an analysis assuming the maximum capacity at maximum radius per the load chart in the manual (worst case). The safety factor was 4.7, which exceeds the requirements. Table 4.5.2 provides the safety factors for all three scenarios.

Radius Meters (m)	Load with Factor (mt)	Total Force (mt)	Line of Rope Force (mt)	Min Break Strength (mt)	Safety Factor (times)
11.90	8.99	27.01	6.75	96.2	14.2
52.40	8.99	72.98	18.25	96.2	5.3
52.40	11.18	82.22	20.56	96.2	4.7

Table 4.5.2

The safety factors are above those required in the ANSI standard B 30.3 noted below when selecting boom hoist ropes (safety factor of 3.5). The above supports the position that the rope was more than sufficient to withstand the forces acting upon the rope at the time of the collapse at the maximum radius with maximum capacity. The heat from the fire caused the rope to fail. Due to the safety factors, the CTS investigators believe that further testing of the rope was not necessary. The reader should note that the above calculations use the configuration of the crane (55 m boom) involved in the incident.

The CTS investigators reviewed various standards and determined that ASME B30.3-2016 provides recommendations related to design criteria to running ropes (ropes moving over sheeves). The applicable sections of 3-1.10.5 titled “Running Ropes” are:

> *(a) All ropes shall be of construction recommended for their service by the crane or rope manufacturer or by a qualified person.*
>
> *(c) The design factor for luffing boom hoist ropes shall not be less than 3.5.*

(d) Design factors shall be the total minimum breaking force of all the supporting ropes divided by the static load imposed on those ropes when supporting their maximum loads.

(f) If a load is supported by more than one part of rope, the tension in the parts shall be equalized.

(g) Socketing shall be done in the manner specified by the manufacturer of the wire rope or fitting.[14]

5.0 Causation Discussion

5.1 Maintenance prior to fire

NYCE provided maintenance records in the form of Service Work Orders (SWO) outlining the various steps taken to ready the crane to rent to CCC. According to Mechanic2 and the GM, the process involved months of work to ensure the crane was ready to go out to the next project.

The GM said during his interview that the mechanics do not follow a strict checklist, but they follow the manual[15] (i.e., complete all the maintenance tasks) and incorporate the third-party inspector's requirements into this process. Some of the steps included the following: removed the pumps, sent them to a specialized company to rebuild/recalibrate, added new hydraulic fluid (275 gallons), replaced a hose due to visual inspection, drained old diesel fuel from tank, cleaned tank, lubricated fittings, started power pack to remove boom and hoist cable, reinstalled boom hoist cable, and replaced hoist cable, changed all the fluids, and reset and tighten all hydraulic pressure hoses. Mechanic2 performed the 100 hour and 250-hour Favco inspection.

Mechanic2 changed the hydraulic oil using VG 46 during the preparation phase. The independent lab report supports the oil as consistent with VG46. The manual suggests the crane uses VG 68 oil[16] during hot periods (Exhibit 13). However, Favco responded to a DOB request regarding VG 46 and said, "*There is no risk if VG68 is not used for temperatures above +20 degrees C*". According to the Crane and Derrick log maintained on the site, the weather on the day of the fires was 68°F and sunny, which is at or near the upper limit for VG46 pursuant to the manufacturer (Exhibit 13).

The third-party inspector opined that "*A thorough review of the crane installation, operation and maintenance manuals has been undertaken for a comprehensive undertaking of the components, functions, servicing and inspection requirements. All maintenance has been performed based on the current 17,834 hour meter reading as per manufacturer's recommendations*[17] (Exhibit 4 highlight).

[14] Tower Cranes, ASME B30.3-2016, The American Society of Mechanical Engineers, 2016 edition, p. 20
[15] Favelle Favco Cranes – Installation, Operations, Maintenance Manual, Crane Serial Number 1475, delivered March 2008.
[16] Favelle Favco Cranes – Installation, Operations, Maintenance Manual, Crane Serial Number 1475, Section 4.1, p. 118 of 500
[17] Certified Testing & Inspections, Inc., Third Party Certification of Crane Components dated January 10, 2023, p.6 of 193.

The hose that separated from its fitting was a topic in the Mechanics' and General Manager's interviews. When asked, Mechanic2 did not remember changing the high-pressure hoses (swing, hoist, and luffing) on any Favco crane during the readiness to rent phase including the crane involved in the incident. CTS requested an invoice from NYCE detailing when they last replaced this hose. NYCE responded "*New York Crane is unable to identify any particular invoice attributable to the specific hose referenced. It is unclear, from the available records, when the referenced hose was purchased*." Lastly, the GM said during his interview, discussing the invoice search, that it is possible that the hose was one of the original hoses when NYCE purchased the crane (2008), which, in this case, would make this hose approximately 15 years old at the time of its failure.

There are several factors that influence the service life of a hydraulic hose, such as: operating conditions, quality of the hose, its application, and environmental conditions. The manufacturer of the crane did not include hose replacement as one of its preventative maintenance tasks in the manual. Crane companies typically use visual inspection to determine when to replace a hose. Mechanics, operators, and inspectors look for cracking, abrasion, and leaking to determine replacement decisions. According to the HMO's and Mechanic2 the failed hose was not leaking, and the investigators did not see signs of deterioration (other than caused by the fire).

According to the SWO's provided, NYCE sent a mechanic to the job site seven times from April 5, 2023, to July 26, 2023. Six times were due to hydraulic issues and five of these related to slow hoist speed (surging). When asked, the NYCE General Manager said they received calls for the Favco cranes, in general, regarding hoist speed, and he received such calls particularly on concrete jobs.

CCC had an Oiler (mechanic) on staff. This report designates him as HMO3/Oiler. CCC charged this person to maintain the crane and be an HMO. During his interview, he said that he performed all the required maintenance but did not maintain a written log of all these tasks. Section (l)(1)(i) of 1 RCNY §3319-01 requires that "*a preventive maintenance program based on the crane or derrick manufacturer's recommendations shall be established. Dated and detailed records shall be readily available to the department*."

There is a section in the Manual (4 Maintenance) that describes the required preventive maintenance (Exhibit 14). It lists various tasks and assigns a time to perform such based on operating hours or calendar months (whichever occurs first). There are several tasks that the manual required during the crane's tenure at the site, but there were minimal records indicating HMO3/Oiler performed them. The maintenance portion of the crane's manual listed items including, but not limited to, the following:

- Check for external hydraulic leaks and repair immediately
- Pump drive gearbox – every 500 to 1000 hours or every six months
- Slew ring lubrication – every 50 operating hours
- Inspect or drain the collection bowl of water daily and replace the element every 500 hours, every other oil change or if a power loss is noticed

- Engine oil sample every 250 hours
- Coolant samples every 500 hours.

The HMO's noted the engine hours weekly and totaled 1,117 hours. Due to the hours worked, HMO3/Oiler should have performed each of the above while the crane was on-site.

The records available to DOB were the daily and monthly inspections sheets, and the records noted one engine oil change. The manual requires an oil change every 300 hours, and this would equate to at least three times based upon the hours the crane operated at the site. The team requested "*All purchase orders and invoices for all items bought for crane maintenance during the project*." The documents produced were payments for diesel fuel and eight (8) fuel filters, and the inspection log did not indicate when or if HMO3/Oiler installed these filters.

CTS asked the HMO's if they had noticed hydraulic leaks on the crane and specifically in the engine compartment (power pack). The answers varied. HMO 1 said that he did not see any leaks, but when shown Photograph 4.3.1 he adjusted his response to say he did not see any in the power pack area. HMO 2 said that "*to be honest, all cranes have seeps and leaks*." HMO 3 said there may have been a few drips but did not remember any absorbent pads in the power pack area.

Mechanic2 said that when he operated the crane in the shop there were no leaks in the power pack area. Further, he said that the crane operated for a day or two and he would have seen them. His definition of a leak was if he touched the fitting and it felt damp – this was a leak, and he would have replaced the hose. When he travelled to the crane on the service calls, he did not recall noticing leaks from the fittings. He also performed a 100-hour service inspection in May 2023 and did not note any leaks.

Due to the lack of maintenance records, CTS could not independently verify the extent of the on-site maintenance. HMO 3 said that he followed the required maintenance tasks contained in the manual, and the manual was in a toolbox on the crane at the time of the fire. For instance, HMO 3 said that he changed the engine oil every 300 hours but only included such action once in the daily inspection logs. When asked where they procured parts and fluids, he mentioned that the CCC may have had them from other projects.

5.2 Inspections

CCC required the operators to perform a daily inspection, which is also in accordance with DOB regulations (1 RCNY §3319-01(k)). The operators had a rotating schedule they managed themselves. One operator typically worked 4 hours per day for two days per week, one worked 4 hours per day for three days per week, and the other operator worked 4 hours per day five days per week. They would discuss among themselves who would work overtime, and the weekends when CCC required it.

Favco included three types of inspections in the maintenance section of the manual – daily, 40 hour and 100 hour. CCC referred to these as Daily, Weekly, and Monthly. The forms in the manual differ slightly from the forms used by CCC. DOB/DOI provided the

completed forms to CTS. Exhibit 15 includes copies of the inspection forms from the manual, and a sample of the ones used by the HMO's during the project.

The HMO that worked the first 4 hour shift each day would perform the daily inspection. The HMO's used what appears to be a Favelle Favco form, but it was different from the one contained in the manual. The one in the manual included additional items, more fluid level, and the power pack checks. The forms did not have the DOB requirement "*Inspect – Hydraulic and pneumatic hoses*" (1 RCNY §3319-01 (k)(1)(i)(B) 1.). This regulation requires the daily inspection to include items in the ASME30.3 (2016 edition) (3-2.1.3(k)). During the interviews, none of the interviewees knew the source of the form used. Exhibit 15 is an example of the forms used by the HMO's.

Favco provided and CCC had a weekly inspection (40 hour) form. However, pursuant to the information provided, no one performed these inspections. When asked, one HMO said that DOB did not require them. The NYC code requires daily, monthly, and annual and a weekly inspection is not specifically mentioned.

The logs removed from the crane shortly after the fire showed the operators performed the daily inspections (as previously mentioned) and HMO3/Oiler performed the monthly inspections (100 hour). The section for the weekly inspection consisted of blank pages.

As mentioned above, Mechanic2 performed a monthly inspection in May 2023 and used a more detailed form (Exhibit 15).

The HMO's mentioned that they looked for leaks during their daily routine and each gave a slightly different answer to "what is their definition of a leak" ranging from not seeing any to one that said he felt all cranes had some leakage. The investigating team found evidence that HMO3/Oiler used oil absorbent pads at various locations around the upper crane. The slewing motor had one wrapped around the expansion tank (Photograph 4.5.2). HMO3/Oiler said that he did this because he added oil to the slew motor. Mechanic2 said that there should be no need to fill it while the crane is on-site.

Favco requires that the inspector drain one liter of hydraulic fluid during the 100-hour inspection. This task, according to Favco, was necessary to determine if water was present in the hydraulic tank. Existence of water in a hydraulic system can create rust within the system and adversely affect the hydraulic fluid's ability to effectively transmit pressure and lubricate moving parts.

Neither HMO 3 nor Mechanic2 performed this task as outlined. The HMO 3 was unaware of this requirement when asked during the interview. Mechanic2 said that he only opened the valves to see if water came out. The GM said NYCE leaves the decision to perform this test in the manual to the mechanic.

5.3 Day of the Fire

According to the HMO's, the two scheduled to work that day agreed that HMO 3 would operate the crane for the morning shift. HMO 3 said that he arrived that day (July 26th) between 6:00am and 6:10am. He said he met with the Lift Director to discuss the planned lifts, weather conditions, and the area where the crane would work. He said that he reached the operator's cab around 7:00am.

He said that he followed his typical daily routine. He would arrive at the site around 6:00 am and go to the shanty and put on work clothes, talk to the Lift Director, and sign the log. He would then go up to the operator's cab and look at the bolts as he went up. He would perform a visual inspection of (walk around) the machine deck looking for obvious items such as bolts, fuel level, oils, anything out of the ordinary. He would then go to the cab and start the crane. While the crane was warming up, he would fill out the daily inspection log. He would then perform the function test to see if the limits and the crane were operating properly.

After the functional test, he said he was ready to start lifting loads. The planned operations for that day were to pour the 44th floor concrete deck, load material to the 44th floor after the pour, and miscellaneous picks. The weather noted in the Crane and Derrick Log was temperature was 68°, sunny, with wind ranging from 1 – 5 miles per hour.

The operator said that they were using two 3-yard concrete buckets to pour the deck. Each truck contained approximately nine yards equating to three trips per truck. The operator said that on the second bucket of the second truck he noticed a hydraulic system light (indicating low hydraulic fluid) on the panel and at the same time the signal person radioed to him that there was smoke coming from the rear of the crane.

He said that he pressed the emergency stop or turned the key off (same effect) and he came out of the cabin and oil was everywhere. He slipped but did not fall. He heard someone say fire and went back into the operator's cabin to get a fire extinguisher. He noticed that the hydraulic tank sight glass indicated the tank was empty. The fire was between the motor and the drums. He went to the hydraulic pump doors (already open) and thought he was getting the fire under control but could not reach the middle of the power pack, so he went back towards the cab passed through the turntable and arrived on the other side and the fire had grown, he emptied the fire extinguisher and then decided to leave the crane. There was only one fire extinguisher – it was a small one that was behind the operator's seat (see Photograph 4.1.1). He said that he thought he may have been able to put the fire out if he had a larger fire extinguisher.

By the time he reached the 40th floor landing, the fire had grown. He met the LD at the walkway and told the LD to shut down the streets. There was talk about sending up a person with more fire extinguishers, but the fire was too intense, and it was determined it was not safe to send a person. The site proceeded to shut down 10th Avenue and 41st Street to vehicle and pedestrian traffic.

The operator did not recall the time the fire started, but he said that he started lifting around 7:00 am. He was on the second concrete truck, and he thought it was the second pick. This would mean they were on the 5th pick of the day. He said the crane was operating for about 30 minutes before the fire started.

The hydraulic pressure for the slewing system is between 3000 psi and 4000 psi per Mechanic1. This would explain the operator's comments that he saw oil everywhere when he went to investigate the hydraulic light issue.

CTS's opinion is that the separation of the hose from the fitting created a hydraulic mist with a flash point around 240°C (see Laboratory Analysis in Exhibit 5). The separated hose sprayed the mist in the general direction of the engine, and the mist ignited. The auto ignition temperature for the hydraulic oil was approximately 360° so once the mist ignited the temperature increased and the fluid caught fire. The fire was primarily between the diesel engine and the luffing rope drum.

The operator said that he did not see any leaks in the area around the pumps during his daily inspection.

The fire grew in intensity and consumed the rear part of the power pack. The flames and heat were primarily between the motor and the luffing rope drum. The luffing boom rope path goes from the bottom of the drum to the top of the "A" frame (Exhibit 2). This path placed the rope in flames / heat. Wire rope under stress, when exposed to extreme heat, will eventually fail, and in this fire the rope failed.

There are engineering articles covering the effects of extreme heat on wire rope. Engineering Structures published one such article. One point this article noted was: *"… The external wire layers, subjected to the highest temperatures, undergo an extensive plastic deformation at a nearly constant, or even decreasing stress. The applied load is therefore progressively transferred to the internal wires. Since all wires experience the same axial elongation, it is reasonable to assume that failure will occur at the internal wires, as for the estimated time to rupture their temperature is between 350° and 450°C, corresponding to the lowest rupture strain*"[18].

The fire was so intense that it melted the diesel motor's oil pan. The CTS investigator witnessed molten aluminum that had solidified under the rear electrical box (Photograph 5.3.1). In addition, the steel structure supporting the engine deformed bending downward (Photograph 5.3.2). These indicate that the fire was, at a minimum, between 463°C and 671°C[19].

The fire continued for several minutes (time unknown), but it was long enough to adversely affect the boom hoist rope. When the rope failed, the boom started to fall and struck an adjacent building, hit its mast, hit the building it was constructing, and then fell to the ground. There were no fatalities due to the actions of the crane crew stopping vehicle and pedestrian traffic.

[18] Fire behavior of steel ropes: Experimental investigation and numerical analysis, V. Fotanarie, M. Benedetti, B.D. Monelli, F. Degasperi, Engineering Structures, Elsevier, Ltd., 2014, pages 346 -347.
[19] Internet search Melting point of Aluminum alloy provided the chart shown on the following link - https://www.engineersedge.com/materials/metal_melting_temperatures_13214.htm



Photograph 5.3.1



Photograph 5.3.2

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The investigation included calculating the force of the rope, assuming three scenarios (Section 4.5), and the analysis concluded that the rope had sufficient safety factors to withstand normal crane operations and more importantly the force on the rope at the time of the fire.

6.0 Conclusions

Maintenance.

CTS reviewed the SWO's provided by NYCE and the third-party tower crane inspection performed by CTI. CTI affirmed that they performed a thorough review of the crane and opined that "*all maintenance has been performed based on the current 17,834 hour meter reading as per manufacturer's recommendations*[20]". Based upon the documentation presented, the subject tower crane appears to have had all the required maintenance prior to its arrival at site.

The lack of written site documentation prevents the investigation team from opining on the sufficiency of the maintenance performed while the crane was on site. The documents provided were the daily inspections sheets that showed one engine oil change (there should have been at least three based on hours worked), and CCC purchased eight (8) fuel filters. HMO3/Oiler said during his interview that he performed all the maintenance required in the Operator's Manual but did not maintain a separate maintenance log.

Inspection. The documentation provided showed that the operators performed the required daily inspections, and HMO3/Oiler performed the monthly inspections. The weekly inspections outlined in the Operator's Manual were not performed. The completed inspections forms did not have an inspection criterion to check for "*Inspect – Hydraulic and pneumatic hoses"* that the DOB regulations require. The three HMO's and Mechanic2 said that they did not notice a leaking fitting in the power pack area.

[20] Certified Testing & Inspections, Inc., Third Party Certification of Crane Components dated January 10, 2023, p.6 of 193.

The lack of written maintenance documentation and not performing the 40-hour inspection did not directly cause the fire unless the slewing hose was leaking and went unnoticed / unreported by the HMO's.

The investigating team's opinion that performing destructive testing on the hoses and fittings removed from the crane would not likely determine the cause(s) as to why the fitting failed. Further, such testing would not determine if the hose was leaking prior to the failure. Therefore, CTS did not perform this testing.

Favco Service Bulletin FFCA-EB-030 (Exhibit 3)

Favco prepared and issued a service bulletin in July 2016 that offered several actions that would lessen the possibility of a catastrophic failure should a fire start in the power pack. For example, adding two (2) 9kg Class B fire extinguishers, install a fire detection system, and install a fire suppression system in the power pack area.

Favco sent an email to the owner of NYCE on July 1, 2016, that attached this bulletin. The GM mentioned that he did not remember seeing the bulletin until after the fire. However, he did discuss a conversation NYCE had with a customer around 2016 regarding steps that NYCE would take to lessen the chances of a fire on cranes that the customer rented from NYCE in 2016. The result was NYCE installed fire retardant material around various hydraulic hoses.

NYC DOB did not receive a copy of this bulletin until after the fire even though 1_RCNY §3319-01(d)(6) required Favco to send it. It is unclear whether Favco knew of this requirement between 2016 to 2023.

Day of the Fire.

Hydraulic hose separation. The CTS opinion is that the separation of the hose from the fitting created a hydraulic mist with a flash point around 240°C. The separated hose sprayed in the general direction of the engine, and the mist ignited. The auto ignition temperature for the hydraulic oil was approximately 360° so once the mist ignited the temperature increased and the fluid caught fire. The fire was primarily between the diesel engine and the luffing rope drum.

The rope failed about 8' from the bottom of the drum or slightly less than 8' above the fire. There are engineering studies that addressed how heat affects wire rope, and these are mentioned above. Due to the heat, the luffing rope failed, and the luffing boom fell and struck the building across 10th Avenue and then the building and its own mast at 550 10th Ave.

CTS calculated the safety factor of the luffing rope using three scenarios: 1) estimated load on hook at the estimated radius, 2) estimated weight at maximum radius (not possible due to building across the street), and 3) maximum weight per load chart at maximum radius. In all three scenarios, the rope exceeded the design safety factor outlined in the ANSI B30.3 Tower Cranes standard. Therefore, the rope was sufficient to use in the crane's configuration.

There was one small fire extinguisher on the machine deck, which proved to be insufficient to extinguish the fire. The Favco bulletin issued in 2016 recommended that the owner's place two (2) 9kg Class B fire extinguishers (larger than the one of the 10th Ave. Crane) to be available on the machinery deck. Pursuant to HMO 3's comments, having two such extinguishers he may have been able to extinguish the fire before it went out of control.

Favco also recommended the owners install a fire detection device into the power pack to aid in early detection. Had such a device been installed and in conjunction with addition fire extinguishers, the operator may have had more time and capacity to bring the fire under control.

Favco also included a recommendation from WorkSafe (Australian regulator) to install a plumbed fire extinguishing system that would be directed to the areas where flammable fluids might pool in the event of leakage within the power pack.

CTS did not believe it was necessary to evaluate the rope since the cause of failure was the intense fire. Such testing would add little, if anything, to the overall assessment of the collapse or recommendations.

7.0 Recommendations

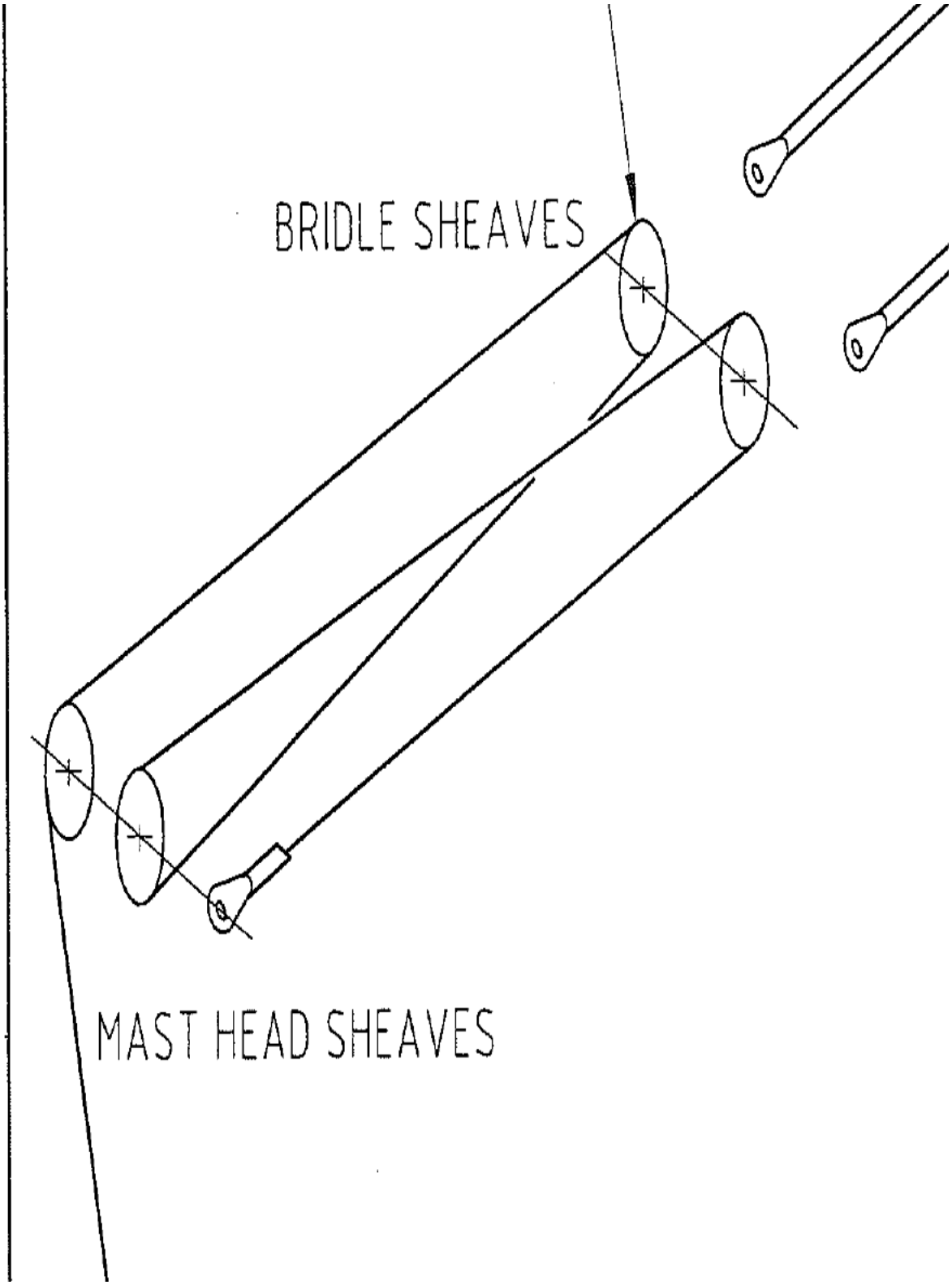
Based upon the evidence collected, there are actions that, if implemented, could have prevented the catastrophic boom failure. The Favco Engineering Bulletin issued in 2016 listed these tasks (Exhibit 3).

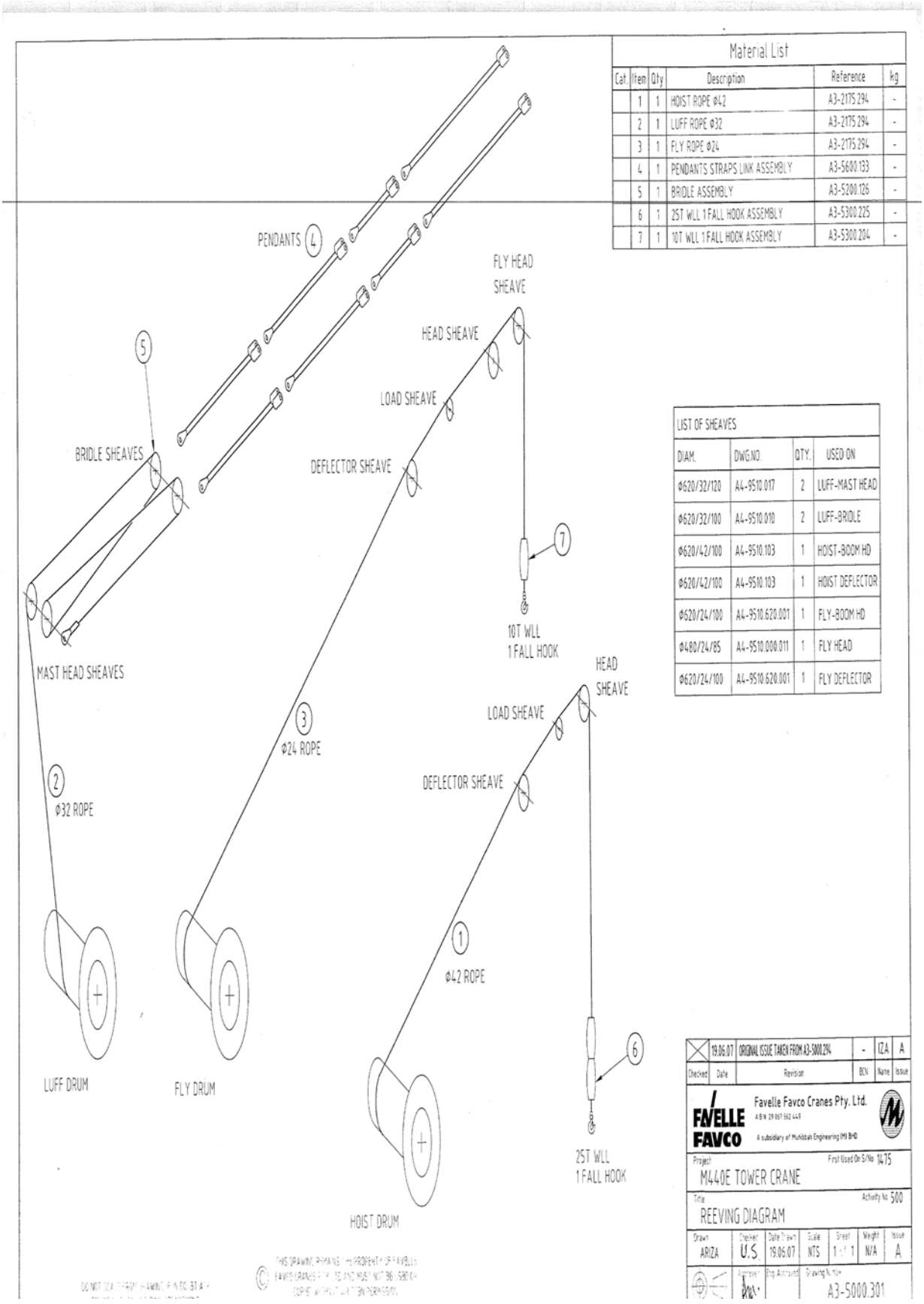
Shortly after the fire, DOB instituted a ruling (based upon the above Favco bulletin – Exhibit 3) that all diesel tower cranes must have a fire suppression system, among other requirements contained in the bulletin. Russo opined that such systems are designed to quench such a fire in heavy equipment. DOB should codify the fire suppression requirement, and the others included in the bulletin.

Electric tower cranes do not require a fire suppression system because flammable hydrocarbons are limited to small quantities and do not have a heat source significant enough to ignite hydrocarbons.

DOB may consider formalizing / codifying the third-party tower crane inspections currently performed prior to the assembly of a tower crane. CTS reviewed two third party inspections provided by NYCE and they were detailed and provided a thorough examination of the crane. This is important for tower cranes because Users assemble them on site, and they remain in place for several months.

Crane Tech Solutions, LLC reserves the right to amend and/or supplement this report if additional information, documentation, or evidence becomes available.


BRIDLE SHEAVES
MAST HEAD SHEAVES



Material List					
Cat.	Item	Qty	Description	Reference	kg
	1	1	HOIST ROPE Φ42	A3-2175.294	-
	2	1	LUFF ROPE Φ32	A3-2175.294	-
	3	1	FLY ROPE Φ24	A3-2175.294	-
	4	1	PENDANTS STRAPS LINK ASSEMBLY	A3-5600.133	-
	5	1	BRIDLE ASSEMBLY	A3-5200.126	-
	6	1	25T WLL 1 FALL HOOK ASSEMBLY	A3-5300.225	-
	7	1	10T WLL 1 FALL HOOK ASSEMBLY	A3-5300.204	-

LIST OF SHEAVES			
DIAM.	DWG.NO.	QTY.	USED ON
Φ620/32/120	A4-9510.017	2	LUFF-MAST HEAD
Φ620/32/100	A4-9510.010	2	LUFF-BRIDLE
Φ620/42/100	A4-9510.103	1	HOIST-BOOM HD
Φ620/42/100	A4-9510.103	1	HOIST DEFLECTOR
Φ620/24/100	A4-9510.620.001	1	FLY-BOOM HD
Φ480/24/85	A4-9510.000.011	1	FLY HEAD
Φ620/24/100	A4-9510.620.001	1	FLY DEFLECTOR

19.06.07	ORIGINAL ISSUE TAKEN FROM A3-5000.294	-	IZA	A
Checked	Date	Revision	BCN	Name	Issue

Favelle Favco Cranes Pty. Ltd.
ABN 29 007 562 449
A subsidiary of Muhibbah Engineering (M) BHD

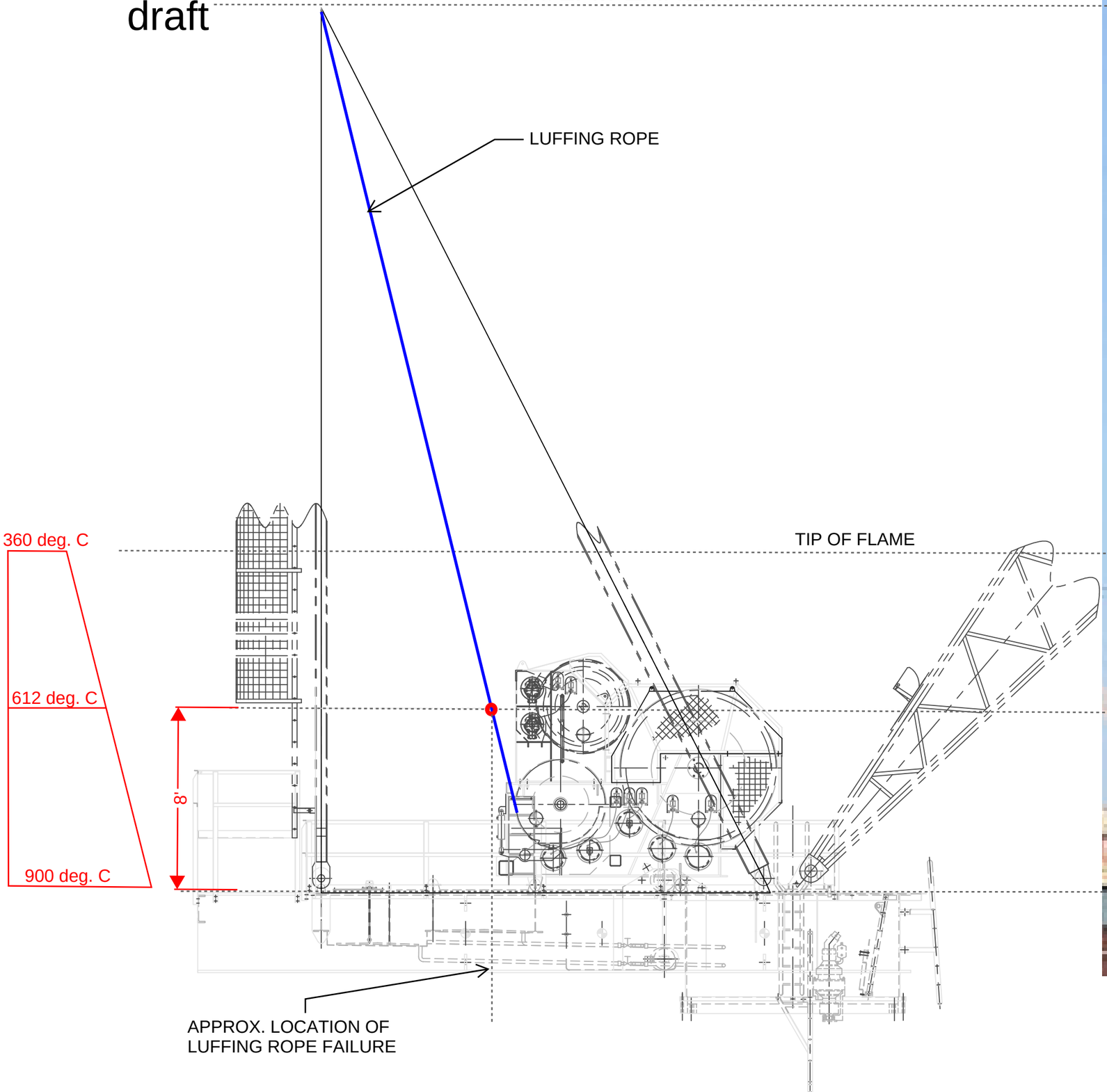
Project: M440E TOWER CRANE — First Used On S/No 1475

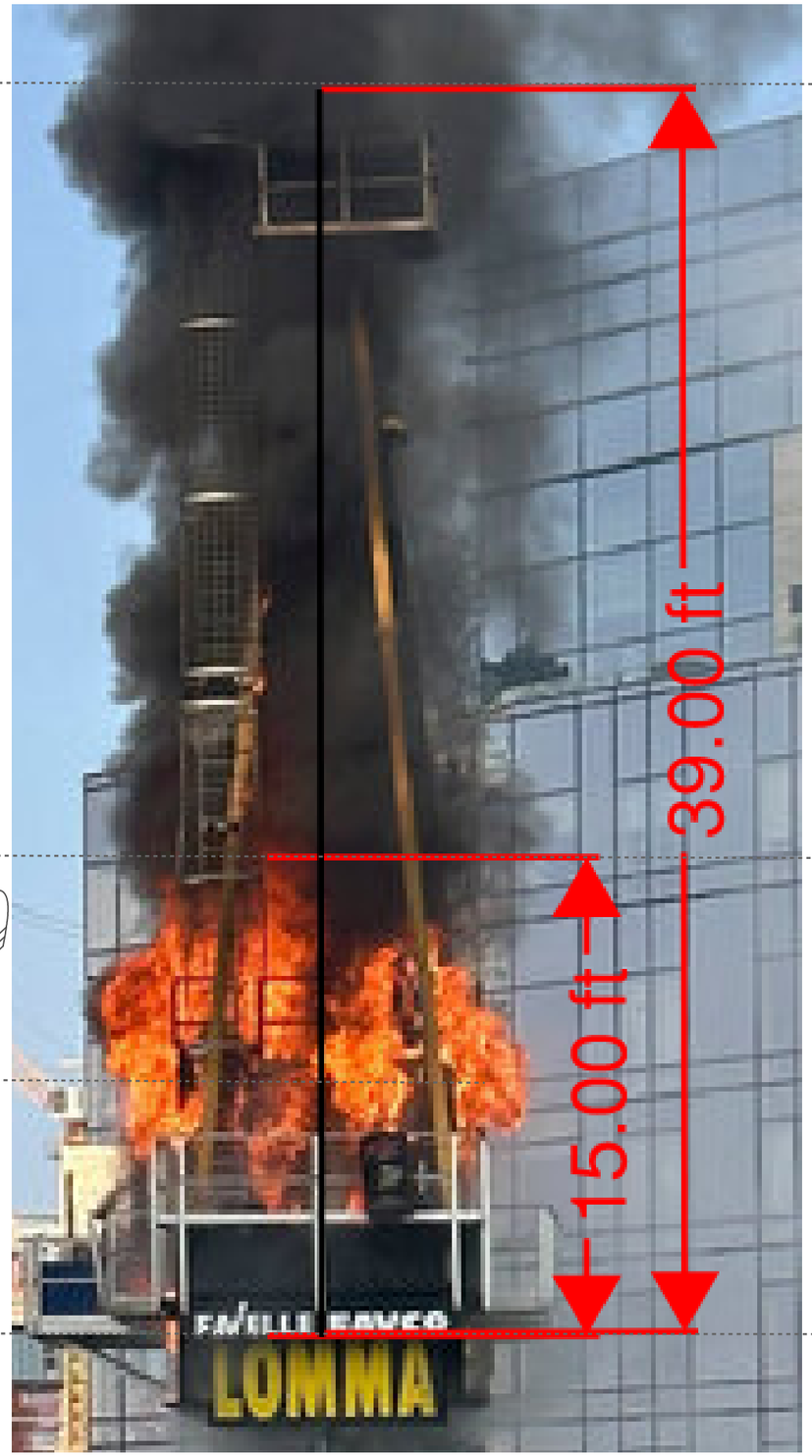
Title: REEVING DIAGRAM — Activity No 500

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
ARIZA	U.S.	19.06.07	NTS	1 of 1	N/A	A

Approved | Eng Approved | Drawing No.: A3-5000.301

DO NOT SCALE DRAWING IF IN DOUBT ASK
THIS DRAWING REMAINS THE PROPERTY OF FAVELLE FAVCO CRANES PTY. LTD. AND MUST NOT BE COPIED WITHOUT OUR WRITTEN PERMISSION.


LUFFING ROPE
TIP OF FLAME
360 deg. C
612 deg. C
900 deg. C
8'
APPROX. LOCATION OF
LUFFING ROPE FAILURE


39.00 ft
15.00 ft
LOMMA

FAVELLE FAVCO

ENGINEERING BULLETIN

Reference No.	: FFCA-EB-030
Revision	: A
Effective Date	: 01.07.16
Prepared By	: J. Dawson
Approved By	: S. Chong

	SAFETY	X	SERVICE	X	INFORMATION

SUBJECT:	**Fire that occurred on a Favelle Favco Tower cranes**
CRANES S/No.	**All Favelle Favco diesel/hydraulic tower cranes operating outside Australia**

This bulletin is published in response to recommendations from Safework (NSW) specifically for the state of New South Wales (NSW), Australia and after detailed studies and further discussions with users within Australia.

It should be noted that the recommendations forwarded within this Bulletin are not subject to the laws of NSW, Australia, and are thus not compulsory to implement in other parts of the World. However, as the consequence of the fire was a loss of the luff rope supporting the boom Favelle Favco Cranes (FFC) advises all customers to follow the recommendations given herein.

The possibility of fire still remains very low without implementation of the recommendations given below but FFC still advises that they are implemented in a timeous manner. The implementation of these recommendations are to be done as soon as practically possible and is not viewed as posing any immediate danger, thus cranes can continue to operate whilst the recommendations are implemented.

This bulletin is published for information to all Favelle Favco diesel/hydraulic driven tower cranes operated outside of Australia. FFC are at your disposal should you have any further questions with respect to this bulletin

1. Immediate Action (as soon as practically possible)

1. 1 Maintenance/Daily operations

FFC would like to take this to opportunity to emphasise the importance of regular inspection and maintenance within the power pack and makes the following recommendations.

1.1.1) Any leaking hoses or fittings should be attended to immediately.

1.1.2) All electrical connections must be tight to ensure no possible sparks can occur. FFC forwards the following products (or equivalent) that can be considered to ensure that connections do not work loose:

i) Nord Lock Washers (http://www.nord-lock.com/)

ii) Palnuts (https://issuu.com/araymond-network/docs/arti_catalog-final_feb_2015?e=8836684/11602219) – page 14

iii) Loctite Thread locking solutions recommended product Loctite 222 up to M14.

1.1.3) Owners/operators are requested to ensure that no extraneous materials are left within the power pack area that could potentially initiate or accelerate a fire (cleaning agents, greases, rags etc.).

1.1.4) Inspect electrical cables within the power pack particularly the battery cables. If any cables show signs of damage then they should be replaced with cables of the same capacity and if possible incorporating insulation that meets a recognized fire rating. FFC can be contacted if further advice is required.

1.1.5) If an engine sump drain line has been fitted then FFC recommends that care is taken to ensure that this hose cannot come into contact with the battery terminals or any other items that

might compromise the hose integrity in anyway (see further recommendations under the Longer Term Actions section).
1.1.6) Ensure that the battery isolator has been activated if the crane is going to be unattended for any period. Owners/operators are requested to emphasise to their crews the importance of following this simple safety step.
1.1.7) Ensure that the sludge tank is emptied regularly.

FFC believes that good inspection and maintenance regimens within the power pack area will significantly lower the potential for a fire to occur.

1. 2 Hydraulic hoses

Owners and operators are requested to inspect all hoses that are used for the transmission of flammable liquids (hydraulic hoses, fuel lines, etc.) within the power pack and winch systems to ascertain their fire ratings.

If any of these hoses are found to carry no approved fire rating then they should eventually be replaced with hoses that do meet a recognised fire rating. We would like to highlight that the lack of fire rating does not pose any immediate danger to the operations of the crane and should be done as soon as practical.

If an offending hose is found on a crane in service and will prove difficult to replace while in service; then the offending hose should be wrapped in a fire blanket until a convenient time is found to replace the hose. Suitable fire blankets can be discussed with your hose supply company or contact FFC for further advice.

A recognised fire rating such as MSHA (Mine Safety and Health Administration (USA)) "Hydraulic hose meeting interim fire rating" and is indicated as an MSHA marking on the hose, or hoses meeting ISO15540/41 would be suitable. There are likely other certified fire ratings and owner/operators can discuss this with their hose supplier or contact FFC to discuss further

FFC does not believe that the replacement of said hoses reduces the risk of a fire starting. However, we believe that they would act to retard the rate at which a fire would escalate and hence could potentially give vital time for escape, fire fighting, or other actions to take place.

1. 3 Fire Detection

Install any suitable fire detection device (which could possibly be a small camera) into the power pack to aid early detection should a fire occur.

1. 4 Fire extinguishing

FFC recommends owners/operators to have at least two 9kg Class B fire extinguishers available on the machinery deck of the crane.

2. Longer Terms Action (next major in-yard service of the crane)

2.1) Relocate the engine batteries

The batteries should be removed from the power pack bay and placed in a separate protected enclosure. The battery cables should enter the power pack bay via as small an opening as practical. These cables should be suitably sized and routed and supported to minimise the possibility of damage to the cables. (NB recommendations given in section 1.4) also apply)

2.2) Further protection of electrical connections

If suitable insulating boots can be found to cover battery connections, starter motor connections, and alternator connections then they should be fitted.

2.2) Battery Isolator

With reference to 1.1.6) above the isolator will need relocating in conjunction with the battery. FFC takes the opportunity to inform their customers that many of our Australian customers have chosen to fit an automatic battery isolator and FFC can be contacted should you choose to fit such an option.

2.3) Use of thread sealants

As an additional safe guard against flammable fluid leakage FFC recommends the use of thread sealants on any threaded connection (acting as additional line of defence against leakage should the primary means fail to seal in some way). Suitable sealants are Loctite 542, or Slic tite (http://www.laco.com/pipe-thread-sealants/slic-tite-paste-with-ptfe/).

2.4) Fire Detection

FFC recommends the installation of a fire detection system within the power pack. The system should deliver an audible and visual alarm to the crane operator's cabin.

FFC is aware that some users in Australia have chosen to fit a camera system in the power pack in conjunction with the detection system on the premise it will offer further visual benefits in terms of ascertaining the conditions within the power pack at any time.

2.5) Fire extinguishing

FFC recommends owners/operators to have at least two 9kg Class B fire extinguishers available on the machinery deck of the crane. However, FFC would like to inform their customers/operators that the WorkSafe (NSW) recommendations included the inclusion of a plumbed fire extinguishing system that would be directed to the areas where flammable fluids might pool in the event of leakage within the power pack. FFC to be contacted should customers require further information on fixed fire extinguishing systems.

2.6) Hydraulic tank

FFC recommend the following modifications should be made to protect the contents of the hydraulic tank should a fire occur:

2.6.1) Replace all pump suction hoses with flexible metal hose, flexible metal hoses are available from most recognised hose manufacturers. FFC can be contacted for further information with respect to these products.

2.6.2) Fit S type check valves from Rexroth (https://www.boschrexroth.com/en/us/products/product-groups/industrial-hydraulics/onoff-valves/isolator-valves/check-non-return-valves/index) to all tank return lines.

2.7) Further protection to luff rope

Install an extended wall (sheet metal) between the luff winch and power pack to act as a further barrier to shield the luff rope.

If you require further information on this matter, please contact:

1. Mr. John Dawson, Engineering Manager, Favelle Favco Cranes P/L, Australia.
   Email: johnd@favellefavco.com.au
2. Mr. Alistair McCulloch, Chief Designer, Favelle Favco Cranes P/L, Australia.
   Email: Alistairm@favellefavco.com.au

Gmail VOL. III EXHIBIT 4 David Kuang <dk@valjatopc.com>

CN 456-22 Tower Crane 3rd Party Certification (550 10th Ave., New York, NY)

Frank Damiani (Buildings) <FDamiani@buildings.nyc.gov> Wed, Jan 25, 2023 at 10:03 AM
To: David Kuang <dk@valjatopc.com>
Cc: "cranesandderricksIR (Buildings)" <cranesandderricksIR@buildings.nyc.gov>, Steve Valjato <steve@valjatopc.com>, "Veronica Windley (Buildings)" <VWindley@buildings.nyc.gov>, "Ashraf Omran (Buildings)" <AOmran@buildings.nyc.gov>, "Mohammad Seraz (Buildings)" <MSeraz@buildings.nyc.gov>, "Wilkin Deleon (Buildings)" <WDeleon@buildings.nyc.gov>, "Daniel Meyer (Buildings)" <dameyer@buildings.nyc.gov>, "David McEwen (Buildings)" <damcewen@buildings.nyc.gov>, "Richard Hamilton (Buildings)" <rihamilton@buildings.nyc.gov>, "Toshee Newson (Buildings)" <TNewson@buildings.nyc.gov>, Karla Alvarez <ka@valjatopc.com>, Joseph Solek <js@valjatopc.com>

Morning all the above 3rd party report is accepted with no remaining issues. Please upload approved /accepted documents to the record ASAP.

Frank Damiani

Chief Inspector

Cranes and Derricks Unit

Division of Engineering and Safety Operations

New York City Department of Buildings

2 Lafayette street, New York, NY 10007

Office: 212-602-0577

E-Mail: FDamiani@buildings.nyc.gov

From: David Kuang <dk@valjatopc.com>
Sent: Tuesday, January 24, 2023 10:20 AM
To: Frank Damiani (Buildings) <FDamiani@buildings.nyc.gov>
Cc: cranesandderricksIR (Buildings) <cranesandderricksIR@buildings.nyc.gov>; Steve Valjato <steve@valjatopc.com>; Veronica Windley (Buildings) <VWindley@buildings.nyc.gov>; Ashraf Omran (Buildings) <AOmran@buildings.nyc.gov>; Mohammad Seraz (Buildings) <MSeraz@buildings.nyc.gov>; Wilkin Deleon (Buildings) <WDeleon@buildings.nyc.gov>; Daniel Meyer (Buildings) <dameyer@buildings.nyc.gov>; David McEwen (Buildings) <damcewen@buildings.nyc.gov>; Richard Hamilton (Buildings) <rihamilton@buildings.nyc.gov>; Toshee Newson (Buildings) <TNewson@buildings.nyc.gov>; Karla Alvarez <ka@valjatopc.com>; Joseph Solek <js@valjatopc.com>
Subject: [EXTERNAL] Re: CN 456-22 Tower Crane 3rd Party Certification (550 10th Ave., New York, NY)

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe. Forward suspect email to phish@oti.nyc.gov as an attachment (Click the More button, then forward as attachment).

Mr. Damiani, Good morning. We'd like to check the status of the 3rd party certification for CN#456-22, since we're concerned about the expiration date of the mag reports (the last date of the inspection is 12/21/22) which can be considered invalid around the President day weekend. We are currently targeting to erect the tower crane during the Feb. 4th weekend. If you have any further comments for the 3rd party certification submission, please let us know. Thanks,

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[Quoted text hidden]

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[Quoted text hidden]



[Quoted text hidden]
[Quoted text hidden]

VALJATO ENGINEERING, P.C.
249 Hinsdale Street, 2nd Floor
Brooklyn, NY 11207
Phone: (718)701-2707 | Fax:(646)351-0412 | Alt. Fax:(718)342-3266

Jan. 10th, 2023

Department of Buildings
Borough of Manhattan
2 Lafayette Street, 12th Floor
New York, NY 10007

RE: 550 Tenth Ave., New York, NY 10018
Tower Crane Favco M440 Third Party Report
CN00045622, CD#4052, SN#1475

To whom it may concern:

As the crane EOR of the CN shown above, we have reviewed the enclosed inspector certification package, including all relevant documents of the inspection. We have found it to be complete. I do not object to the crane's erection.

Foundation elements 3rd party was filed on August 12th, 2022 and approved on August 18th, 2022. Foundation elements 3rd party amendment/supplement was filed on November 23rd, 2022 due to changes for the CD#, SN#, report date, and removing the tower section from previous package, and it's approved on December 1st, 2022.

Sincerely,



Steve Valjato, PE

THIRD PARTY CERTIFICATION OF CRANE COMPONENTS

M440E Favelle Favco SN#1475 CD#4052

Prepared by:
Alice Kupper, P.E.

Total Pages: 185 (including this page)

NY Crane & Equipment
37-30Review Avenue
Long Island City, NY 11101
Phone# 718-254-9500
Fax# 718-643-0942

Alice Kupper, P.E.

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CERTIFIED TESTING & INSPECTIONS, INC.

TESTING • INSPECTIONS • ENGINEERING

January 10, 2023

Department of Buildings
C/O Crane & Derricks
280 Broadway
New York, NY 10007

Dear Sir/Madam,

During the inspection on December 2022 at 9 Albert Avenue, Newark, NJ all components and hardware accessories were inspected including pins, bolts, nuts, washers and torque. All fastening hardware for the crane is OEM, all bolts and connecting hardware have been cleaned, adequately lubricated and no damage or corrosion found. An inspection was performed on the Slew Mount and Front Split Deck - all structural welds were inspected utilizing magnetic particle inspection inside and outside welds, approximately 6,500 linear inches were inspected with no cracks or relevant indications found.

Favco Engineering modifications FFCA-EB-034 have been performed as per manufacturer's procedures on the Slew Mount and Front Machine Deck. As per NY Crane Logbook there were no other major repairs performed on any part of the crane. Maintenance history was made available. All VI, MT, UT and Torque Testing reports for components were reviewed. To the best of my Professional knowledge all components complied with Manufacturer Specification.

A thorough review of the crane installation, operation and maintenance manuals has been undertaken for a comprehensive undertaking of the components, functions, servicing and inspection requirements. All maintenance has been performed based on current 17,834 hour meter reading as per manufacturer's recommendation.

A complete inspection and non-destructive testing of the unassembled state of the crane and all of its structural, mechanical, electrical and control components were performed and documented.

Certified Testing & Inspections, Inc. performed field audit of shop maintenance manuals of Favco M440E CD#4052 SN#1475. CTI reviewed all available crane installation, operation and maintenance manuals and found that the equipment serial numbers was properly identified.

Anti-two Block device should be inspected upon completion of assembly. Since all 3rd party inspection for Favco M440E CD#4052 SN#1475 was inspected prior to the crane assembly, this type inspection could not be performed.

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(Continued)

Crane report (first page before Magnetic Particle Report) states "all areas are inspected from two planes to insure 100% coverage". Actually all accessible welds have magnetic particle performed on them. Also, paint does not need to be removed from welds to perform dry magnetic particle inspections as per CTI-MT-001 procedure and ASTM E709-15, paragraph 9.1.1.

The unassembled crane components are in acceptable condition for permitted erection.

Respectfully submitted,

Alice Kupper, PE

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January 10, 2023

Department of Buildings
C/O Crane & Derricks
280 Broadway
New York, NY 10007

Dear Sir/Madam,

Certified Testing & Inspections, Inc. performed field audit of shop maintenance records of Favco M440E CD#4052 SN#1475. CTI reviewed all available maintenance records, including records for the complete overhaul that occurred in December 2022. Reviewed were maintenance records at 9 Albert Avenue, Newark, NJ. Based on these records provided by NY Crane all maintenance was performed from daily through 17,834-hour intervals per manufacturer's recommendations. The following maintenance is performed:

- Engine oil levels,
- Radiator water level,
- Diesel fuel level,
- Pump drive oil level,
- Hydraulic oil level,
- Engine air cleaner,
- Hoist rope lay,
- Check the annunciator to ensure the visual and audible alarms are working,
- Hoist up/down limit,
- Luff in/out limit,
- Check the engine/crane battery (if applicable),
- Power Pack holding down bolts/pins,
- Emergency stop function,
- Slew limits,

Weekly or every 40 working hours the following maintenance is performed:

- Overall inspection including visually checking for oil leakage around the power pack and the winch,
- Operation of luff ratchet
- Check the hoist rope for defects and/or failure,
- Check the luff rope for defects and/or failure,
- Inspect and grease slew ring bearing,
- Inspect and grease the hoist drum gear,
- Inspect and grease the luff drum gear,
- Inspect and grease the slew ring gear,
- Grease the boom heel bushes.

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(Continued)

Monthly or every 100 working hours the following maintenance is performed:

- Check the engine oil level,
- Check the radiator water level,
- Check the pump drive oil level,
- Check the hoist break,
- Inspect and grease the sheave bearings of mast, bridle, boom and hook sheaves assemblies,
- Inspect and grease hoist drum bearings,
- Inspect and grease luff drum bearings,
- Inspect and grease hoist drum drive bearings,
- Inspect and grease luff drum drive bearings,
- Inspect and grease slew drive bearings,
- Inspect the hydraulic oil tank.

Every three months or 250 working hours the following maintenance is performed:

- Inspect and grease hoist drum bearings,
- Inspect and grease luff drum bearings,
- Inspect and grease hoist drum drive bearings,
- Inspect and grease luff drum drive bearings,
- Inspect and grease slew drive bearings,
- Lubrication of limit switch drives,
- Inspect the hydraulic oil tank.

Every 5,000 working hours the following maintenance is performed:

- Inspect the slew drive splined pinions,
- Inspect the luff drive splined pinions,
- Inspect the hoist drive splined pinions.

This is a general maintenance based on Favco's recommendations and based on records provided by NY Crane and inspected by CTI, Inc. with a current meter reading indicating 17,834 hours. All maintenance has been performed based on current usage per manufacturer's guideline and are in compliance with section 4 of Favco's maintenance schedule. Please do not hesitate to contact me if you have any questions.

Respectfully submitted,

Alice Kupper, PE

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January 10, 2023

Department of Buildings
C/O Crane & Derricks
280 Broadway
New York, NY 10007

Dear Sir/Madam,

As per NYC Buildings Required Protocol to erect tower cranes:

- The crane installation, operation, and maintenance manuals (properly identified with equipment serial number) have been reviewed.
- Maintenance/repair records, inspection reports and logs have been reviewed. Records are showing crane meter hour and load cycle counter collating manufacturer's interval maintenance requirements with the actual performance hour readings. Winch assembly, brakes and covers, fittings, valves, hoses, and gears were inspected and are in good working condition and it's been maintained in accordance with manufacturer's recommendations. As per NY Crane provided information, all functions on crane during testing were within the manufacturer's specs and recommendations.
- Original equipment has not been altered, except for Favco Engineering modifications FFCA-EB-034 which have been performed as per manufacturer's procedures on Slew Mount and Front Machine Deck. Any visual structural damage and/or repairs and modifications performed have been identified and disclosed, and all repairs and replacement components match the original manufacturer's standards and safety factors.
- All the unassembled crane components are identified with unique numbers and component description in the summary and checklist and are in acceptable condition to permit erection. All individual counterweights are marked permanently noting their appropriate weights.
- Hardware, including but not limited to structural bolts, nuts, washers, pins (boom/jib), mast, sheaves, ladders, railings, platforms – were inspected and found to be in good condition.
- Paint is in good condition and no evidence of corrosion found.
- Electronic monitoring (Favelle Favco) controlling load, moment, angle, radius, anemometer, visual and audible warning – Load Moment Indicator (LMI) – cannot be properly inspected in unassembled state of the crane. LMI is OEM Favelle Favco.
- Undercarriages, templates and mast sections are all OEM, inspected and are in good working condition.
- Boom/jib sections and jib extension sections were inspected and found to be in good condition to be utilized.
- Turntable, slew ring, bearings and gears were inspected and found to be in good condition to be utilized.
- Winch assembly, brakes and covers, fitting, valves, hoses, and gears were inspected and found to be in good condition.

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(Continued)

- Machine deck, A-Frame, bridle, pendants, connection lugs and bushings were inspected and are found to be in good condition.
- Wire rope pendants, wire ropes and sheaves were inspected and are in good condition.
- Trolley, hooks, headache/overhaul ball, load blocks and anti-two block device were inspected and are in good condition.
- Operator's cab (the cab housing, wiring, dead-man control, control panels and windshields) – was inspected and is in good condition.
- Electrical, direct/hard wire communication system, aviation strobe, lighting arrestor/grounding systems – cannot be properly inspected in unassembled state of the crane.
- Hydraulic system (hoses, fittings and valves, and pumps, motors) – were inspected and are in good working condition.
- Top Climbers Climbing Frames (cylinders, valves, hoses, fittings, clips, shoes, and gauges) – were visually inspected and are in good working condition.
- Counterweights are OEM, inspected and are in good working condition.
- All components have unique number stamped or otherwise tagged on the component itself.
- All components weighing 2000lbs or more have been marked with their weights in pounds.

Respectfully submitted,

Alice Kupper, PE

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SUMMARY

This inspection is in accordance with the NYCDOB requirement for a third-party inspection of Crane Components by a Professional Engineer unaffiliated with engineer of record. The inspection took place at 9 Albert Avenue, Newark, NJ.

All components are in good condition. The components are free from rust and damage. All components have been recently cleaned. All components have markings for identification purpose. Favco Engineering modifications FFCA-EB-034 have been performed as per manufacturer's procedures on Slew Mount and Machine Split Deck. Discussions with the NY Crane General Manager Sal Isola indicate that no other structural repairs have been performed on any of the crane components. The visual inspection supports this. Also, Magnetic Particle Report for: 2 Split Deck Lugs on Front Split Deck, 4 Split Deck Lugs on Rear Split Deck, Mast Leg and Boom Pivot Plates, and All Four Legs on Slew Mount were reviewed and found to be acceptable.

We have no affiliation with equipment owner. At the time of inspections all components were in acceptable state to permit their erection.

Tower Sections Inspected

Crane: Favco
Model# M440E
Serial# 1475

Item ID	*Length*	*Description*	*Photo#*
USA-TS-020004	13'1"	Reinforced Tower Section	SECTION VI – Photo 1-3
USA-TS-02033	13'1"	Reinforced Tower Section	SECTION VI – Photo 4-6
USA-TS-497-042	13'1"	Reinforced Tower Section	SECTION VI – Photo 7-9
USA-TS-07-053	13'1"	Tower Section	SECTION VI – Photo 10-12

Crane Components Inspected

Crane: Favco
Model# M440E
Serial# 1475

Crane Component	*Item ID*	*Photo#*
45' Heel Section	#HLB1-1475	SECTION VI – Photo 13
30' Insert	#B2-1475	SECTION VI – Photo 14
30' Insert	#B3-1475	SECTION VI – Photo 15
30' Insert	#B4-1475	SECTION VI – Photo 16
45' Head Section (two sheaves inspected)	#HD-1475	SECTION VI – Photo 17-18

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Revised Copy – January 18, 2023

Crane Components Inspected

Crane: Favco
Model# M440E
Serial# 1475

Crane Component	*Item ID*	*Photo #*
14,600lbs Counterweight	#CWT-1-1475	SECTION VI – Photo 18-22
14,600lbs Counterweight	#CWT-2-1475	SECTION VI – Photo 18-22
14,600lbs Counterweight	#CWT-3-1475	SECTION VI – Photo 18-22
14,600lbs Counterweight	#CW4-1475	SECTION VI – Photo 18-22
14,600lbs Counterweight	#CWT-5-1475	SECTION VI – Photo 18-22
14,600lbs Counterweight	#CWT-6-1475	SECTION VI – Photo 18-22
Pinions	#MH1-1475	SECTION VI – Photo 23-33
	#MH2-1475	SECTION VI – Photo 23-33
	#MH3-1475	SECTION VI – Photo 23-33
	#BH1-1475	SECTION VI – Photo 23-33
	#BH2-1475	SECTION VI – Photo 23-33
Slew Drive	-	SECTION VI – Photo 34
Tilt Test	-	SECTION VI – Photo 35-38
Slew Ring Bolts	-	SECTION VI – Photo 39
Wire Rope - Hoist (Main)	42mm 1,200 feet	SECTION VI – Photo 40-47
Wire Rope - Luff (Boom)	32mm 525 feet	SECTION VI – Photo 40-47
Power Pack	#PP-1475	SECTION VI – Photo 48
Operator's Cab	#CAB-1475	SECTION VI – Photo 49-52
25 Ton Double Ball & Hook	DMB-1475	SECTION VI – Photo 53
Rear Split Deck	#MD-1475	SECTION VI – Photo 53
Slew Mount (including 4 legs)	#SM-1475	SECTION VI – Photo 54
Front Split Deck	#FMD-1475	SECTION VI – Photo 54-56
A-Frame (two sheaves inspected)	#AF-1475	SECTION VI – Photo 57-59
Bridle (two sheaves inspected)	#BR-1475	SECTION VI – Photo 60
Deflector Sheave (two sheave inspected)	#DS-1475	SECTION VI – Photo 61
40' Boom Pendant (Strap)	#PB1-1475	SECTION VI – Photo 62
40' Boom Pendant (Strap)	#PB2-1475	SECTION VI – Photo 63
29' Boom Pendant (Strap)	#1475-PB3	SECTION VI – Photo 63-64
29' Boom Pendant (Strap)	#1475-PB4	SECTION VI – Photo 64
29' Boom Pendant (Strap)	#PB5-1475	SECTION VI – Photo 65
29' Boom Pendant (Strap)	#PB6-1475	SECTION VI – Photo 65
External Climbing Frame	#USA-TSC-04-001-A	SECTION VI – Photo 66
External Climbing Frame	#USA-TSC-04-001-B	SECTION VI – Photo 67
External Climbing Frame Tie	#USA-TSC-04-001-C	SECTION VI – Photo 67-68
External Climbing Frame Tie	#USA-TSC-04-001-D	SECTION VI – Photo 68-69
Climbing Platform	#USA-TSC-04-001-M	SECTION VI – Photo 70
Climbing Platform	#USA-TSC-04-001-K	SECTION VI – Photo 71-72
Climbing Platform	#USA-TSC-04-001-L	SECTION VI – Photo 73-74

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(Continued)

Hydraulic Cylinder	#P1-04001	SECTION VI – Photo 75
Hydraulic Cylinder	#P2-04001	SECTION VI – Photo 75
Jacking Shoe	#USA-TSC-04-001-JS1	SECTION VI – Photo 76-77
Jacking Shoe	#USA-TSC-04-001-JS2	SECTION VI – Photo 77-78
Monorail	#USA-TSC-04-001-TB	SECTION VI – Photo 79-80
Monorail Trolley	#USA-TSC-03-001-E	SECTION VI – Photo 80-81
Hook Adaptor (Monorail Hanger)	#USA-TSC-04-001-F	SECTION VI – Photo 82
Operating Hours	17,834hours	SECTION VI – Photo 83
Direct Wire Communication System	-	SECTION VI – Photo 84
Aviation Strobe	-	SECTION VI – Photo 84
Lighting Arrestor Grounding System	-	SECTION VI – Photo 84
Windmeter (Anemometer)	-	SECTION VI – Photo 85
LMI	-	SECTION VI – Photo 85
Temporary Pendant	#TP1-1475	SECTION VI – Photo 86-87
Temporary Pendant	#TP2-1475	SECTION VI – Photo 86-87
Ladders	-	SECTION VI – Photo 88-89
Railings	-	SECTION VI – Photo 88-89
Platforms	-	SECTION VI – Photo 88-89
Tower Bolts	-	SECTION VI – Photo 90
Electric	-	SECTION VI – Photo 91
Hydraulic	-	SECTION VI – Photo 92-93
Maintenance Manuals/ Logs	-	SECTION VI – Photo 94

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CERTIFIED TESTING & INSPECTIONS, INC.

TESTING • INSPECTIONS • ENGINEERING

CLIENT: NY Crane
37-30 Review Avenue
Long Island City, NY 11101

Date: 12-21-22
CD# 4052
Report# 1

SUBJECT:

Magnetic Particle Inspection 100% of
All welds on 4
Crane towers on Favco
Crane Model# M440E
Serial# 1475
In accordance with New York City Building Code Specifications. Tests were performed at
9 Albert Avenue - Newark, NJ
on 12-21-22

TEST METHOD AND PROCEDURE:

Magnetic Particle Inspection was accomplished using 'white line' portable magnetic particle machine and using the dry powder and prod methods of inspection. All areas are inspected from two planes to insure 100% coverage. All test results are based at time of inspection.

RESULTS:
X INDICATES WELD LOCATION.

DISTANCE FROM REAR OF SECTION	TOP RIGHT CORD	BOTTOM RIGHT CORD	TOP LEFT CORD	BOTTOM LEFT CORD
#USA-TS-020004 13'1" Reinforced Tower Section				
0'3" through 12'10"	X Accepted	X Accepted	X Accepted	X Accepted
#USA-TS-02033 13'1" Reinforced Tower Section				
0'3" through 12'10"	X Accepted	X Accepted	X Accepted	X Accepted
#USA-TS-497-042 13'1" Reinforced Tower Section				
0'3" through 12'10"	X Accepted	X Accepted	X Accepted	X Accepted
#USA-TS-07-053 13'1" Tower Section				
0'3" through 12'10"	X Accepted	X Accepted	X Accepted	X Accepted

NOTE: These Tower Sections are interchangeable. Visual inspection was also performed on the items listed above.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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CERTIFIED TESTING & INSPECTIONS, INC.

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MAGNETIC PARTICLE INSPECTION REPORT

CLIENT: NY Crane DATE: 12-21-22 REPORT# 1MT
JOB / DRAWING# WEATHER:
JOB LOCATION: 9Albert Avenue - Newark, NJ
CREW (Level): J. Cuozzo (Level III)/ J.A. Cuozzo (Level II)/ R. Elmaalem (Level II)/ M.J. Baez (Level II)
SHIFT TIME: to HOURS RE: STAND BY
REQUESTED BY: PHONE#
CLIENT SIGNATURE, NUMBER & DEPT.:
EQUIPMENT: P2/ DA400 Contour Probe MANUFACTURER: Parker Research
S/N: 1415C/ 10998/ 21456 CALIBRATION DATE: 05-18-22/ 05-23-22/ 02-18-22
MEDIA: Magnavis MANUFACTURER: Magnaflux BATCH# 20J015/ 21A039
METHOD: DRY: X WET: FLOURECENT: RESIDUAL: CONTINUOUS: X TRUE-CONTINUOUS:
YOKE: X PRODS: COIL: CIRCULAR: LONGITUDINAL: X AC: X DC: HALF-WAVE:
PART DESCRIPTION: Interchangeable Tower Sections

CRANE CD# 4052 TYPE: Favco MODEL: M440E S/N: 1475
ACCEPTANCE CRITERIA & PROCEDURE: AWS D1.1 Cyclical & CTI-MT-001

IDENTIFICATION #	TYPE	LENGTH	ACCEPT	REJECT	DEFECT LOCATION	DEFECT TYPE
USA-TS-020004	Reinforced Tower Section	13'1"	X			
USA-TS-02033	Reinforced Tower Section	13'1"	X			
USA-TS-497-042	Reinforced Tower Section	13'1"	X			
USA-TS-07-053	Tower Section	13'1"	X			

REMARKS: All test results are based at time of inspection.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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CERTIFIED TESTING & INSPECTIONS, INC.

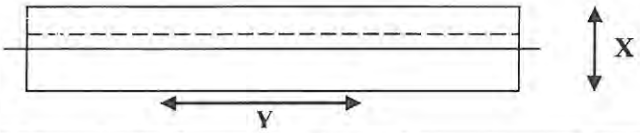
TESTING • INSPECTIONS • ENGINEERING

CLIENT:	NY Crane	DATE:	12-21-22
PROJECT:	M440E Tower Sections CD#4052 SN#1475	LAB. NO.:	669-10
JOB LOCATION:	9 Albert Avenue - Newark, NJ	REPORT#	UT-1
SHIFT TIME:	8 hours	TECHNICIAN:	J.C.
		SPECIFICATIONS:	Project &AWS D1.1

ULTRASONIC INSPECTION REPORT

MATERIAL TYPE:	Fe	INSPECTION METHOD:	Contact
PLATE OR PIPE:	Plate single Bevel Full Penetration Welds	TRANSDUCER'S ANGLE:	0° , 70°
UNIT:	LTC Epoch	FREQUENCY:	2.25 MHz
CALIBRATION DATE:	04-01-22	SURFACE CONDITION:	Satisfactory
CALIBRATION BLOCK TYPE:	DSC & IIW	SCAN DECIBELS:	76 dB
TRANSDUCER:	Technisonic, angle beam, round shape, 0.500" diameter, SN#BFQ-0204-GP		
COUPLING:	Sonotech UT-X, Part#62-001, Batch#17E066		

Sketch



Location of Weld	Weld#	From Face	Leg(s)	Decibels			Discontinuity						Acceptable	Number of Welds
				Indication Level	Reference Level	Attention Factor	Indication Rating	Length	Angular Distance (Sound Path)	Depth From "A" Surface	Distance From X	Distance From Y		
				A	B	C	D							
USA-TS-020004		A-B	1-2	-	54	-	-	-	-				X	
USA-TS-02033		A-B	1-2	-	54	-	-	-	-				X	
USA-TS-497-042		A-B	1-2	-	54	-	-	-	-				X	
USA-TS-07-053		A-B	1-2	-	54	-	-	-	-				X	

REMARKS: All test results are based at time of inspection. Visual Inspection was also performed on the items listed above. All accessible welds were found to be satisfactory throughout the length and width of the weld, no internal or surface irregularities.
These Tower Sections are interchangeable.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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CERTIFIED TESTING & INSPECTIONS, INC.

TESTING • INSPECTIONS • ENGINEERING

CLIENT: NY Crane
37-30 Review Avenue
Long Island City, NY 11101

Date: 12-21-22
CD# 4052
Report# 2

SUBJECT:

Magnetic Particle Inspection 100% of
All welds on 5
Crane towers on Favco
Crane Model# M440E
Serial# 1475
In accordance with New York City Building Code Specifications. Tests were performed at
9 Albert Avenue - Newark, NJ
on 12-21-22

TEST METHOD AND PROCEDURE:

Magnetic Particle Inspection was accomplished using 'white line' portable magnetic particle machine and using the dry powder and prod methods of inspection. All areas are inspected from two planes to insure 100% coverage. All test results are based at time of inspection.

RESULTS:
X INDICATES WELD LOCATION.

DISTANCE FROM REAR OF SECTION	TOP RIGHT CORD	BOTTOM RIGHT CORD	TOP LEFT CORD	BOTTOM LEFT CORD
#HLB1-1475 45' Heel Section				
0'3" through 44'9"	X Accepted	X Accepted	X Accepted	X Accepted
#B2-1475 30' Insert				
0'3" through 29'9"	X Accepted	X Accepted	X Accepted	X Accepted
#B3-1475 30' Insert				
0'3" through 29'9"	X Accepted	X Accepted	X Accepted	X Accepted
#B4-1475 30' Insert				
0'3" through 14'9"	X Accepted	X Accepted	X Accepted	X Accepted
#HD-1475 45' Head Section (All sheaves inspected)				
0'3" through 44'9"	X Accepted	X Accepted	X Accepted	X Accepted

NOTE: Visual inspection was also performed on the items listed above.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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MAGNETIC PARTICLE INSPECTION REPORT

CLIENT: NY Crane DATE: 12-21-22 REPORT# 2MT
JOB / DRAWING# WEATHER:
JOB LOCATION: 9Albert Avenue - Newark, NJ
CREW (Level): J. Cuozzo (Level III)/ J.A. Cuozzo (Level II)/ R. Elmaalem (Level II)/ M.J. Baez (Level II)
SHIFT TIME: to HOURS RE: STAND BY
REQUESTED BY: PHONE#
CLIENT SIGNATURE, NUMBER & DEPT.:
EQUIPMENT: DA400 Contour Probe MANUFACTURER: Parker Research
S/N: 1415C/ 10998/ 21456 CALIBRATION DATE: 05-18-22/ 05-23-22/ 02-18-22
MEDIA: Magnavis MANUFACTURER: Magnaflux BATCH# 20J015/ 21A039
METHOD: DRY: X WET: FLOURECENT: RESIDUAL: CONTINUOUS: X TRUE-CONTINUOUS:
YOKE: X PRODS: COIL: CIRCULAR: LONGITUDINAL: X AC: X DC: HALF-WAVE:
PART DESCRIPTION: Boom Sections for the crane listed below

CRANE CD# 4052 TYPE: Favco MODEL: M440E S/N: 1475
ACCEPTANCE CRITERIA & PROCEDURE: AWS D1.1 Cyclical & CTI-MT-001

IDENTIFICATION #	TYPE	LENGTH	ACCEPT	REJECT	DEFECT LOCATION	DEFECT TYPE
HLB1-1475	Heel Section	45'	X			
B2-1475	Insert	30'	X			
B3-1475	Insert	30'	X			
B4-1475	Insert	30'	X			
HD-1475	Head Section (All sheaves inspected)	45'	X			

REMARKS: All test results are based at time of inspection.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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MAGNETIC PARTICLE INSPECTION REPORT

CLIENT: NY Crane DATE: 12-21-22 REPORT# 3MT
JOB / DRAWING# WEATHER:
JOB LOCATION: 9Albert Avenue - Newark, NJ
CREW (Level): J. Cuozzo (Level III)/ J.A. Cuozzo (Level II)/ R. Elmaalem (Level II)/ M.J. Baez (Level II)
SHIFT TIME: to HOURS RE: STAND BY
REQUESTED BY: PHONE#
CLIENT SIGNATURE, NUMBER & DEPT.:
EQUIPMENT: P2/ DA400 Contour Probe MANUFACTURER: Parker Research
S/N: 1415C/ 10998/ 21456 CALIBRATION DATE: 05-18-22/ 05-23-22/ 02-18-22
MEDIA: Magnavis MANUFACTURER: Magnaflux BATCH# 20J015/ 21A039
METHOD: DRY: X WET: FLOURECENT: RESIDUAL: CONTINUOUS: X TRUE-CONTINUOUS:
YOKE: X PRODS: COIL: CIRCULAR: LONGITUDINAL: X AC: X DC: HALF-WAVE:
PART DESCRIPTION: Counterweights for the crane listed below

CRANE CD# 4052 TYPE: Favco MODEL: M440E S/N: 1475
ACCEPTANCE CRITERIA & PROCEDURE: AWS D1.1 Cyclical & CTI-MT-001

IDENTIFICATION #	TYPE	WEIGHT	ACCEPT	REJECT	DEFECT LOCATION	DEFECT TYPE
CWT-1-1475	Counterweight	14,600lbs	X			
CWT-2-1475	Counterweight	14,600lbs	X			
CWT-3-1475	Counterweight	14,600lbs	X			
CW4-1475	Counterweight	14,600lbs	X			
CWT-5-1475	Counterweight	14,600lbs	X			
CWT-6-1475	Counterweight	14,600lbs	X			

REMARKS: Magnetic Particle Inspection was accomplished using DA400/P2 Parker Research portable magnetic particle machine and using the dry powder and prod methods of inspection. All areas are inspected from two planes to insure 100% coverage. Visual inspection was also performed on the items listed above. All test results are based at time of inspection.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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CERTIFIED TESTING & INSPECTIONS, INC.

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SUMMARY REPORT

Client:	NY Crane	Date:	12-21-22
Project:	Favco M440E CD#4052 SN#1475	Lab#	669-10
Location:	9 Albert Avenue – Newark, NJ	Report#	4
Contractor:		Tech.:	J. Cuozzo/ R. Elmaalem

Drawing Available for Inspections YES_____NO_____
Code or Specifications: as per manufacturer's specs.

Per the request of the client, a representative of Certified Testing & Inspections, Inc. (CTI) arrived at the above noted site to perform a structural steel inspection. The following is a summary of our observation:

SERVICES PROVIDED (Check All That Apply)

- [ ] **Plumbness**
- [ ] **Bolted Connections**
- [ ] **Welded Connections**
- [X] **NDE Services (Specify):** Visual inspection
- [ ] **Other (Specify):**
- [ ] **Metal Deck**
- [ ] **Shear Studs**
- [ ] **Roof Deck**

Location of Work Inspected: Components inspected:
Main Hoist Drum Pinion Gear & Pinion Drive Shaft - #MH1-1475
Main Hoist Drum Pinion Gear & Pinion Drive Shaft - #MH2-1475
Main Hoist Drum Pinion Gear & Pinion Drive Shaft - #MH3-1475
Boom Drum Pinion Gear & Pinion Drive Shaft - #BH1-1475
Boom Drum Pinion Gear & Pinion Drive Shaft - #BH2-1475
Pinions and spline shafts wear were measured utilizing following Go/NoGo gauges: "A80x74 DIN5482 Hub Warning Gauge 79.45 +/-0.02mm" for the pinions and "B80x74 DIN 5482 Shaft Warning Gauge 74.15 +/-0.02mm" for the spline shafts.

Observations:
-Inspection for wear, corrosion, & excessive wear of pinions and pinion drive shafts.
-Pinion Gear & Pinion Drive Shafts were Inspected on specified crane prior to inspection.
-All specified components were gauged and found to be within tolerance of Favelle Favco Go/NoGo Warning Gauges. The warning Gauges would not fit on shafts or in pinions.

Discrepancies: None.

Follow-up Inspection Required:

[ ] **Yes** [X] **No**

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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CERTIFIED TESTING & INSPECTIONS, INC.

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SUMMARY REPORT

Client:	NY Crane	Date:	12-21-22
Project:	Favco M440E CD#4052 SN#1475	Lab#	669-10
Location:	9 Albert Avenue – Newark, NJ	Report#	5
Contractor:	N/A	Tech.:	J. Cuozzo/ R. Elmaalem

Drawing Available for Inspections YES X NO

Code or Specifications: as per manufacturer's specs. : Favco SB-012319-004, March 29,2019 "Amendment on Installation, Operation and Maintenance Manual, Maintenance Inspection of Splined Pinion Drives"

Per the request of the client, a representative of Certified Testing & Inspections, Inc. (CTI) arrived at the above noted site to perform a structural steel inspection. The following is a summary of our observation:

SERVICES PROVIDED (Check All That Apply)

- [ ] **Plumbness**
- [ ] **Bolted Connections**
- [ ] **Welded Connections**
- [ ] **NDE Services (Specify):**
- [X] **Other (Specify):** Visual inspection of Slew Drive Spline and Pinion
- [ ] **Metal Deck**
- [ ] **Shear Studs**
- [ ] **Roof Deck**

Location of Work Inspected: Front Split Deck #FMD-1475

Observations: A visual inspection was performed on the Slew Drive. The Slew Drive was disassembled for the spline and pinion inspection. Spline and Pinion are in good condition, see pictures attached. The measurement of the play of the Slew Drive Pinion was also measured – 0.74 mm of play was recorded. It is within manufacturer's tolerance (no more than 2mm), as per manufacturer's procedure noted above.

Discrepancies: None.

Follow-up Inspection Required:

- [ ] **Yes**
- [X] **No**

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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SLEW BEARING WEAR/ CLEARANCE MEASURMENT REPORT

Client:	NY Crane	Date:	12-21-22
Project:	Favco M440E CD#4052 SN#1475	Lab#	669-10
Location:	9 Albert Avenue – Newark, NJ	Report#	6
Code or Specifications:	FAVCO FP-SLEW-032	Tech:	J. Cuozzo

Per the request of the client, a representative of Certified Testing & Inspections, Inc. (CTI) arrived at the above noted site to perform testing and or inspection of Rothe Erde Grobwalzlager, 10003473680002, 012.45.2940.009.49.1521, 36106940.

The following is a summary of our observation:

Location of Work Inspected: 9 Albert Avenue - Newark, NJ
Crane Model Favco M440E CD#4052 SN#1475 Slew Mount

Observations: On the above date, slew ring bearing clearance measurements were taken at the above reference location. Representatives from CTI and NY Crane were present. The Tilt Method was utilized with the following equipment: 10 Ton hydraulic jack and dial gauges with accuracy of 0.0025mm Measurements and additional observation recorded below.

BASE MEASUREMENTS	TEST MEASUREMENTS	ACCEPTABLE	REMARKS
N/A	0.26mm	X	
N/A	0.17mm	X	
N/A	0.17mm	X	
N/A	0.25mm	X	

Additional Notes: Based, on specification, all results are within the acceptable limits (see chart below). All test results are based at the time of inspection.

MANUFACTURERS SPECIFICATIONS											
Track Diameter (mm)	Double-row ball bearing slewing rings Ball diameter (mm)										
	18	20	22	25	30	35	40	45	50	60	70
	Permissible increase in bearing clearance (mm)										
1000	1.8	1.8	1.9	1.9	2.0	2.1	2.5	2.8			
1250	1.9	1.9	2.0	2.0	2.1	2.2	2.6	2.9	3.4	3.6	
1500		2.0	2.1	2.1	2.2	2.3	2.7	3.0	3.5	3.7	
1750			2.2	2.2	2.3	2.4	2.8	3.1	3.6	3.8	4.0
2000				2.3	2.4	2.5	2.9	3.2	3.7	3.9	4.1
2250					2.5	2.6	3.0	3.3	3.8	4.0	4.2
2500						2.7	3.1	3.4	3.9	4.1	4.3
2750							3.3	3.6	4.1	4.3	4.5
3000							3.4	3.7	4.2	4.4	4.6

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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MAGNETIC PARTICLE INSPECTION REPORT

CLIENT: NY Crane DATE: 12-21-22 REPORT# 7MT
JOB / DRAWING# WEATHER:
JOB LOCATION: 9Albert Avenue - Newark, NJ
CREW (Level): J. Cuozzo (Level III)/ J.A. Cuozzo (Level II)/ R. Elmaalem (Level II)/ M.J. Baez (Level II)
SHIFT TIME: to HOURS RE: STAND BY
REQUESTED BY: PHONE#
CLIENT SIGNATURE, NUMBER & DEPT.:
EQUIPMENT: P2/ DA400 Contour Probe MANUFACTURER: Parker Research
S/N: 1415C/ 10998/ 21456 CALIBRATION DATE: 05-18-22/ 05-23-22/ 02-18-22
MEDIA: Magnavis MANUFACTURER: Magnaflux BATCH# 20J015/ 21A039
METHOD: DRY: X WET: FLOURECENT: RESIDUAL: CONTINUOUS: X TRUE-CONTINUOUS:
YOKE: X PRODS: COIL: CIRCULAR: LONGITUDINAL: X AC: X DC: HALF-WAVE:
PART DESCRIPTION: All welds on legs of Slew Mount and lugs, mast leg and boom pivot plates on Front Split Deck and Split Deck Lugs on Rear Split (Machine) Deck
CRANE CD# 4052 TYPE: Favco MODEL: M440E S/N: 1475
ACCEPTANCE CRITERIA & PROCEDURE: AWS D1.1 Cyclical & CTI-MT-001

SECTION #	TYPE	WEIGHT	ACCEPT	REJECT	DEFECT LOCATION	DEFECT TYPE
Front Split Deck Connection Lugs	Port and Starboard Sides	-	X			
Rear Split Deck Connector Lugs	Port - inner, outer; Starboard - inner, outer.	-	X			
Mast Leg and Boom Pivot Plates	Port and Starboard Sides	-	X			
4 Slew Mount Legs	All welds on Slew Mount Legs	-	X			

REMARKS: Magnetic Particle Inspection was accomplished using DA400/P2 Parker Research portable magnetic particle machine and using the dry powder and prod methods of inspection. All areas are inspected from two planes to insure 100% coverage. Visual inspection was also performed on the items listed above. All test results are based at time of inspection.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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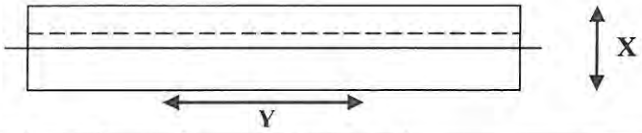
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CLIENT:	NY Crane	DATE:	12-21-22
PROJECT:	Favco M440E CD#4052 SN#1475	LAB. NO.:	669-10
JOB LOCATION:	9 Albert Avenue - Newark, NJ	REPORT#	UT-2
SHIFT TIME:	8 hours	TECHNICIAN:	J.C.
		SPECIFICATIONS:	Project &AWS D1.1

ULTRASONIC INSPECTION REPORT

MATERIAL TYPE:	Fe	INSPECTION METHOD:	Contact
PLATE OR PIPE:	Plate single Bevel Full Penetration Welds	TRANSDUCER'S ANGLE:	0° , 70°
UNIT:	LTC Epoch	FREQUENCY:	2.25 MHz
CALIBRATION DATE:	04-01-22	SURFACE CONDITION:	Satisfactory
CALIBRATION BLOCK TYPE:	DSC & IIW	SCAN DECIBELS:	76 dB
TRANSDUCER:	Technisonic, angle beam, round shape, 0.500" diameter, SN#BFQ-0204-GP		
COUPLING:	Sonotech UT-X, Part#62-001, Batch#17E066		

Sketch



Location of Weld	Weld#	From Face	Leg(s)	Decibels			Discontinuity						Acceptable	Number of Welds
				Indication Level	Reference Level	Attention Factor	Indication Rating	Length	Angular Distance (Sound Path)	Depth From "A" Surface	Distance From X	Distance From Y		
				A	B	C	D							
Slew Mount below Slew Ring SN#1475	#1	A-B	1-2	-	53	-	-	-	-	-	-	-	X	

REMARKS: All test results are based at time of inspection. Visual Inspection was also performed on the items listed above. All accessible welds were found to be satisfactory throughout the length and width of the weld, no internal or surface irregularities.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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REPORT OF STRUCTURAL STEEL BOLT INSPECTIONS

CLIENT:	NY Crane 37-30 Review Avenue Long Island City, NY 11101	DATE:	12-21-22
		LAB No.:	669-09
PROJECT:	Slew Ring Bolts For Favelle Favco M440E SN#1475 CD# 4052	REPORT No.:	SSI-1
		ENGINEER:	FAVCO
SUBJECT:	Torque Testing		

1. HIGH STRENGTH BOLTS:

66 bolts inside and 66 bolts outside were inspected utilizing calibrated torque wrench on Slew Ring bolts located between Slew Mount and Front Split Deck. Torque – tested all bolts to 1,394 Ft-lbs on inside and outside of the Slew Mount. All tests met required specifications for torque.

ACCEPTED

EXTENT OF INSPECTION

1. HIGH STRENGTH BOLTS: Specifications for Structural fasteners are in accordance to OEM specifications and Drawing #A4-9900.214, SAE Imperial series clean dry threads. Installation and tightening by hydraulic tensioning. Calibrated wrench method or Direct Tension Indicator Method was used for testing. Size of Bolt 30mm (10.9 Grade) required torque 1,394 Ft-lbs.

ACCEPTED

INSPECTED BY: J. Cuozzo
C. Perez ICC# 8133800

REMARKS: All test results are based at the time of inspection.
Visual inspection was also performed on the items listed above.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level

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SUMMARY REPORT

Client:	NY Crane	Date:	12-21-22
Project:	Favco M440E CD#4052 SN#1475	Lab#	669-10
Location:	9 Albert Avenue – Newark, NJ	Report#	8
Contractor:	N/A	Tech.:	J. Cuozzo/ J.A. Cuozzo

Drawing Available for Inspections YES_____ NO X

Code or Specifications: OSHA 1926.1413

Per the request of the client, a representative of Certified Testing & Inspections, Inc. (CTI) arrived at the above noted site to perform testing and/or inspection of Wire Rope for Favco M440E crane SN#1475
The following is a summary of our observation:

SERVICES PROVIDED (Check All That Apply)

- [ ] **Plumbness**
- [ ] **Bolted Connections**
- [ ] **Welded Connections**
- [X] **NDE Services (Specify):** Visual inspection on Wire Rope
- [ ] **Other (Specify):**
- [ ] **Metal Deck**
- [ ] **Shear Studs**
- [ ] **Roof Deck**

Location of Work Inspected: 9 Albert Avenue – Newark, NJ

Observations:

1. Main Rope, 42mm, 1200ft – inspected end-to-end – Accepted
2. Luffing Rope, 32mm, 525ft – inspected end-to-end – Accepted

Diamaters of the wire ropes were also checked with caliper at random points to verify any reduction in accordance to OSHA guidelines as per 1926.1413(a)(2)(ii)(B) with the following acceptable results:

- Main Rope, 42mm nominal diameter: 42.73mm, 42.57mm, 42.44mm, 42.65mm, 42.32mm, 42.50mm.
- Luffing Rope, 32mm nominal diameter: 32.21mm, 32.26mm, 32.39mm, 32.32mm, 32.26mm, 33.21mm.

No Broken wires, birdcages, kinks, abrasions, peening or other deficiencies.
Wire ropes are in good condition to be utilized.

Discrepancies: None.

Follow-up Inspection Required:

- [ ] **Yes**
- [X] **No**

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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Revised Copy – January18, 2023

CLIENT: NY Crane
37-30 Review Avenue
Long Island City, NY 11101

Date: 12-21-22
CD# 4052
Report# 9

SUBJECT:

Magnetic Particle Inspection 100% of All welds on 29 Sections of boom on Favco Crane Model # M440E Serial # 1475 in accordance with New York City Building Code Specifications. Tests were performed at 9 Albert Ave., Newark, NJ 12-21-22

TEST METHOD AND PROCEDURE:

Magnetic Particle Inspection was accomplished using 'white line' portable magnetic particle machine and using the dry powder and prod methods of inspection. All areas are inspected from two planes to insure 100% coverage. All test results are based at time of inspection.

Inspected and find to be free of any weld defects:

- Power Pack - #PP-1475
- Operator's Cab - #CAB-1475
- 25 Ton Double Ball & Hook - #DB-1475
- Rear Split Deck - #MD-1475
- Slew Mount (including 4 legs) - #SM-1475
- Front Split Deck (including all lugs, mast legs and boom pivot plates) - #FMD-1475
- A-Frame (two sheaves also inspected) - #AF-1475
- Bridle (two sheaves also inspected) - #BR-1475
- Deflector Sheave (two sheaves also inspected) - #DS-1475
- 40' Boom Pendant (Strap) - #PB1-1475
- 40' Boom Pendant (Strap) - #PB2-1475
- 29' Boom Pendant (Strap) - #1475-PB3
- 29' Boom Pendant (Strap) - #1475-PB4
- 29' Boom Pendant (Strap) - #PB5-1475
- 29' Boom Pendant (Strap) - #PB6-1475
- External Climbing Frame - #USA-TSC-04-001-A
- External Climbing Frame - #USA-TSC-04-001-B
- External Climbing Frame Tie - #USA-TSC-04-001-C
- External Climbing Frame Tie - #USA-TSC-04-001-D

NOTE: Visual inspection was also performed on the items listed above.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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CERTIFIED TESTING & INSPECTIONS, INC.

TESTING • INSPECTIONS • ENGINEERING

CLIENT: NY Crane
37-30 Review Avenue
Long Island City, NY 11101

Date: 12-21-22
CD# 4052
Report# 9

Inspected and find to be free of any weld defects:

- Climbing Platform - #USA-TSC-04-001-M
- Climbing Platform - #USA-TSC-04-001-K
- Climbing Platform - #USA-TSC-04-001-L
- Hydraulic Cylinder - #P1-04001
- Hydraulic Cylinder - #P2-04001
- Climbing Support (Jacking Shoe) - #USA-TSC-04-001-JS1
- Climbing Support (Jacking Shoe) - #USA-TSC-04-001-JS2
- Monorail - # USA-TSC-04-001-_TB
- Monorail Trolley - #USA-TSC-03-001-E
- Hook Adaptor (Monorail Hanger) - #USA-TSC-04-001-F

NOTE: Visual inspection was also performed on the items listed above.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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MAGNETIC PARTICLE INSPECTION REPORT

CLIENT: NY Crane DATE: 12-21-22 REPORT# 9MT
JOB / DRAWING# _____ WEATHER: _____
JOB LOCATION: 9Albert Avenue - Newark, NJ
CREW (Level): J. Cuozzo (Level III)/ J.A. Cuozzo (Level II)/ R. Elmaalem (Level II)/ M.J. Baez (Level II)
SHIFT TIME: _____ to _____ HOURS RE: _____ STAND BY _____
REQUESTED BY: _____ PHONE# _____
CLIENT SIGNATURE, NUMBER & DEPT.: _____
EQUIPMENT: P2/ DA400 Contour Probe MANUFACTURER: Parker Research
S/N: 1415C/ 10998/ 21456 CALIBRATION DATE: 025-18-22/ 05-23-22/ 02-18-22
MEDIA: Magnavis MANUFACTURER: Magnaflux BATCH# 20J015/ 21A039
METHOD: DRY: X WET: ___ FLOURECENT: ___ RESIDUAL: ___ CONTINUOUS: X TRUE-CONTINUOUS: ___
YOKE: X PRODS: ___ COIL: ___ CIRCULAR: ___ LONGITUDINAL: X AC: X DC: ___ HALF-WAVE: ___
PART DESCRIPTION: Components for the crane listed below

CRANE CD# 4052 TYPE: Favco MODEL: M440E S/N: 1475
ACCEPTANCE CRITERIA & PROCEDURE: AWS D1.1 Cyclical & CTI-MT-001

IDENTIFICATION #	TYPE	LENGTH	ACCEPT	REJECT	DEFECT LOCATION	DEFECT TYPE
PP-1475	Power Pack	-	X			
CAB-1475	Operator's Cab	-	X			
DB-1475	25 Ton Double Ball & Hook	-	X			
MD-1475	Rear Split Deck	-	X			
SM-1475	Slew Mount (including 4 legs)	-	X			
FMD-1475	Front Split Deck (including all lugs, mast legs and boom pivot plates)	-	X			
AF-1475	A-Frame	-	X			
BR-1475	Bridle	-	X			
DS-1475	Deflector Sheave	-	X			
PB1-1475	Boom Pendant (Strap)	40'	X			
PB2-1475	Boom Pendant (Strap)	40'	X			
1475-PB3	Boom Pendant (Strap)	29'	X			
1475-PB4	Boom Pendant (Strap)	29'	X			
PB5-1475	Boom Pendant (Strap)	29'	X			
PB6-1475	Boom Pendant (Strap)	29'	X			

REMARKS: All test results are based at time of inspection.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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CERTIFIED TESTING & INSPECTIONS, INC.

TESTING • INSPECTIONS • ENGINEERING

MAGNETIC PARTICLE INSPECTION REPORT

CLIENT: NY Crane DATE: 12-21-22 REPORT# 9MT
JOB / DRAWING# WEATHER:
JOB LOCATION: 9Albert Avenue - Newark, NJ
CREW (Level): J. Cuozzo (Level III)/ J.A. Cuozzo (Level II)/ R. Elmaalem (Level II)/ M.J. Baez (Level II)
SHIFT TIME: to HOURS RE: STAND BY
REQUESTED BY: PHONE#
CLIENT SIGNATURE, NUMBER & DEPT.:
EQUIPMENT: P2/ DA400 Contour Probe MANUFACTURER: Parker Research
S/N: 1415C/ 10998/ 21456 CALIBRATION DATE: 025-18-22/ 05-23-22/ 02-18-22
MEDIA: Magnavis MANUFACTURER: Magnaflux BATCH# 20J015/ 21A039
METHOD: DRY: X WET: FLOURECENT: RESIDUAL: CONTINUOUS: X TRUE-CONTINUOUS:
YOKE: X PRODS: COIL: CIRCULAR: LONGITUDINAL: X AC: X DC: HALF-WAVE:
PART DESCRIPTION: Components for the crane listed below

CRANE CD# 4052 TYPE: Favco MODEL: M440E S/N: 1475
ACCEPTANCE CRITERIA & PROCEDURE: AWS D1.1 Cyclical & CTI-MT-001

IDENTIFICATION #	TYPE	LENGTH	ACCEPT	REJECT	DEFECT LOCATION	DEFECT TYPE
USA-TSC-04-001-A	External Climbing Frame	-	X			
USA-TSC-04-001-B	External Climbing Frame	-	X			
USA-TSC-04-001-C	External Climbing Frame Tie	-	X			
USA-TSC-04-001-D	External Climbing Frame Tie	-	X			
USA-TSC-04-001-M	Climbing Platform	-	X			
USA-TSC-04-001-K	Climbing Platform	-	X			
USA-TSC-04-001-L	Climbing Platform	-	X			
P1-04001	Hydraulic Cylinder	-	X			
P2-04001	Hydraulic Cylinder	-	X			
USA-TSC-04-001-JS1	Jacking Shoe	-	X			
USA-TSC-04-001-JS2	Jacking Shoe	-	X			
USA-TSC-04-001-TB	Monorail	-	X			
USA-TSC-03-001-E	Monorail Trolley	-	X			
USA-TSC-04-001-F	Hook Adaptor (Monorail Hanger)	-	X			

REMARKS: All test results are based at time of inspection.

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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CERTIFIED TESTING & INSPECTIONS, INC.

TESTING • INSPECTIONS • ENGINEERING

SUMMARY REPORT

Client:	NY Crane	Date:	12-21-22
Project:	Favco M440E CD#4052 SN#1475	Lab#	669-10
Location:	9 Albert Avenue – Newark, NJ	Report#	10
Contractor:	N/A	Tech.:	J. Cuozzo/ R. Elmaalem

Drawing Available for Inspections YES_____ NO X

Code or Specifications: _____

Per the request of the client, a representative of Certified Testing & Inspections, Inc. (CTI) arrived at the above noted site to perform testing and/or inspection of Components for Favco M440E crane SN#1475
The following is a summary of our observation:

SERVICES PROVIDED (Check All That Apply)

- [ ] **Plumbness**
- [ ] **Bolted Connections**
- [ ] **Welded Connections**
- [X] **NDE Services (Specify):** Visual inspection on components
- [ ] **Other (Specify):**
- [ ] **Metal Deck**
- [ ] **Shear Studs**
- [ ] **Roof Deck**

Location of Work Inspected: 9 Albert Avenue – Newark, NJ

Observations: Visual on

1. Operator's Cab #CAB-1475 - wiring, control panels, windshields - Accepted.
2. Operating Hours – 17,834 hours.
3. Power Pack- #PP-1475, electrical, condition wiring, contacts and components – Accepted.
4. Direct/hard wire communication system – Accepted.
5. Lighting Arrestor Grounding System – Accepted.
6. Aviation Strobe – Accepted.
7. Anemometer - Accepted.
8. LMI - Accepted.
9. Mast Section #AF-1475 ladders, railings, platforms - Accepted.
10. Ø36mm 93.88' Temporary Pendants – #TP1-1475 – inspected full length - Accepted
11. Ø36mm 93.88' Temporary Pendants – #TP2-1475 – inspected full length - Accepted
12. Ladders, Railings, Platforms - Accepted.
13. Tower Bolts – Accepted.
14. Electric System and Hydraulic System -
15. Maintenance Manuals/ Logs - Accepted.

Discrepancies: None

Follow-up Inspection Required:

[ ] **Yes** [X] **No**

Respectfully submitted,
CERTIFIED TESTING & INSPECTIONS, INC.

Joseph Cuozzo
President / NDE-Level III

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CERTIFIED TESTING & INSPECTIONS, INC.

TESTING • INSPECTIONS • ENGINEERING

CLIENT: NY Crane
37-30 Review Avenue
Long Island City, NY 11101

Date: 12-21-22
Favco M440E CD#4052 SN#1475
Report# 11

The following items were visually inspected and/or reviewed:

- Favco Engineering modifications FFCA-EB-034 of April 26, 2018 have been performed as per manufacturer's procedures on Slew Mount #SM-1475 and Front Split Deck #FMD-1475.
- Counterweights permanently marked noting their appropriate weights in pounds.
- All inspected crane components are in good acceptable condition to permit erection.
- All paint coatings are in good condition with no indications of corrosion.
- Aviation Strobe and Lightning Arrestor and or Grounding Systems condition of (Wiring, Contacts, and Components) - are in good condition.
- All hydraulic components are in good condition.
- Visual inspection was performed on Top Climbers Climbing Frames (external towers), cylinders, valves, hoses, fittings, clips, etc. are in good condition.
- All components are uniquely identified with clearly visible ID numbers.
- All electrical equipment was labeled.
- A thorough review of the crane installation, operation and maintenance manuals has been undertaken for a comprehensive understanding of the components, functions, servicing and inspection requirements.
- All fastening hardware is OEM, cleaned, adequately lubricated, no damaged or corrosion.
- Ball & Hook #DB-1475 was also inspected as per OSHA 1926.1400. Ball & Hook is rated 25 Ton capacity, and has functional latch. The hook is free of distortion, cracks, significant wear, nicks, gouges, corrosion, deformation (bent or twist), and evidence of excessive heat exposure, unauthorized alterations or other modifications.
- Following sheaves were inspected: two metal sheaves on Deflector Sheave #DS-1475, two metal sheaves on Head Section #HD-1475, two metal sheaves on Bridle #BR-1475, two metal sheaves on A-Frame #AF-1475. The sheaves were inspected as per following standards: ASME B30.3 3-2.1.4(9) and OSHA 1926.1412 (f)(2)(ii). Surface of the sheave grooves have no corrugations and no wear. Measuring with sheave gauge (minimum for worn grooves +2.5%) geometries matched without a space at the bottom- no wear at the groove root. The sheaves have no cracks or other visible deformations (like fleet angle wear). All sheaves freely rotate with minimal resistance.
- All components weighing 2000lbs or more have been marked with their weights in pounds.

Respectfully submitted,
CERTIFIED TESTING & INSPECTION, INC.

Joseph Cuozzo
President / NDE-Level III

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CERTIFIED TESTING & INSPECTIONS, INC.

TESTING • INSPECTIONS • ENGINEERING

SECTION III

Correspondence

P.O. Box 116 • Florence, NJ 08518 • 609.239.0994 • FAX 609.239.2118

NEW YORK CRANE
37-30 Review Ave
Long Island City, New York 11101
Office – (718) 254-9500

January 3, 2023

NYC Department of Buildings
Cranes and Derricks Unit
2 Lafayette Street, 12th Floor
New York, New York 10007

Attn: Ahraf Omran, P.E.

RE: Certification of Event Recorder Installation
CD#: 4052
Favelle Favco M-440D
Serial#: 1475

Dear Mr. Omran:

As the owner of the above listed equipment, I hereby certify the following:

The crane associated with the above certificate of operation is equipped with an event recorder supplied by the crane manufacturer, or by a dealer, vendor, or third-party authorized crane manufacturer, and such recorder complies with the requirements of Local Law 79 of 2017, including but not limited to its data collection requirements.

Thank you,

Sal Isola
General Manager
New York Crane & Equipment Corp.

NEW YORK CRANE
37-30 Review Ave
Long Island City, New York 11101
Office – (718) 254-9500

NYC Department of Buildings
Cranes and Derricks Unit
2 Lafayette Street, 12th Floor
New York, New York 10007

January 3, 2023

Reference: Third-Party Certification for Favco M440D—SN: 1475 CD 4052

To Whom It May Concern,

With respect to the above referenced crane, please note:

- Current installation, operation and maintenance manuals were made available to the Third-Party Inspector for review.
- Installation, operation and maintenance manuals referencing the relevant serial number of the crane will be furnished when the crane is sent to the jobsite. These manuals are up-to-date, including current service bulletins and a maintenance checklist.
- No major structural repairs and/or modifications have been performed on the crane or any of its components except as noted for: (1) Service bulletin modifications to the slew mount.
- Records listing all accidents, major repair history, and maintenance history were made available to the third-party inspector for review.
- All fastening hardware is OEM supplied. Bolts and nuts are original components.
- Hydraulic oil and filter of the hydraulic systems (both for operation and climbing) have been drained, flushed, replaced with new hydraulic fluid and filters according to the manufacturer's recommendation.
- All required operational safety devices (indicators, limiters, visual and audio warnings) on the crane and associated components, including software, are current to manufacturer's specifications. All devices will be calibrated by the manufacturer, its representative or a certified mechanic immediately after erection and prior to scheduling the load testing.
- The crane or its components were not submerged in water or exposed to flooding conditions.
- No crane components are 25 years old and any future components utilized in any phase will not be over 25 years old.
- No current or future crane components are from prototypes/CD's revoked by The Department.
- Special inspection on by Certified Testing and Inspections, Inc. (CTI) of pinions were performed on main hoist, boom hoist and whip hoist with all items being within manufactures accepted guidelines, and can be found in the third-party inspection.

Sincerely,

Sal Isola
General Manager
New York Crane & Equipment Corp.

PYTHON®
HIGH PERFORMANCE WIRE ROPE



INSPECTION CERTIFICATE (according to EN 10204 - 3.1): 22662262 / 1,0

Manufacturer declaration

We, Westfälische Drahtindustrie GmbH, hereby declare that the following machinery fulfills all of the relevant requirements of EC Machinery Directive 2006/42/EC. The declaration becomes invalid if the product is changed without the agreement of Westfälische Drahtindustrie or if the instructions for "use and maintenance" as stated in EN 12385-3 and/or if the instructions for "care, maintenance, installation, examination and discard" as per ISO 4309 is disregarded.

CE

EAC

Date: 12-Oct-2016

Customer:	Manufacturer:
A.S.C. Industries Ltd.	Westfälische Drahtindustrie GmbH
1406 W. 175th Street	Weidenstrasse 60
USA IL 60429 East Hazel Crest	D - 44147 Dortmund
Customer no: 1314853	Order confirmation: 16312
Customer P/O: 109893/Attn.PO107440	Bill of delivery: 22662262
	Production batch: 378566

ROPE DETAILS

Article:	100213
Brand name:	Compac 35
Construction:	35(W)xK7-KWSC
Nominal diameter:	42,00 mm (+2,0%/+4,0%)
Surface finish:	galvanised class B
Tensile grade:	2160 N/mm²
Lay type and direction:	Right lang lay (zZ)
Minimum breaking strength Fmin:	1708,00 kN
Lubrication:	D5
Weight:	870,00 kg/100 m
Applicable standard:	Manufactured acc. to DIN EN 12385-1/2/4

Example of working load limit when coefficient of utilisation is 5: 341,60 kN

NOTES

1500 FT
inner end: Thimble acc. to DIN 3091, size 44 borehole 54 by using a bronze bushing, aluminum sleeve spliced acc. to EN 13411-3.
Marks: VD 2016 16312-1
outer end: fused & tapered

TEST RESULTS

Actual diameter:	43,40 mm
Actual breaking load Fm:	1.881,00 kN

REEL DETAILS

Reel	Length (m)	Net weight (kg)	Gross weight (kg)
S-00378566-007	457,20	3934	4274

I certify that the product described herein complies with the terms of the order.

Olaf Rost
Quality Control

Document was issued electronically - valid without signature.

PYTHON®
HIGH PERFORMANCE WIRE ROPE

WDI WIRE ROPE

WESTFÄLISCHE DRAHTINDUSTRIE GMBH

INSPECTION CERTIFICATE (according to EN 10204 - 3.1): 22677133 / 1,0

Manufacturer declaration
We, Westfälische Drahtindustrie GmbH, hereby declare that the following machinery fulfills all of the relevant requirements of EC Machinery Directive 2006/42/EC. This declaration becomes invalid if the product is changed without the agreement of Westfälische Drahtindustrie or if the instructions for "use and maintenance" as stated in EN 12385-1 and/or if the instructions for "care, maintenance, installation, examination and discard" as per ISO 4309 is disregarded.

CE

Date: 23-Mar-2017

Customer:		Manufacturer:	
A.S.C. Industries Ltd.		Westfälische Drahtindustrie GmbH	
1406 W. 175th Street		Seilerstraße 1 b	
USA IL 60429	East Hazel Crest	D - 08056 Zwickau	
Customer no:	1314853	Order confirmation:	17713
Customer P/O:	109679 / Attn.PO107323	Bill of delivery:	22677133
		Production batch:	406623

ROPE DETAILS

Article:	123031
Brand name:	High Performance Rope PYTHON Solid 8 C
Construction:	8xK31WS-IWRC(K)
Nominal diameter:	32,00 mm (0,0%/+2,5%)
Surface finish:	bright
Tensile grade:	2160 N/mm²
Lay type and direction:	Right lang lay (zZ)
Minimum breaking strength Fmin:	943,00 kN
Lubrication:	D4, Nyrosten T55
Weight:	477,00 kg/100 m
Applicable standard:	Manufactured acc. to DIN EN 12385-1/2/4

Example of working load limit when coefficient of utilisation is 5: 188,60 kN

NOTES

Ends welded

TEST RESULTS

Actual diameter:	32,40 mm
Actual breaking load Fm:	1.034,00 kN

REEL DETAILS

Reel	Length (m)	Net weight (kg)	Gross weight (kg)
S-00406623-001	2.030,00	9683	9920

I certify that the product described herein complies with the terms of the order.

Matthias Schmidt
Quality Control

SECTION IV

History

NEW YORK CRANE
37-30 Review Ave
Long Island City, New York 11101
Office – (718) 254-9500

NYC Department of Buildings
Cranes and Derricks Unit
2 Lafayette Street, 12th Floor
New York, New York 10007

January 3, 2023

RE: Crane History Favco M440D —S/N: 1475 CD 4052

Dear Mr. Damiani

1- December 16, 2017 to January 28, 2019, crane was rented to Cornell & Company Inc. at 74 Trinity Place, NYC.
2- January 29, 2019 till May 30, 2019 crane was at our storage facility at 9 Albert Ave, Newark, NJ.
3- May 31, 2019 to November 9, 2019, crane was rented to High Rise Safety at 202 Broome St., NYC.
4- November 10, 2019 till November 13, 2020, crane is at our storage facility at 9 Albert Ave, Newark, NJ.
5- November 14, 2020 to May, 15, 2022, crane was rented to Sorbara Construction at 1568 Broadway, NYC.
6- May 16, 2022 'til current, crane is at our storage facility at 9 Albert Ave, Newark, NJ.

Please contact me if additional information is needed.

Sincerely,

Sal Isola
General Manager
New York Crane & Equipment Corp.

CERTIFIED TESTING & INSPECTIONS, INC.

TESTING • INSPECTIONS • ENGINEERING

SECTION V

Drawings and Specifications

P.O. Box 116 • Florence, NJ 08518 • 609.239.0994 • FAX 609.239.2118

FAVELLE FAVCO
The Cranemakers

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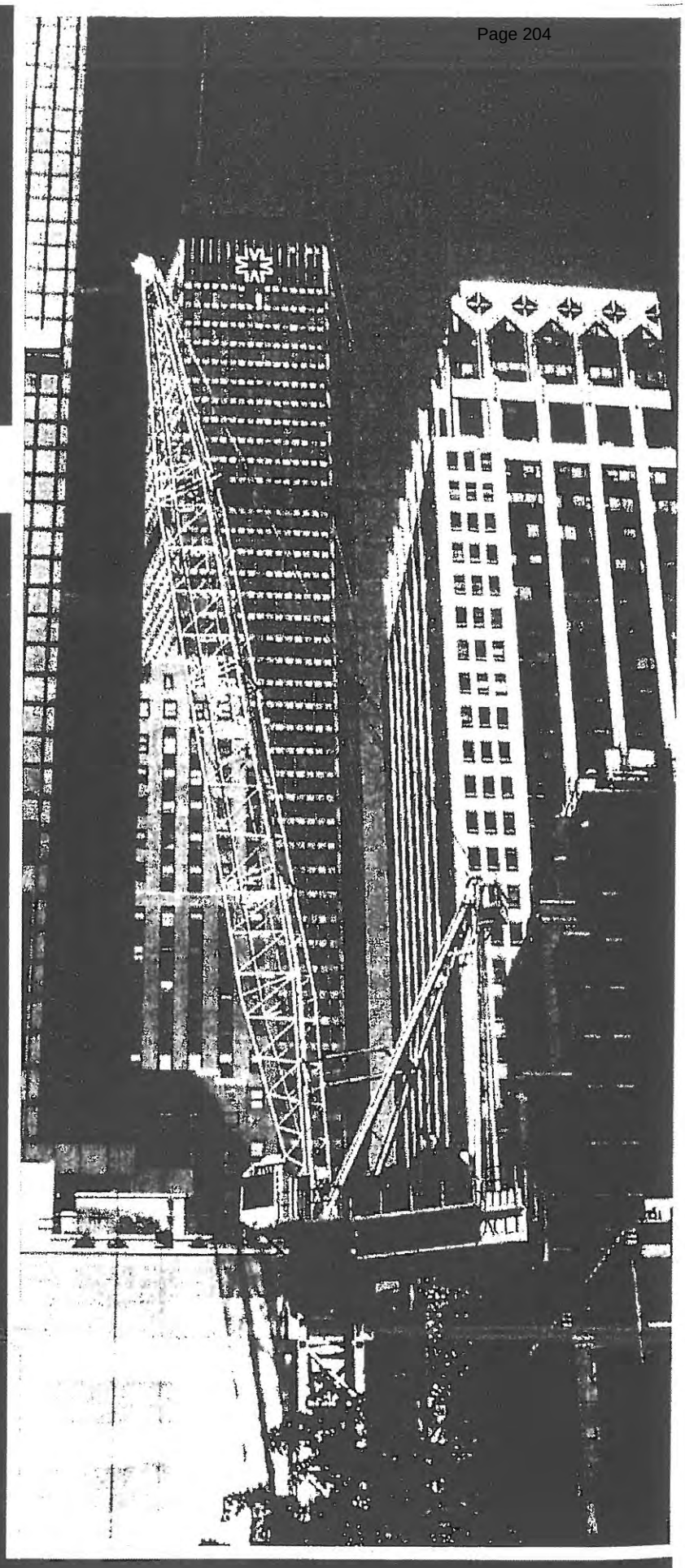
Note: All charts and specifications are for information only and should not be used for lifting purposes. Continuous engineering and improvements makes it necessary that we reserve the right to make specification, equipment and price changes without notice.

FAVELLE FAVCO
The Cranemakers

Tower Cranes

Model M440D

PRODUCT GUIDE



New York, USA

1) GENERAL DESCRIPTION

Developments in the construction industry have indicated the need for a new high performance crane to take over where the Favco STD1500 left off. The STD1500 was built from 1970 and was conceived for the heavy construction sector originally.

In recent years many of these cranes have appeared in building sites erecting new style high-rise buildings. These new buildings have a lot more steel and heavier manufactured items in their build schedule and the M440D offers improved construction speed and lift to meet these needs.

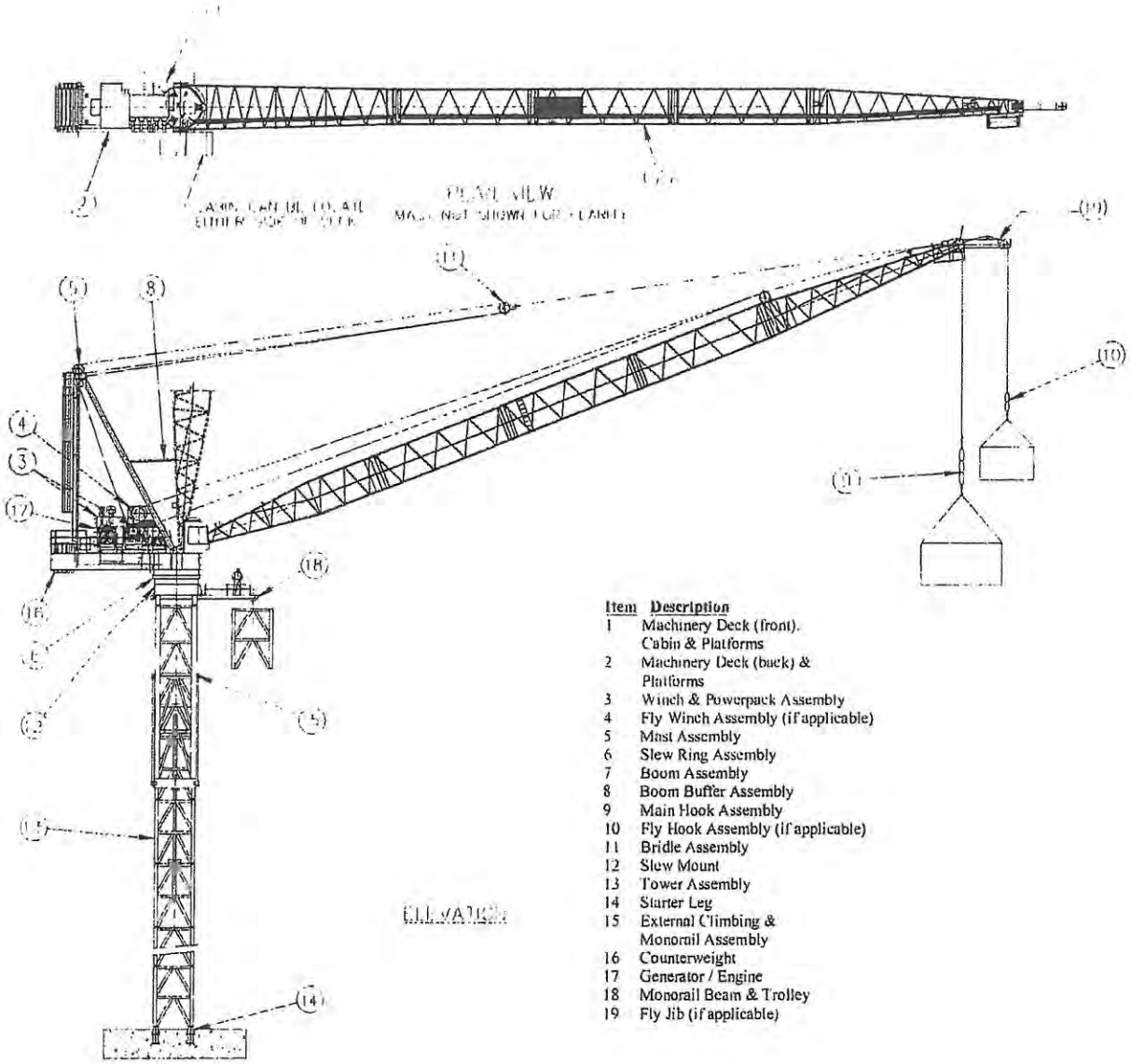
The M440D was designed to cover both heavy construction and high rise projects, steel or concrete works and offers improved performance over the STD1500.

- Significantly improved load charts over the STD1500.
- It is lighter.
- Higher winch performance in both luff and hoist with new generation hydraulics.
- Optional winches.
- It can sit on standard 1500 3.0 m square towers or on smaller 2.7 m square towers for internal climbing.
- Safety systems are vastly improved.
- Optional modular booms (up to 70 m [230 ft]) depending on application needs.
- Offered with two-piece machinery deck for ease or erection and recovery.

To date M440Ds have been built for export and are being used in various high rise building projects in USA, Australia, Taiwan, Korea, Malaysia, Middle East and China.

Note: All charts and specifications are for information only and should not be used for lifting purposes. Continuous engineering and improvements makes it necessary that we reserve the right to make specification, equipment and price changes without notice.

FAVELLE FAVCO
The Cranemakers



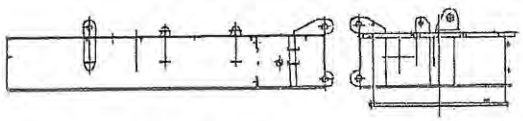
Item	Description
1	Machinery Deck (front). Cabin & Platforms
2	Machinery Deck (back) & Platforms
3	Winch & Powerpack Assembly
4	Fly Winch Assembly (if applicable)
5	Mast Assembly
6	Slew Ring Assembly
7	Boom Assembly
8	Boom Buffer Assembly
9	Main Hook Assembly
10	Fly Hook Assembly (if applicable)
11	Bridle Assembly
12	Slew Mount
13	Tower Assembly
14	Starter Leg
15	External Climbing & Monorail Assembly
16	Counterweight
17	Generator / Engine
18	Monorail Beam & Trolley
19	Fly Jib (if applicable)

Note: All charts and specifications are for information only and should not be used for lifting purposes. Continuous engineering and improvements makes it necessary that we reserve the right to make specification, equipment and price changes without notice.

FAVELLE FAVCO
The Cranemakers

UPPERWORKS

MACHINERY DECK (SPLIT)



The machinery deck is split into two pieces (front and back) of fully welded construction, joint by pins. This reduces the weight of each component, thus eliminating the need for large street cranes during erection and dismantling.

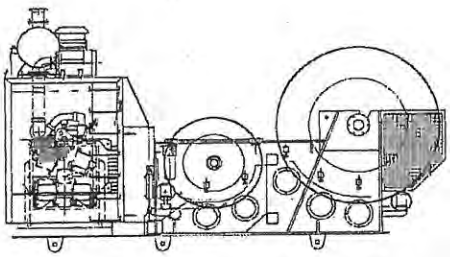
PUMP DRIVE GEARBOX

Multiple Output – Spur Gear – Splash Lubricated

HYDRAULIC PUMPS

Multiple variable displacement Hydraulic Pumps dedicated to Luff, Slew, Hoist and Climbing.

WINCH



Winches consist of parallel grooved drums for hoist and luff motion. Each drum is driven by fixed or variable displacement hydraulic motors, which through oil immersed disc brake and multiple planetary gearboxes and pinion, drive the external drum gear.

Multiple drives are used on each drum, providing multiple brakes on each winch.

The Luff Drum is fitted with a pawl and ratchet system, which engages whenever the crane is shutdown. This allows for maintenance on pumps or motors with the boom held firmly in position.

Average luff speed from maximum to minimum radius with maximum radius load on hook is 90 to 120 seconds, depending on boom length.

For Hoist Speeds refer to separate winch performance sheet.

Winch Options

Optional 16 t (35,270 lb) winch with 250 hp Caterpillar 3126 engine. Using a 32 mm hoist rope, lifting 32,000 kg (70,545 lb) with double fall hook.

Caterpillar 3126 Diesel
In-Line 6

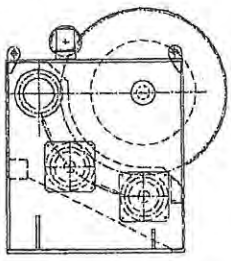
Bore	*4.33 in (110 mm)*
Stroke	*6.0 in (127 mm)*
Displacement	*439 cu in (7.2 L)*
Ship Weight	*1,250 lb (566 kg)*
Approximate Dimensions (L x W x H)	*1086 x 674 x 927 mm 42.8 x 26.5 x 36.5 in*

Optional 25 t (55,115 lb) winch with 575 hp Caterpillar 3456 engine. Using a 42 mm hoist rope, lifting 50,000 kg (110,230 lb) with double fall hook.

Caterpillar 3456
(1800 – 2100 rpm)
Specifications
In-Line 6, Four Stroke Cycle Diesel

Bore	*5.5 in (140 mm)*
Stroke	*6.75 in (171 mm)*
Displacement	*964 cu in (15.8 L)*
Rotation (from flywheel end)	*Counterclockwise*
Capacity for Liquids	
Cooling System (engine only)	*5.5 US gal (20.8 L)*
Lube Oil System (refill)	*9.0 US gal (34.0 L)*
Weight, Net Dry (approx)	*2,897 lb (1,317 kg)*
Approximate Dimensions (L x W x H)	*1661 x 901 x 1336 mm 65.4 x 35.5 x 52.6 in*

Fly Winch Option



Optional 8.5 t fly winch using 24 mm rope lifting 8,500 kg (18,735 lb) on a single fall hook.

Optional 10.0 t fly winch using 24 mm rope lifting 10,000 kg (22,045 lb) on a single fall hook.

Note: All charts and specifications are for information only and should not be used for lifting purposes. Continuous engineering and improvements makes it necessary that we reserve the right to make specification, equipment and price changes without notice.

WIRE ROPES

Luff
32 mm (1¼ in) diameter rope, galvanized and compact outer strand.

Hoist

42 mm (1 5/8 in) diameter rope, low rotation balanced (it is dependant on size of winch), non-rotating construction.

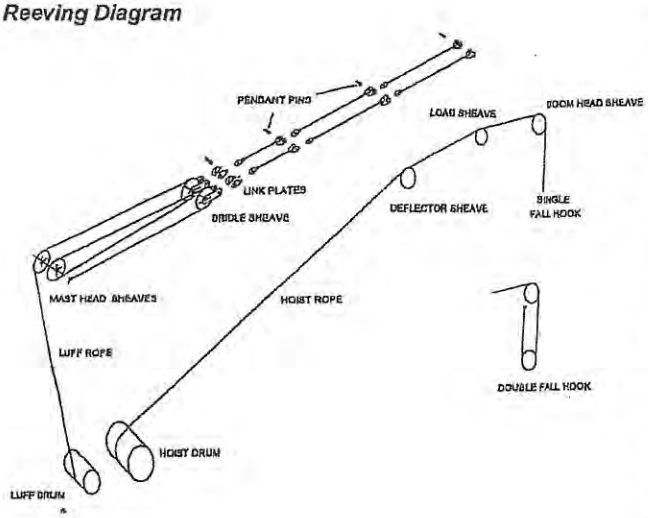
Fly

32 mm (1¼ in) diameter rope, low rotation balanced non-rotating construction.

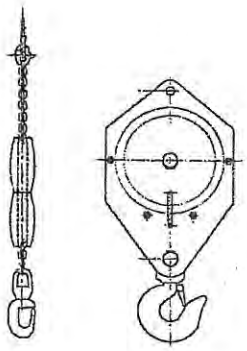
Pendants

48 mm (1 7/8 in) diameter rope, low rotation balanced non-rotating construction.

Reeving Diagram



HOOKS

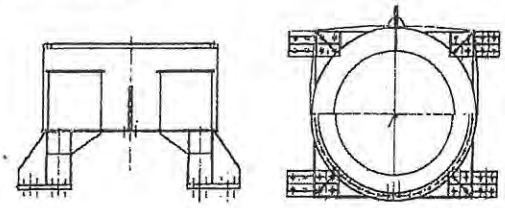


25,000 kg (55,115 lb) Single fall Swivel Hook Block.

Optional Double Fall Hook Block of 64,000 kg (141,096 lb) available.

Single fall Fly Hook Block of 8,500 kg (18,735 lb) or 10,000 kg (22,045 lb) S.W.L.

SLEW SYSTEM



The slew mount is a rigid welded structure which is bolted to the crane tower and to which the slew bearing is fastened. The slew bearing has an integral gear to provide a drive via a hydraulic motor and gearbox situated on the machinery deck.

Bearing

Ball Bearing Ring with internal gear from Rothe-Erde, Germany.

Drive(s)

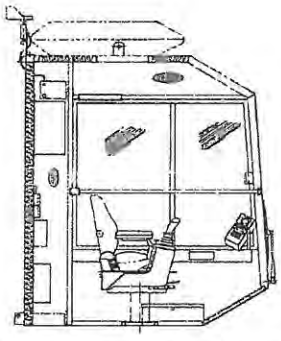
Fixed displacement motor drives through oil immersed disc brake and triple stage epicyclic gearbox and pinion, which meshes with the internal gear of the slew ring.

Slew speed is variable from zero to maximum rpm.

Brake(s)

Slew brake is manually controlled and used as a parking brake only. Normal braking is by closed loop hydrostatic transmission.

CABIN



The cabin can be mounted on either side of the machinery deck.

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It is ergonomically designed and now fitted as standard with
Suspension Seat
Air Conditioning & Heater
Tinted Glass
Insulation for sound and heat

Optional radio and telephone are available for in-cabin communications.

CONTROLS

"Dead man" controls operate all functions and are stepless, allowing excellent "feel" for maximum productivity.

All controls are load sensitive and operate at the optimum speed for the load being lifted or lowered. The control system is a constant horsepower system.

Luff and Hoist are by fingertip lever control (forward/backward).

Slew (left/right) is incorporated into the luff hand lever.

INDICATION EQUIPMENT

Power System Monitor

A Power Pack Annunciator Panel in the cabin monitors the operation of the Prime Mover System.

Engine performance and Hydraulic System integrity is constantly monitored. If an irregularity is detected in the following areas, a visible and audible warning is given and the display panel indicates the problem:

- engine water temperature
- engine oil pressure
- hydraulic oil level
- engine coolant level
- filter bypass
- gearbox temperature
- engine over-speed
- boost pressure
- coolant filter blocked
- reeving bypass

Crane Safety System

An onboard computer designed for the M760D and programmable for any boom or hook configuration of the crane is installed.

The system constantly monitors the load on the hook, and the load radius, it calculates and displays the permitted load, the actual load and the radius of the load, indicating the safe working zones.

As the crane reaches the limits, a visual and audible alarm sounds and the hydraulic system is neutralized, to prevent the crane leaving the safe zone of operation.

Limited functions are still available to allow the crane to resume working in the safe zone.

The functions are:

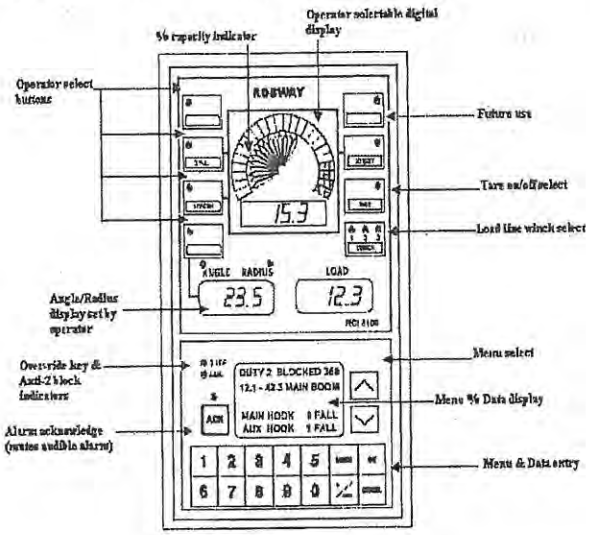
a) "Luff in" to reduce radius

b) "Hoist down" to lower load

This electronic safety system is also fitted with lighting protection to minimize damage to the unit in the event of a direct lightning strike.

Safe Load Indicator

RCI-3100



The RCI-3100 automatic Rated Capacity Indicator (RCI) is designed to assist the operator in the course of normal crane operation and consists of boom angle, length and slew.

The RCI-3100 display provides the following capabilities:

- *Multi-hoisting winch operation*
- *Monitoring and display of*
  - *Boom Length*
  - *Boom Angle & Luffing Fly Jib Angle*
  - *Boom Tip Radius*
  - *Boom Tip Height*
  - *Lifted Load*
  - *Selected Hook Falls*
  - *Selected Crane configuration*
  - *Cranes configured SWL*
  - *SWL as a percentage of Crane configured SWL*
  - *Restricted Slew Zones*
- *Provides visual and audible warnings and motion-cut.*
- *Self-diagnosis and error codes*
- *Unique simulated analogue display for visual feedback of SWL percentage*
- *Multi-line text character window to display messages*
- *Built-in calibration and fault-finding tools*

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Safety Devices and Limits

Luff and Hoist Motions are fitted with working and final limits. The Luff-up Limit has a deceleration motion fitted.

All operating circuits are protected from overload by hydraulic relief valves. The system brakes are fail-safe, spring applied, and are crane code rated to hold the design load of the winch. In the case of hydraulic circuit malfunction such as loss of pressure, the braking system is applied.

DESIGN STANDARDS & QUALITY ASSURANCE

Favelle Favco cranes are designed to meet Australian Standards AS 1418.4 – Tower Cranes, which was derived from European Standards and comply with the relevant ANSI standards.

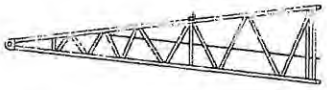
All Favelle Favco manufacturing facilities are certified to ISO 9001 standards and the API 2C monogram.

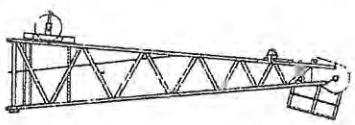
Favelle Favco also manufactures cranes for the Offshore Oil industry and is required to meet stringent manufacturing standards laid down by various international testing authorities.

Our construction tower cranes are manufactured in conjunction with the offshore cranes and are subject to the same Q.A. systems.

ATTACHMENTS

BOOMS



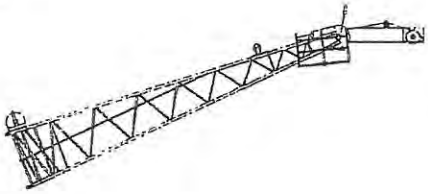




The boom sections are of tubular steel construction, fully welded high yield steel, pin connected with various insert lengths. All sections are jig assembled to allow interchangeability of sections for boom extension.

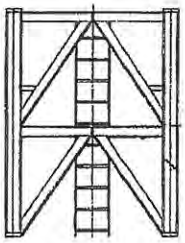
Boom Butt & Top	13.7m (45 ft)
Boom Inserts	4.6 m (15 ft) and 9.2 m (30 ft)
Maximum Boom	65.0 m (214 ft)

FLY JIB



This 3.1m (10.2 ft) fly jib section is pinned to the end of the boom top section at an offset of 30°.

TOWERS



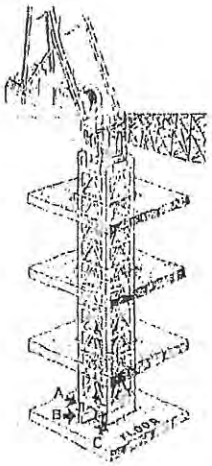
Tower sections are of welded construction and are braced for maximum torsional bending strength. Connection is made by high tensile steel bolts at each corner, developing the full strength of each corner. The tower sections have included a platform and ladders to provide access to machinery deck.

Type 393 4m x 2.4m x 2.4m (13.1ft x 7.9ft x 7.9ft)

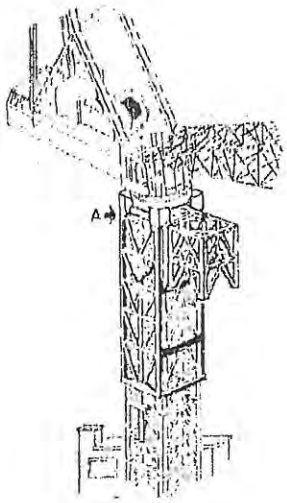
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CLIMBING SYSTEMS

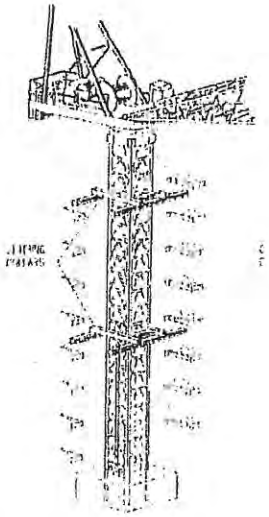
☑ Internal 3-Beam Climbing



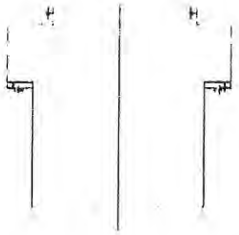
☑ External Climbing Frame



☑ Internal Ladder Climbing Frame with 32 m (105 ft) ladder and 3 sets of collars



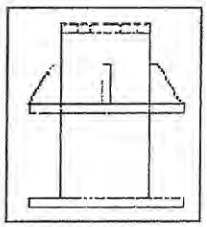
COUNTERWEIGHTS



The counterweights of 39,400 kg (86,870 lb) consist of heavy steel plate or concrete sections, which are supported on the rear of the machinery deck.

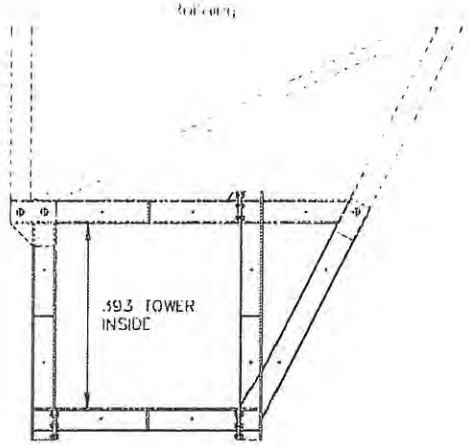
(Refer to manufacturer for details)

STARTER LEGS



Consists of 4 units in a set, typically 1,285 mm (50.6 in) in height, cast into the concrete with approximately 305 mm (12.0 in) protrusion above the concrete surface. The starter legs are normally set in by using the first tower section as template.

TIE BEAM COLLARS



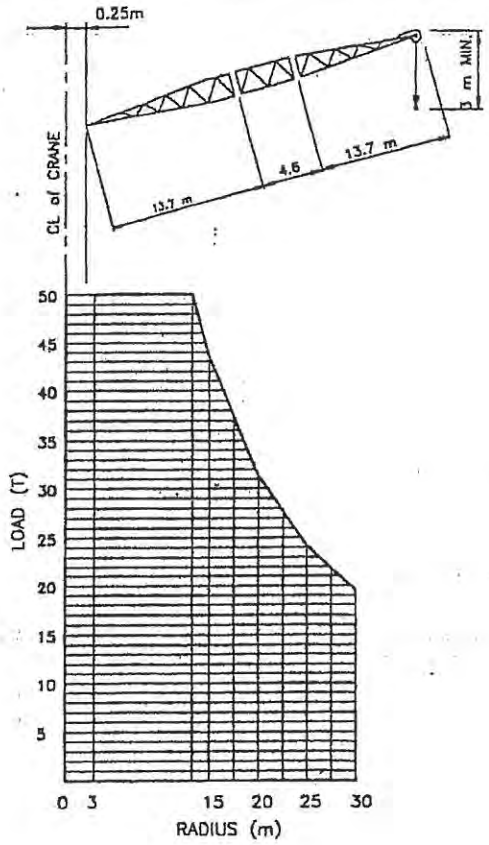
The collar is used to transfer the horizontal forces (exerted by the tower to the tie beam which is in turn transferred to the building). The collar is pin jointed to the tie beam. Pir joints are used to ease the dismantling process.

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2) PERFORMANCE CHARTS

Load Charts with Boom Configuration
(25 MT & 16 MT Winches & 2-Fall Hook)

Boom Length	32.0 m	(104.9 ft)	Working Radius	30.0 m	(98.4 ft)



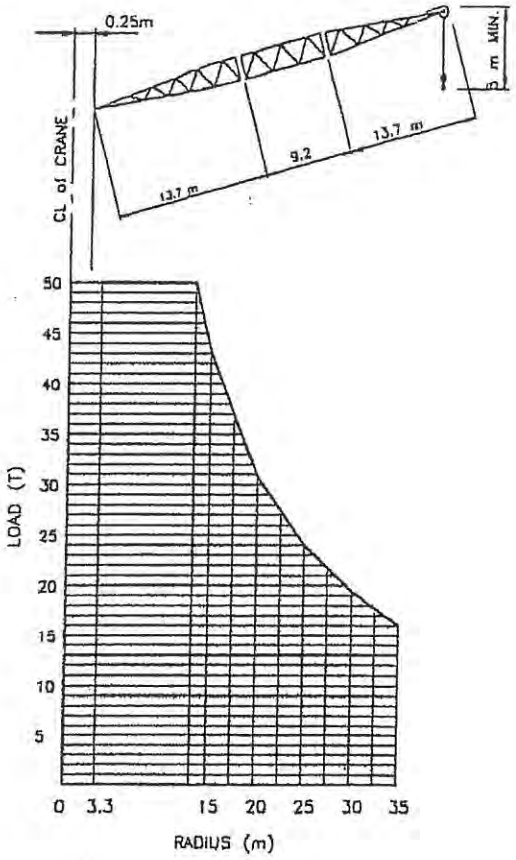
RADIUS m (ft)	3.0 (9.8)	13.3 (43.6)	15.0 (49.2)	20.0 (65.6)	25.0 (82.0)	30.0 (98.4)
LOAD Kg (lb)	50,000 (110,230)	50,000 (110,230)	43,500 (95,900)	31,300 (69,000)	24,200 (53,350)	19,500 (42,990)
ANGLE	86.0	66.9	63.5	52.9	40.5	23.3

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Boom Length 36.6 m (120.1 ft) Working Radius 35.0 m (114.8 ft)



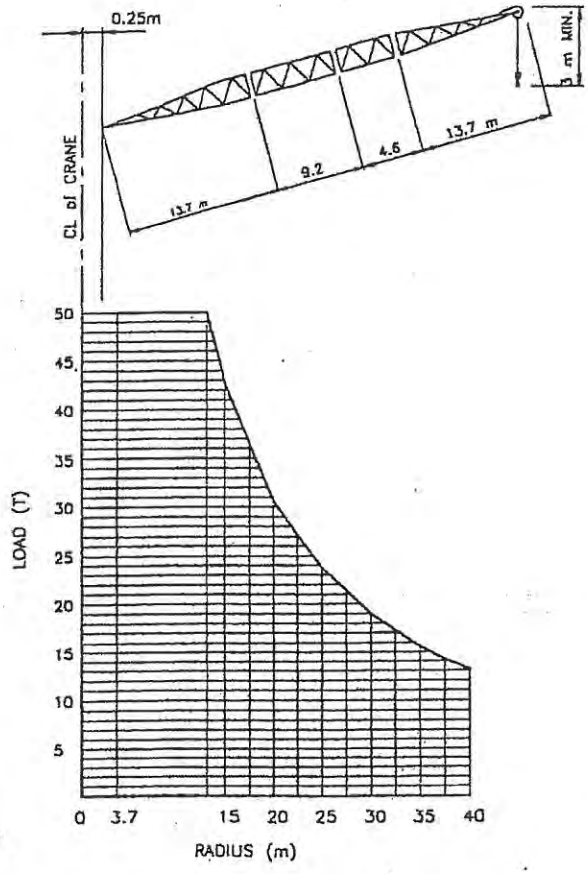
RADIUS m (ft)	3.3 (10.8)	13.3 (43.6)	15.0 (49.2)	20.0 (65.6)	25.0 (82.0)	30.0 (98.4)	35.0 (114.8)
LOAD Kg (lb)	50,000 (110,230)	50,000 (110,230)	43,300 (95,460)	30,800 (67,900)	24,000 (52,910)	19,400 (42,770)	16,100 (35,495)
ANGLE	86.0	69.5	67.1	58.2	48.4	36.7	20.0

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Boom Length	41.2 m	(135.2 ft)	Working Radius	40.0 m	(131.2 ft)



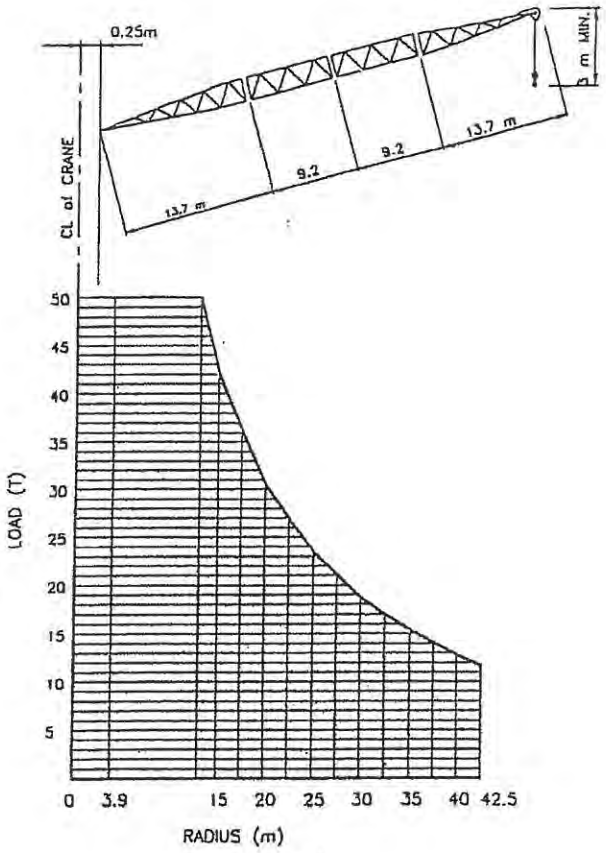
RADIUS m (ft)	3.7 (12.1)	13.2 (43.3)	15.0 (49.2)	20.0 (65.6)	25.0 (82.0)	30.0 (98.4)	35.0 (114.8)	40.0 (131.2)
LOAD Kg (lb)	50,000 (110,230)	50,000 (110,230)	42,800 (94,355)	30,700 (67,680)	23,800 (52,470)	19,000 (41,885)	15,600 (34,390)	13,100 (28,880)
ANGLE	85.9	72.4	70.0	62.1	53.9	44.7	33.5	16.9

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Boom Length 45.8 M (150.3 ft) Working Radius 42.5 m (139.4 ft)



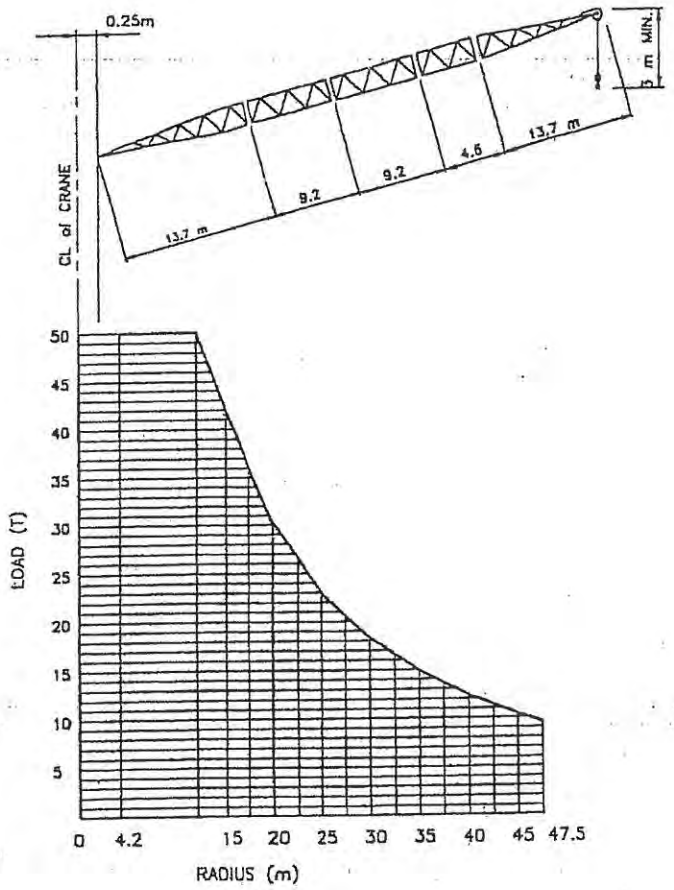
RADIUS m (ft)	3.9 (12.8)	13.0 (42.7)	15.0 (49.2)	20.0 (65.6)	25.0 (82.0)	30.0 (98.4)	35.0 (114.8)	40.0 (131.2)	42.5 (139.4)
LOAD Kg (lb)	50,000 (110,230)	50,000 (110,230)	42,300 (93,255)	30,600 (67,460)	23,500 (51,805)	18,700 (41,225)	15,400 (33,950)	12,800 (28,220)	11,700 (25,795)
ANGLE	86.1	74.5	71.9	65.1	58.0	50.2	41.5	30.8	23.9

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Boom Length	50.4 m	(165.4 ft)	Working Radius	47.5 m	(155.8 ft)



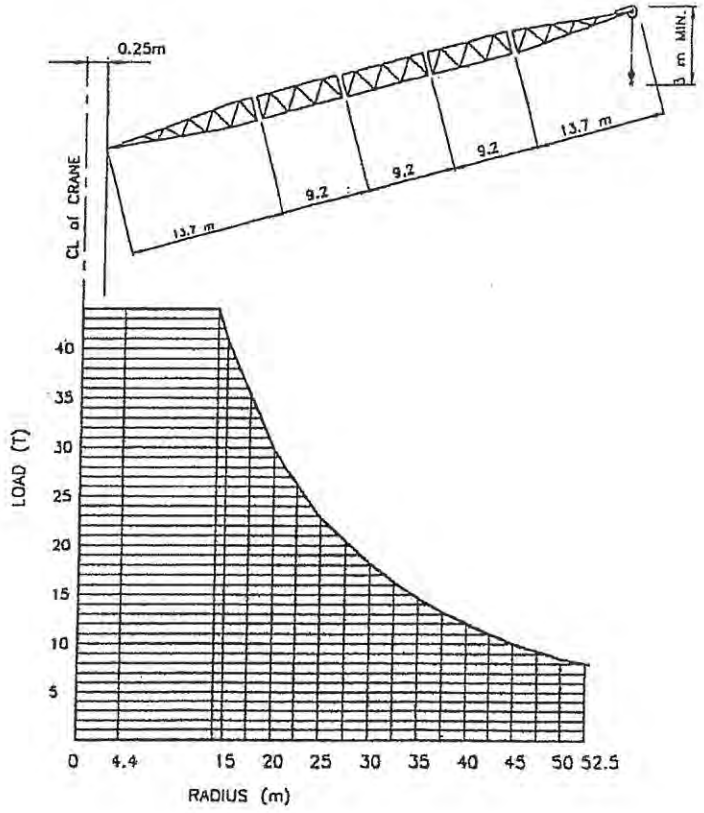
RADIUS m (ft)	4.2 (13.8)	12.0 (39.4)	15.0 (49.2)	20.0 (65.6)	25.0 (82.0)	30.0 (98.4)	35.0 (114.8)	40.0 (131.2)	45.0 (147.6)	47.5 (155.8)
LOAD Kg (lb)	50,000 (110,230)	50,000 (110,230)	42,000 (92,590)	30,200 (66,580)	23,000 (50,705)	18,300 (40,345)	14,900 (32,845)	12,400 (27,335)	10,400 (22,925)	9,500 (20,940)
ANGLE	86.1	77.1	73.6	67.6	61.2	54.5	47.1	38.7	28.3	21.5

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Boom Length 55.0 m (180.4 ft) Working Radius 52.5 m (172.2 ft)



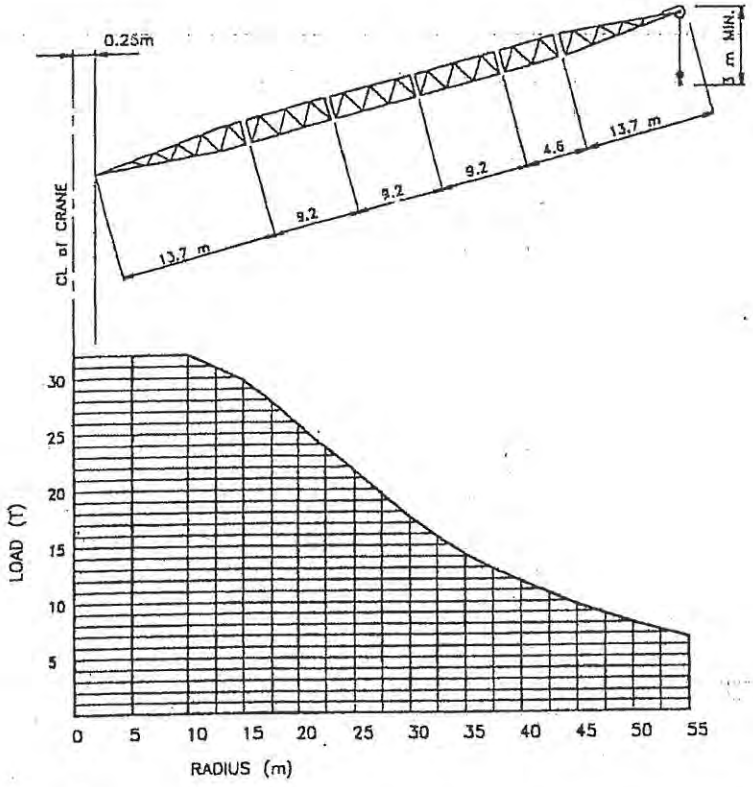
RADIUS m (ft)	4.4 (14.4)	14.0 (45.9)	15.0 (49.2)	20.0 (65.6)	25.0 (82.0)	30.0 (98.4)	35.0 (114.8)	40.0 (131.2)	45.0 (147.6)	50.0 (164.0)	52.5 (172.2)
LOAD Kg (lb)	44,000 (97,000)	44,000 (97,000)	41,000 (90,390)	29,800 (65,695)	22,800 (50,265)	18,100 (39,905)	14,600 (32,185)	12,000 (26,455)	10,000 (22,045)	8,500 (18,740)	8,000 (17,635)
ANGLE	86.2	76.1	75.0	69.5	63.8	57.9	51.4	44.4	36.3	26.1	19.3

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Boom Length	59.6 m	(195.5 ft)	Working Radius	55.0 m	(180.4 ft)



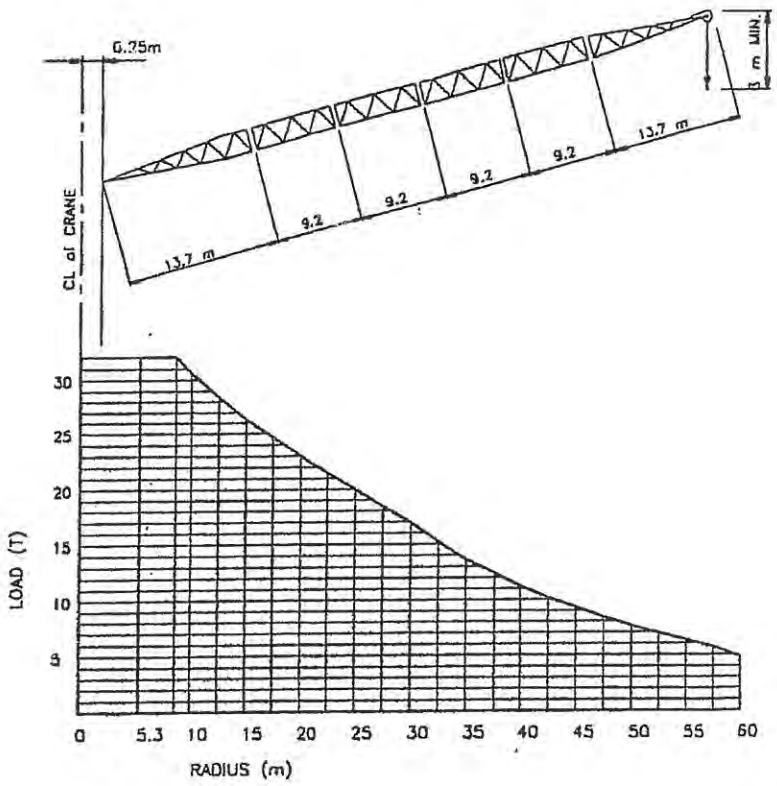
RADIUS m (ft)	5.0 (16.4)	10.0 (32.8)	15.0 (49.2)	20.0 (65.6)	25.0 (82.0)	30.0 (98.4)	35.0 (114.8)	40.0 (131.2)	45.0 (147.6)	50.0 (164.0)	55.0 (180.4)
LOAD Kg (lb)	32,000 (70,545)	32,000 (70,545)	29,800 (65,695)	25,800 (56,880)	21,700 (47,840)	17,500 (38,580)	14,200 (31,305)	11,800 (26,015)	9,700 (21,385)	8,000 (17,635)	6,600 (14,550)
ANGLE	85.9	81.1	76.2	71.2	66.0	60.6	54.9	48.8	42.0	34.1	24.2

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Boom Length 64.2 m (210.6 ft) Working Radius 60.0 m (196.8 ft)



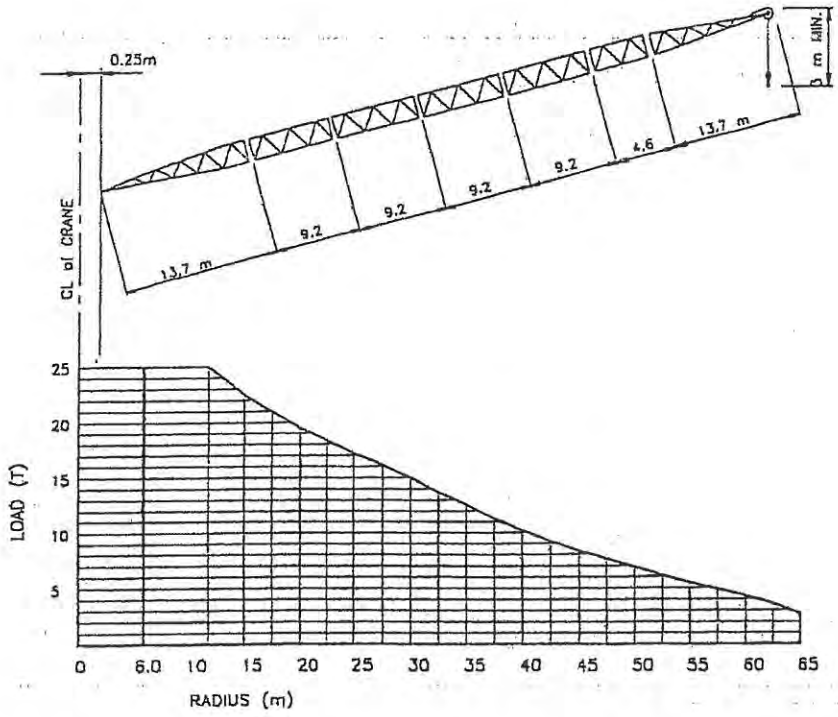
RADIUS m (ft)	5.3 (17.4)	8.6 (28.2)	10.0 (32.8)	15.0 (49.2)	20.0 (65.6)	25.0 (82.0)	30.0 (98.4)	35.0 (114.8)	40.0 (131.2)	45.0 (147.6)	50.0 (164.0)	55.0 (180.4)	60.0 (196.8)
LOAD Kg (lb)	32,000 (70,545)	32,000 (70,545)	30,600 (67,460)	26,300 (57,980)	23,000 (50,705)	20,000 (44,090)	16,900 (37,255)	13,600 (29,980)	11,200 (24,690)	9,300 (20,500)	7,600 (16,755)	6,300 (13,890)	4,800 (10,580)
ANGLE	86.0	83.0	81.7	77.2	72.6	67.8	62.9	57.7	52.3	46.4	39.8	32.2	22.3

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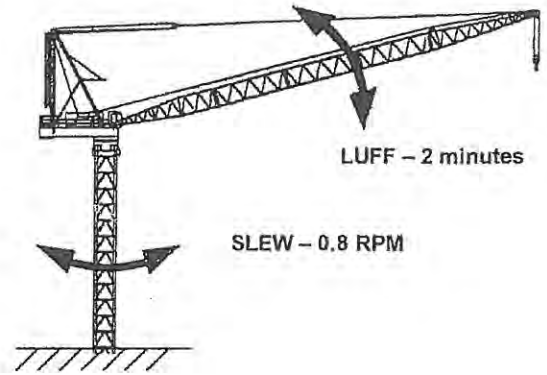
Boom Length	68.8 m	(225.7 ft)	Working Radius	65.0 m	(213.3 ft)

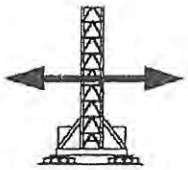


RADIUS m (ft)	6.0 (19.7)	11.8 (38.7)	15.0 (49.2)	20.0 (65.6)	25.0 (82.0)	30.0 (98.4)	35.0 (114.8)	40.0 (131.2)	45.0 (147.6)	50.0 (164.0)	55.0 (180.4)	60.0 (196.8)	65.0 (213.3)
LOAD Kg (lb)	25,000 (55,115)	25,000 (55,115)	22,500 (49,600)	19,500 (42,990)	17,200 (37,920)	15,000 (33,070)	12,600 (27,775)	10,200 (22,485)	8,300 (18,295)	6,900 (15,210)	5,500 (12,125)	4,300 (9,480)	2,700 (5,950)
ANGLE	85.6	80.8	78.0	73.7	69.3	64.8	60.1	55.2	49.9	44.2	37.8	30.6	20.6

Note: All charts and specifications are for information only and should not be used for lifting purposes. Continuous engineering and improvements makes it necessary that we reserve the right to make specification, equipment and price changes without notice.

MOTION SPEEDS





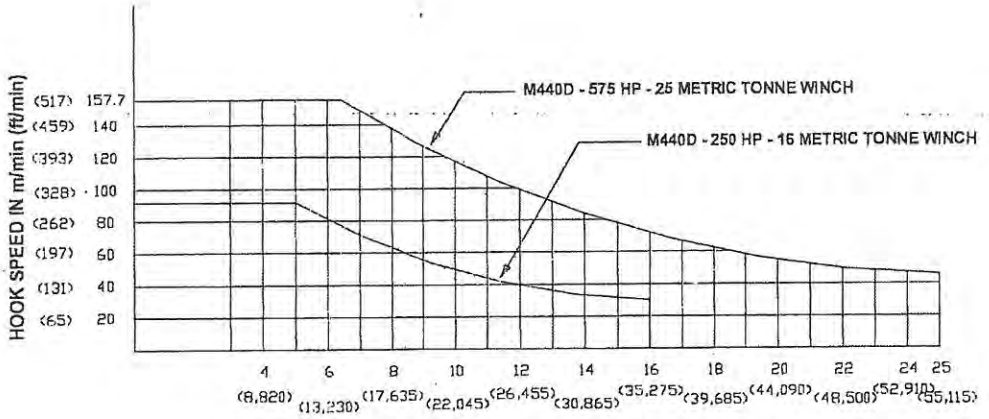
Optional

Note: All charts and specifications are for information only and should not be used for lifting purposes. Continuous engineering and improvements makes it necessary that we reserve the right to make specification, equipment and price changes without notice.

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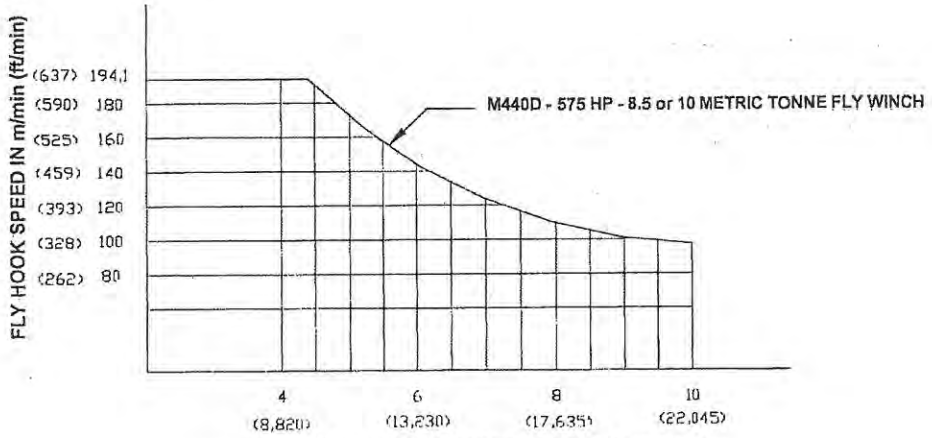
HOOK SPEED

MAIN HOIST



FLY HOIST

8.5 t (18,740 lb) or 10.0 t (22,045 lb) fly winch lifting on a single fall hook



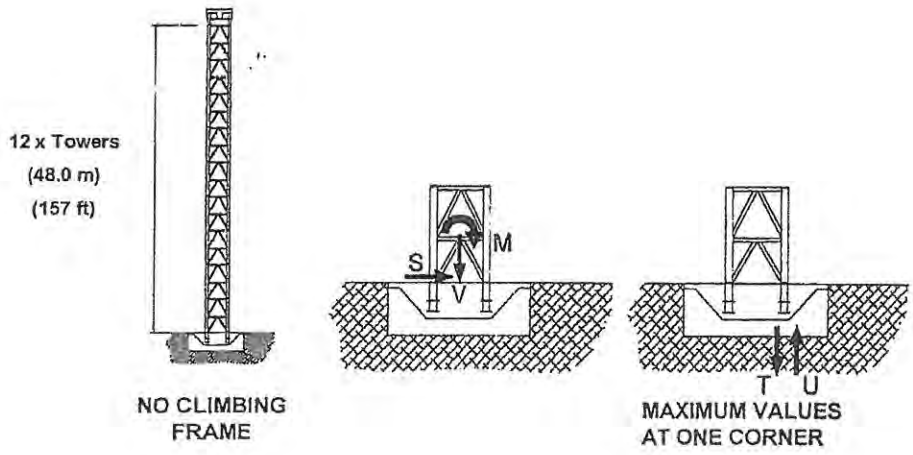
Note: All charts and specifications are for information only and should not be used for lifting purposes. Continuous engineering and improvements makes it necessary that we reserve the right to make specification, equipment and price changes without notice.

FORCES - FOUNDATION REACTION

CRANE ON BASE – FREE STANDING

For in-service wind speeds up to **20 m/s (45 mph)** and out-of-service wind speeds up to **40.2 m/s (90 mph)**.
(Please refer to manufacturer for individual requirements)

No Climbing Frame

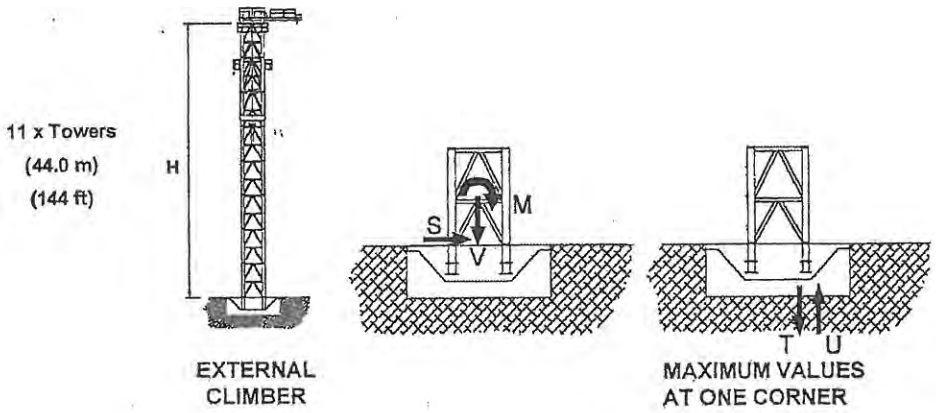


Foundation Reactions – Freestanding on 393 Towers

		In Service		Out of Service	
Wind Speed	*m/s (mph)*	20	(45)	40.2	(90)
M	*mT (ft t)*	885	(6,401,145)	1,263	(9,135,650)
V	*t (lb)*	174	(383,605)	157	(346,125)
S	*t (lb)*	7	(15,430)	27	(59,525)
T	*t (lb)*	343	(756,185)	467	(1,029,560)
U	*t (lb)*	256	(564,383)	388	(855,395)

Note: All charts and specifications are for information only and should not be used for lifting purposes. Continuous engineering and improvements makes it necessary that we reserve the right to make specification, equipment and price changes without notice.

External Climbing

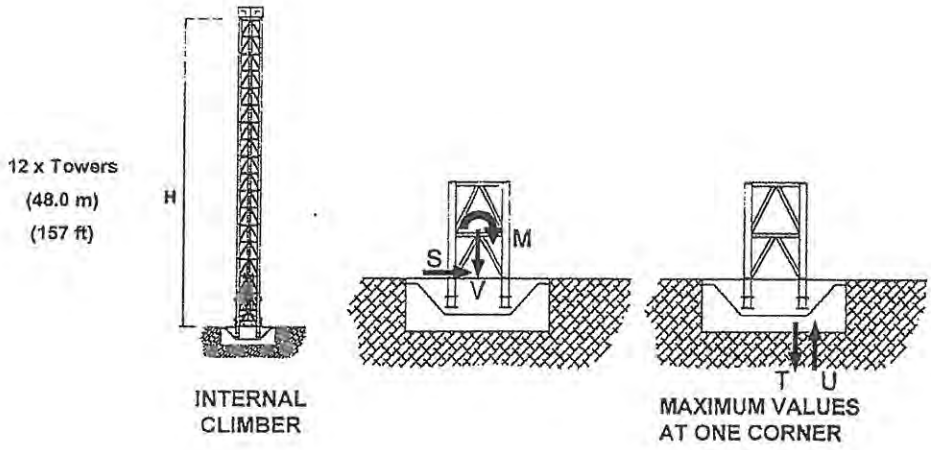


Foundation Reactions
Freestanding with Climbing Frame on 393 Towers

		In Service		Out of Service	
Wind Speed	*m/s (mph)*	20	(45)	40.2	(90)
M	*mT (ft.lb)*	891	(6,444,865)	1,320	(9,547,945)
V	*t (lb)*	184	(405,650)	167	(368,170)
S	*t (lb)*	8	(17,635)	31	(68,345)
T	*t (lb)*	347	(765,005)	488	(1,075,855)
U	*t (lb)*	255	(562,180)	405	(892,870)

Note: All charts and specifications are for information only and should not be used for lifting purposes. Continuous engineering and improvements makes it necessary that we reserve the right to make specification, equipment and price changes without notice.

Internal Climbing



Foundation Reactions
Freestanding with Internal Climber on 393 Towers

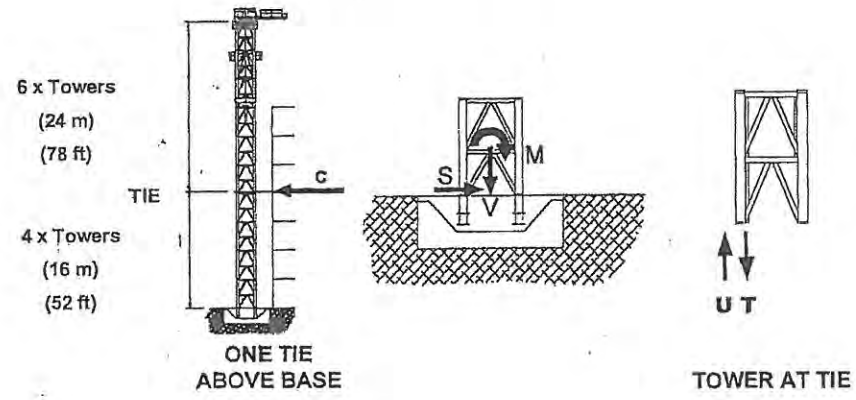
		In Service		Out of Service	
Wind Speed	*m/s (mph)*	20	(45)	40.2	(90)
M	*mT (ft.lb)*	885	(6,401,460)	1,263	(9,135,645)
V	*t (lb)*	189	(416,675)	172	(379,195)
S	*t (lb)*	7	(15,430)	27	(59,525)
T	*t (lb)*	347	(765,005)	470	(1,036,175)
U	*t (lb)*	252	(555,565)	384	(846,575)

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FORCES - BUILDING REACTION

External Climbing

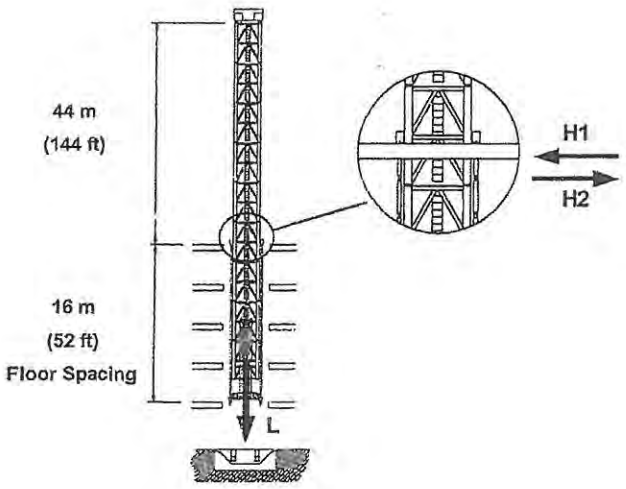


Building Reaction - External Climbing on 393 Towers

		In Service		Out of Service	
Wind Speed	*m/s (mph)*	20	(45)	40.2	(90)
M	*mT (ft.lb)*	361	(2,611,220)	375	(2,712,485)
V	*t (lb)*	179	(394,630)	162	(357,150)
S	*t (lb)*	68	(149,915)	70	(154,325)
T	*t (lb)*	284	(626,110)	289	(637,135)
U	*t (lb)*	201	(443,130)	218	(480,605)
Tie (C)	*t (lb)*	74	(163,140)	94	(207,235)

Note: All charts and specifications are for information only and should not be used for lifting purposes. Continuous engineering and improvements makes it necessary that we reserve the right to make specification, equipment and price changes without notice.

Internal Ladder Climbing



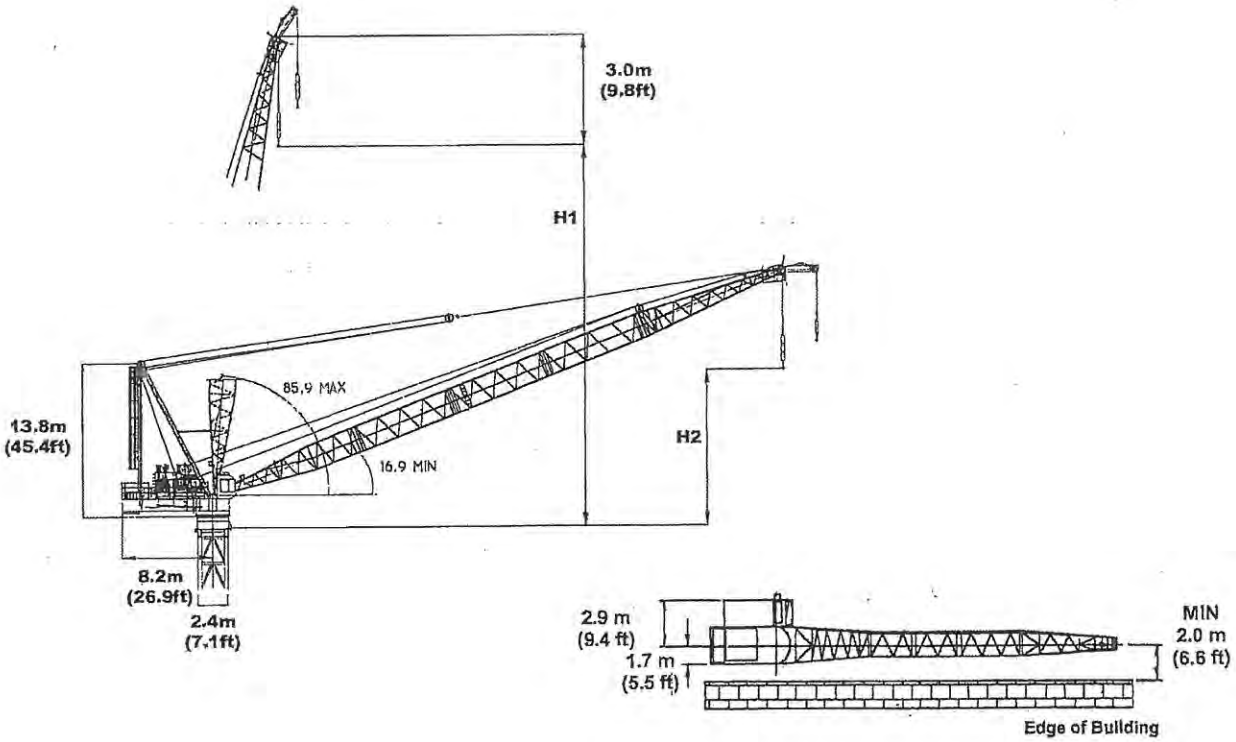
Building Reaction - Internal Climbing on 393 Towers

		In Service		Out of Service	
Wind Speed	*m/s (mph)*	20	(45)	40.2	(90)
L	*t (lb)*	204	(449,745)	187	(412,265)
H1	*t (lb)*	61	(134,480)	98	(216,055)
H2	*t (lb)*	54	(119,050)	72	(158,730)

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3) CRANE DIMENSIONS



Boom Length		Maximum Radius		Hook Height H1		Hook Height H2	
m	(ft)	m	(ft)	m	(ft)	m	(ft)
65.0	(213.3)	68.8	(225.7)	68.6	(225.1)	18.6	(61.0)
60.0	(196.8)	64.2	(210.6)	64.0	(210.0)	17.5	(57.4)
55.0	(180.4)	59.6	(195.5)	59.4	(194.9)	16.3	(53.5)
52.5	(172.2)	55.0	(180.4)	54.8	(179.8)	15.2	(49.9)
47.5	(155.8)	50.4	(165.4)	50.2	(164.7)	14.1	(46.3)
42.5	(139.4)	45.8	(150.3)	45.6	(149.6)	12.1	(39.7)
40.0	(131.2)	41.2	(135.2)	41.0	(134.5)	11.5	(37.7)
35.0	(114.8)	36.6	(120.1)	36.4	(119.4)	9.5	(31.2)
30.0	(98.4)	32.0	(104.9)	31.8	(104.3)	8.7	(28.5)

Note: All charts and specifications are for information only and should not be used for lifting purposes. Continuous engineering and improvements makes it necessary that we reserve the right to make specification, equipment and price changes without notice.

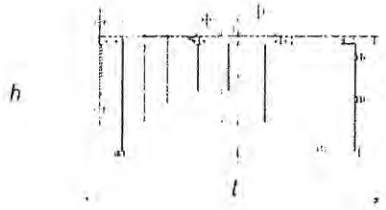
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COMPONENTS DIMENSION & WEIGHTS

Split Deck - Front

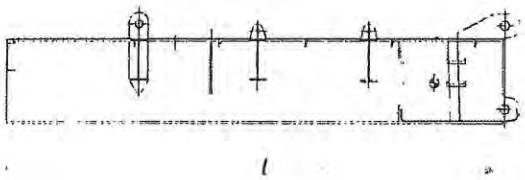
Length (l)		Width (w)		Height (h)		Weight	
3.76	m	3.34	m	1.96	m	5,280	kg
12.34	ft	10.96	ft	6.43	ft	11,640	lb

Note : Weight for Split Deck - Front inclusive of Slew Ring and Slew Drive Assembly.



Split Deck - Back

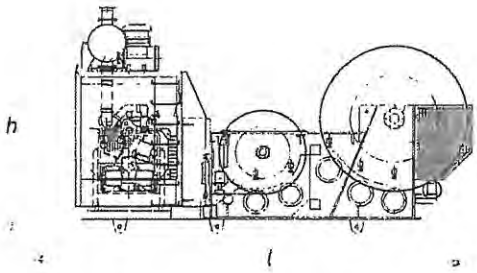
Length (l)		Width (w)		Height (h)		Weight	
6.69	m	3.34	m	1.45	m	11,857	kg
21.95	ft	10.96	ft	4.76	ft	26,140	lb



Powerpack Winches

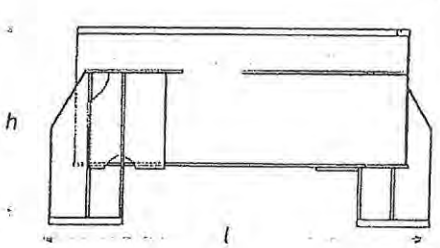
Length (l)		Width (w)		Height (h)		Weight	
5.77	m	3.03	m	3.37	m	17,000	kg
18.93	ft	9.94	ft	11.07	ft	37,478	lb

Note : Weight for Powerpack Winches inclusive of Wire Ropes, Hydraulic Oil, Lubricant, Coolant and Hoses.



Slew Mount

Length (l)		Width (w)		Height (h)		Weight	
3.41	m	3.50	m	1.86	m	4,941	kg
11.18	ft	11.48	ft	6.10	ft	10,893	lb



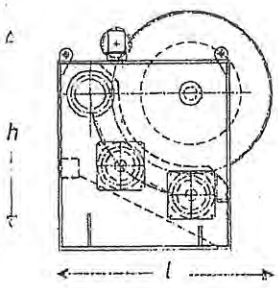
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Fly Winch

Length (l)		Width (w)		Height (h)		Weight	
1.59	m	2.28	m	1.68	m	3,100	kg
5.22	ft	7.48	ft	5.90	ft	6,834	lb

Note : Weight for Fly Winch inclusive of Wire Ropes.

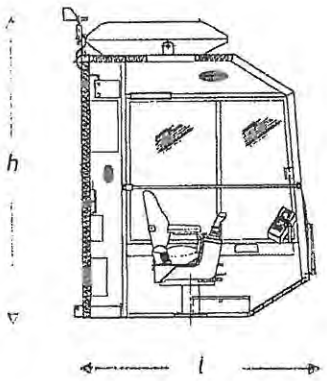


Cabin

Length (l)		Width (w)		Height (h)		Weight	
1.89	m	1.69	m	2.48	m	1,200	kg
6.20	ft	5.54	ft	8.14	ft	2,645	lb

Cabin Support *(not shown)*

Length		Width		Height		Weight	
3.63	m	1.60	m	1.13	m	330	kg
11.90	ft	5.25	ft	3.71	ft	728	lb



(A) Mast & Sheaves

Length		Width		Height		Weight	
6.65	m	3.40	m	12.52	m	4,820	kg
21.81	ft	11.15	ft	41.07	ft	10,626	lb

(B) Mast Ladder

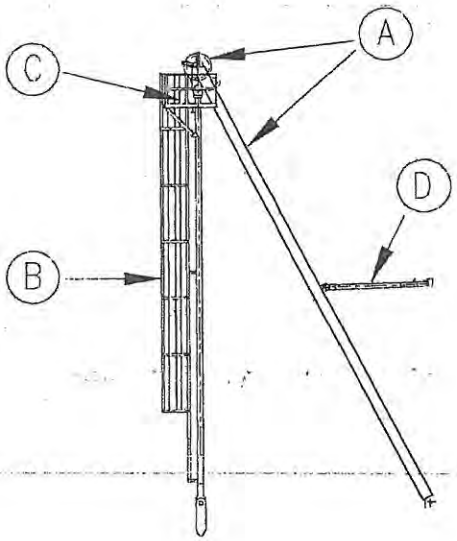
Length		Width		Height		Weight	
1.02	m	0.82	m	11.31	m	290	kg
3.35	ft	2.62	ft	37.11	ft	640	lb

(C) Mast Platform

Length		Width		Height		Weight	
1.92	m	1.54	m	1.00	m	220	kg
6.30	ft	5.05	ft	3.28	ft	485	lb

(D) Boom Buffer

Length		Width		Height		Weight	
3.65	m	2.83	m	0.15	m	300	kg
11.97	ft	9.28	ft	0.49	ft	662	lb



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ATTACHMENTS

Boom Bottom Section

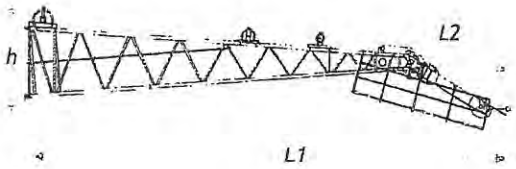
Length (l)		Width (w)		Height (h)		Weight	
13.92	m	3.04	m	2.42	m	2,150	kg
45.67	ft	9.97	ft	7.94	ft	4,740	lb



Boom Top Section

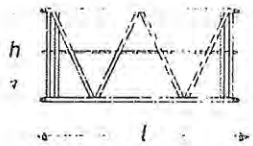
Length (L1)		Width (w)		Height (h3)		Weight	
17.42	m	2.59	m	3.08	m	3,800	kg
57.16	ft	8.50	ft	10.11	ft	8,377	lb

Length (L2)	
3.13	m
10.26	ft



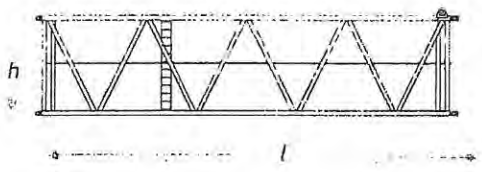
Boom Insert

Length (l)		Width (w)		Height (h)		Weight	
4.72	m	2.42	m	2.42	m	850	kg
15.49	ft	7.94	ft	7.94	ft	1,873	lb



Boom Insert

Length (l)		Width (w)		Height (h)		Weight	
9.32	m	2.42	m	2.42	m	1,552	kg
30.58	ft	7.94	ft	7.94	ft	3,422	lb

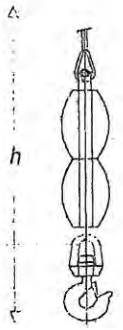


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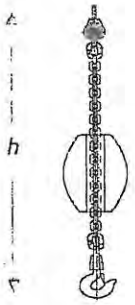
Main Hook - 25T

Height (h)		Weight	
2.47	m	757	kg
8.10	ft	1,669	lb



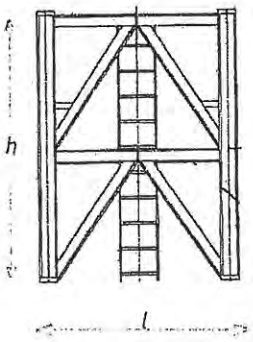
Fly Hook - 10T

Height (h)		Weight	
2.41	m	348	kg
7.91	ft	767	lb



Tower Type 393

Length (l)		Width (w)		Height (h)		Weight	
2.42	m	2.40	m	4.00	m	5,000	kg
7.94	ft	7.87	ft	13.12	ft	11,023	lb



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CLIMBING SYSTEMS

External Climber

(A) Climbing Cylinder

Length		Width		Height		Weight	
5.10	m	0.29	m	0.29	m	1,500	kg
16.73	ft	0.95	ft	0.95	ft	3,307	lb

(B) Side Panel

Length		Width		Height		Weight	
11.52	m	0.37	m	2.43	m	4,970	kg
37.80	ft	1.21	ft	7.97	ft	10,957	lb

(C) Tie

Length		Width		Height		Weight	
7.02	m	0.17	m	3.10	m	900	kg
23.03	ft	0.56	ft	10.17	ft	1,984	lb

(D) Climbing Support

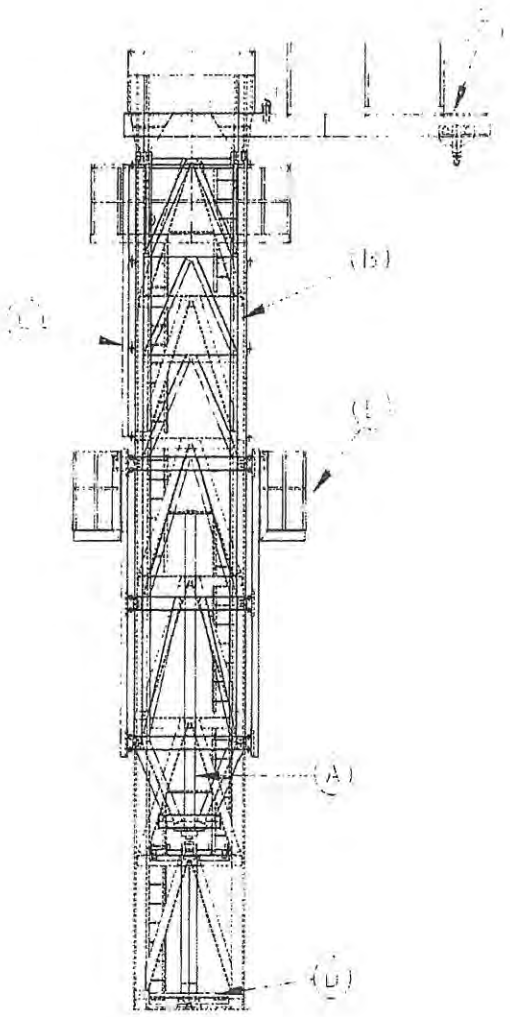
Length		Width		Height		Weight	
2.65	m	0.36	m	0.80	m	350	kg
8.69	ft	1.18	ft	2.62	ft	771	lb

(E) Access Platform

Length		Width		Height		Weight	
3.30	m	1.06	m	1.24	m	215	kg
10.83	ft	3.48	ft	4.07	ft	474	lb

(F) Monorail Beam & Trolley x 1

Length		Width		Height		Weight	
5.73	m	0.65	m	1.20	m	1,810	kg
18.80	ft	2.13	ft	3.94	ft	3,990	lb



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Internal Ladder Climber

A) Bottom Climbing Tower (incl cylinders)

Length		Width		Height		Weight	
2.72	m	2.71	m	4.56	m	8,610	kg
8.92	ft	8.89	ft	14.96	ft	18,981	lb

B) Climbing Foot

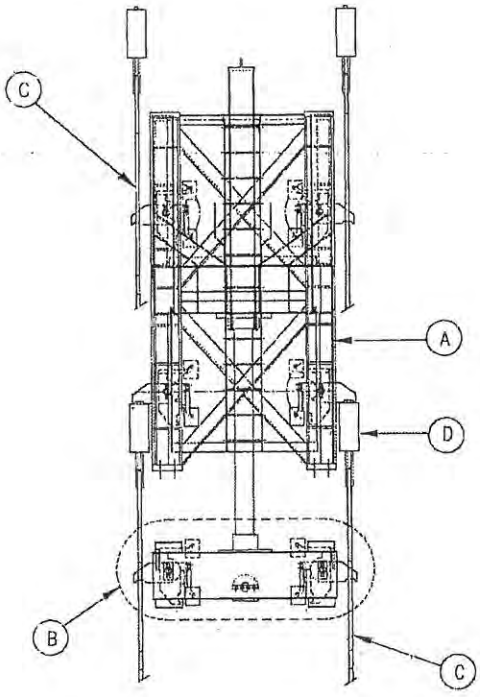
Length		Width		Height		Weight	
3.17	m	0.56	m	1.11	m	1,470	kg
10.40	ft	1.84	ft	3.64	ft	3,241	lb

C) Climbing Ladder

Length		Width		Height		Weight	
5.29	m	0.15	m	0.22	m	405	kg
17.36	ft	0.49	ft	0.72	ft	893	lb

D) Climbing Collar

Length		Width		Height		Weight	
3.75	m	3.26	m	0.94	m	3,055	kg
12.30	ft	10.70	ft	3.08	ft	6,735	lb



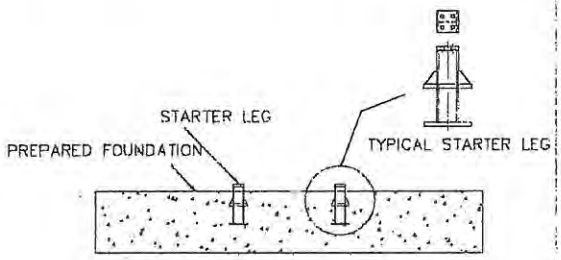
* 3-Beam Internal Climber also available. Contact manufacturer for more information.

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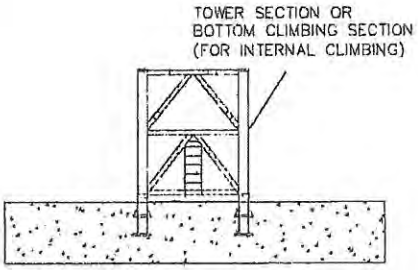
4) OPERATING PROCEDURES

ASSEMBLING

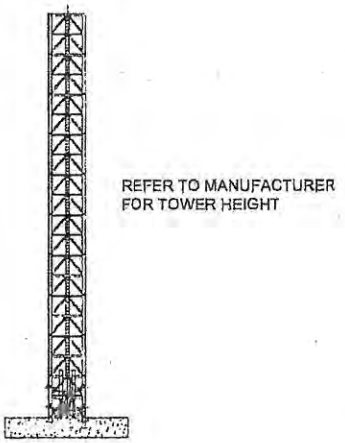
1. Starter legs cast into prepared foundation.



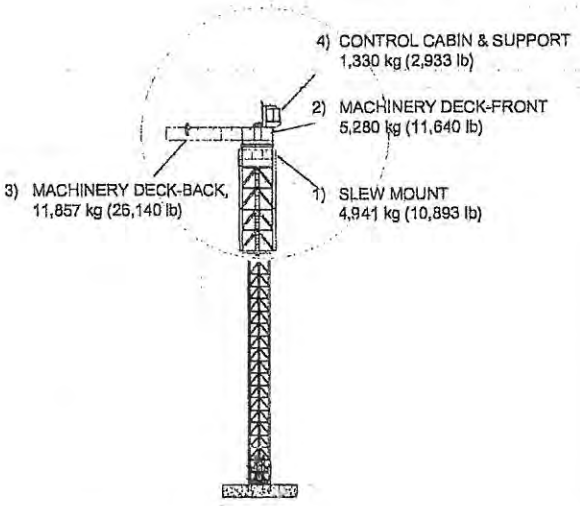
2. Bottom climbing section connected to starter legs.



3. Tower put up to the required height

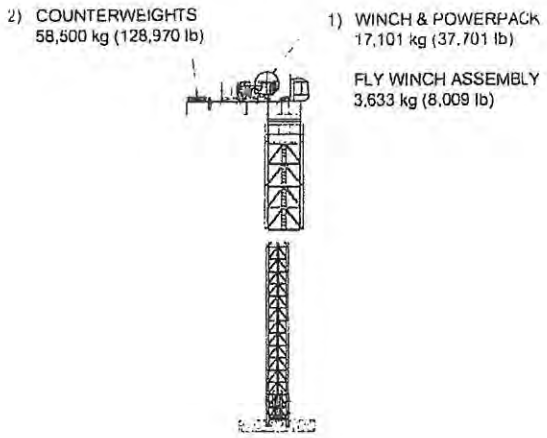


4. Installation of the crane upper section

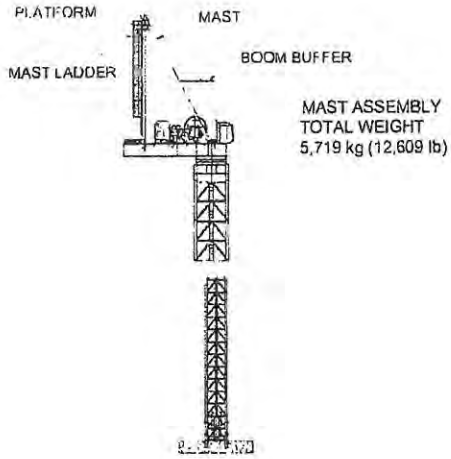


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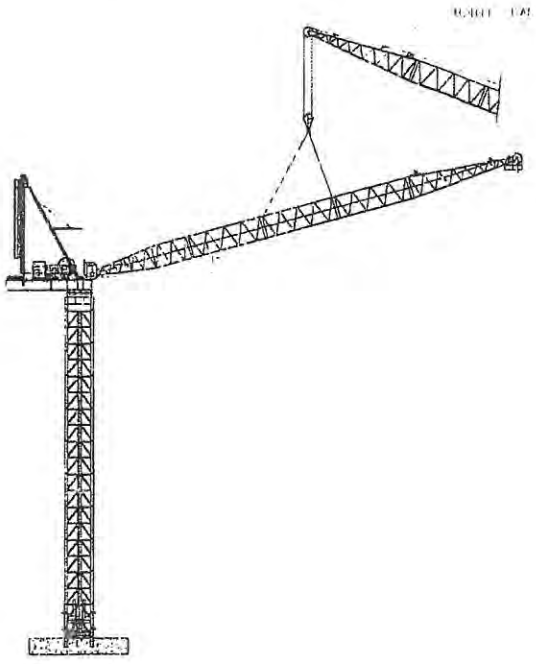
5. Assemble Winch, Powerpack and Counterweights.



6. Assembly of the Mast



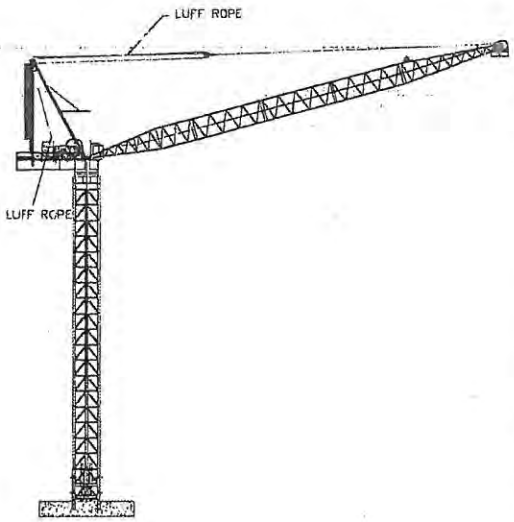
7. Boom Assembly



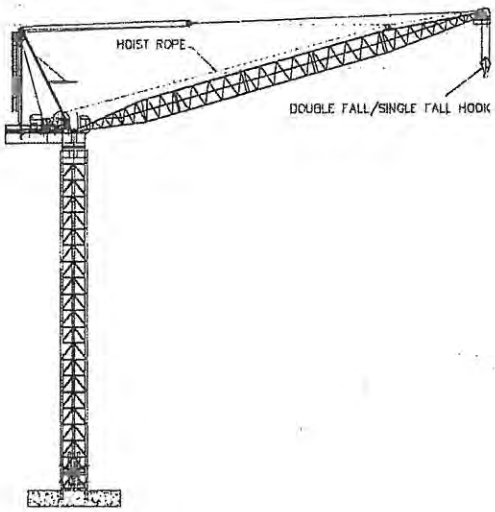
Boom Length		Weight	
m	(ft)	kg	(lb)
32.0	(104.9)	7,146	(15,754)
36.6	(120.1)	7,834	(17,271)
41.2	(135.2)	8,698	(19,176)
45.8	(150.3)	9,386	(20,693)
50.4	(165.4)	10,250	(22,598)
55.0	(180.4)	10,938	(24,115)
59.6	(195.5)	11,802	(26,020)
64.2	(210.6)	12,490	(27,537)
68.8	(225.7)	13,354	(29,442)

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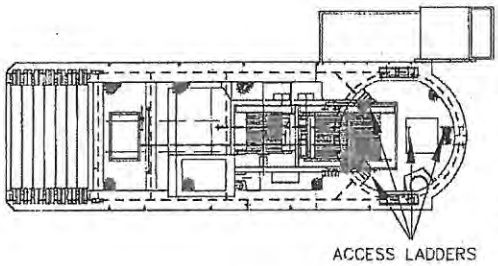
8. The luff rope is reeved.



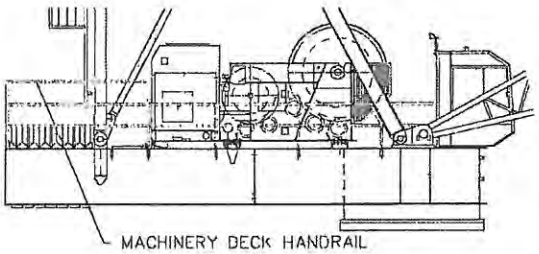
9. Hoist rope and hook assembly



10. Access Ladders Assembly



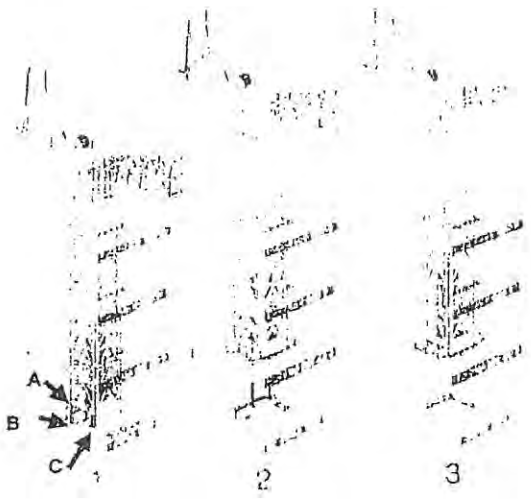
11. Machinery Deck Handrail Assembly



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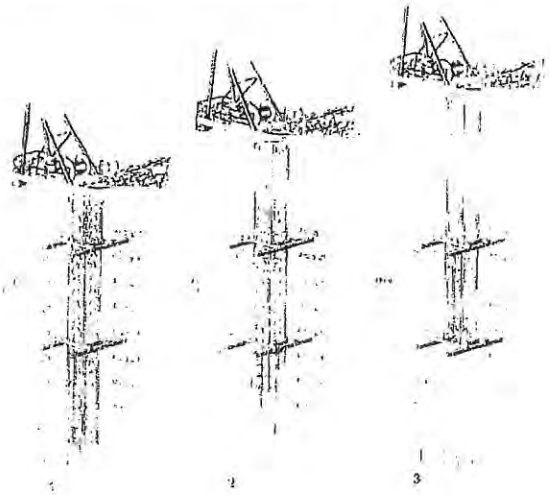
CLIMBING

INTERNAL CLIMBING 3-BEAM



1. Telescopic Internal Sections of beam B are extended at both ends and are supported on the building. The telescopic sections of beams A and C are retracted.
2. Crane, tower and climbing frame, to which beams A and C are attached, are lifted by hydraulic rams.
3. Telescopic sections of beams A and C are extended to support the crane. Telescopic sections of beam B are retracted. Hydraulic cylinders lift beam B to the level of beams A and C. Telescopic sections of beam B are extended.
4. Telescopic Internal Sections of beam B are extended at both ends and are supported on the building. The telescopic sections of beams A and C are retracted.
5. Crane, tower and climbing frame, to which beams A and C are attached, are lifted by hydraulic rams.
6. Telescopic sections of beams A and C are extended to support the crane. Telescopic sections of beam B are retracted. Hydraulic cylinders lift beam B to the level of beams A and C. Telescopic sections of beam B are extended.

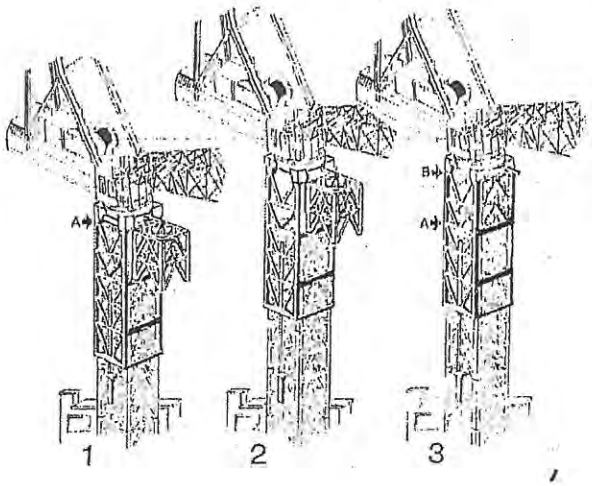
INTERNAL LADDER CLIMBING



1. Install climbing collars and ladder. Balance the crane upper, remove the base bolts and raise the crane, using hydraulic rams, allowing the climbing supports to skid past and then rest on a ladder rung. Climb the ladder in this manner.
2. Climb through the first collar allow the crane supports to rest on the collar. Engage collar chocks to support the crane laterally.
3. Move the ladder to the second collar and install a third collar.

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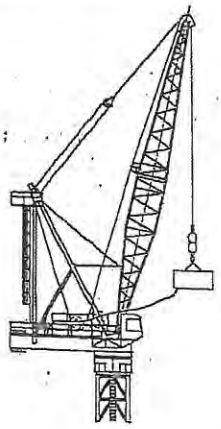
EXTERNAL CLIMBING FRAME



1. Crane lifts additional tower section and suspends it from extendable monorail. Bolts of top tower section are removed at A.
2. Hydraulic ram lifts top section of crane and climbing frame.
3. Additional tower section is drawn into the climbing frame and bolted at B and A

   To climb down, the reverse procedure is followed.

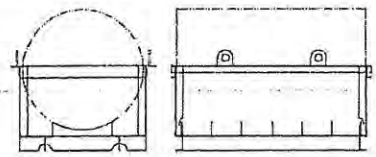
REFUELLING



There are quite a few different procedures to refuel the crane. The suggested procedure is as described below:

1. Hoist the fuel tank up until it is just above the cabin or higher to attain an appropriate fluid head to allow the fuel to flow.
2. Luff in the boom until the refueling hose is close to the machinery deck so that the hose can be reached and obtained by the maintenance personnel.
3. The hose is then inserted into the filler breather opening, and the fuel is allowed to flow into the tank. Check dipstick for tank level or level gauge if fitted.
4. Reverse steps 1 – 3 to lower the empty refueling tank into the ground.

Fuel Tank Support (Optional)



Standard fuel tank support is available from the manufacturer.

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OPERATIONS

(Please refer to the Crane Operations Manual for details)

MAINTENANCE

(Please refer to the Crane Maintenance Manual for details).

5) LIMITED WARRANTY

1. **FAVELLE FAVCO CRANES** warrants its products to be free from defects in material and workmanship for a period of twelve (12) months from the date after commissioning of the goods or eighteen (18) months from the delivery of the project to the original Purchaser-user, whichever comes first. The obligation of **FAVELLE FAVCO CRANES (the company)** under this warranty is limited to repairing or replacing equipment, which in the company's opinion is defective in material or workmanship. Third party equipment/components manufactured by others (e.g. engine, LMI, etc) are covered by the warranty of the respective manufacturers. No recommendation of items made by others shall imply or constitute any warranty by the company with respect to such items.

2. All costs of shipping the product to or from the company's factory for any repair or replacement shall be to purchaser's account. No claim under this warranty will be allowed by the company unless such claim is submitted in writing to the company within thirty (30) days of the date of discovery of the defect, but in no event later than the expiration of the applicable warranty period, and subject always to paragraph 1 above.

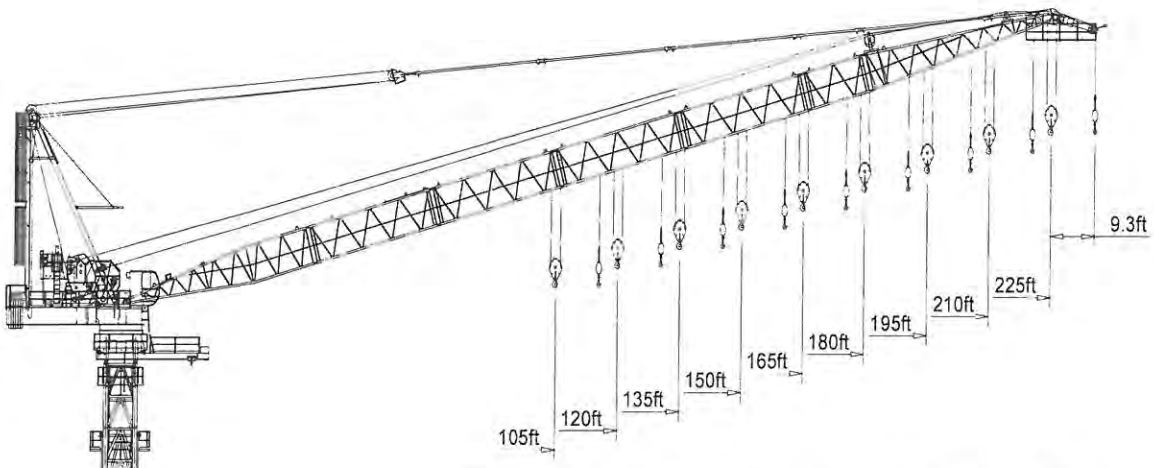
3. This warranty does not cover consumable items, mainly but not limited to hydraulic fluids, lubricants, filters, coolants, fuel and wire rope. In addition, this warranty does not cover ordinary wear and tear, vandalism, abuse, misuse, overloading, altered equipment, equipment or parts which have not been properly installed, operated or maintained or which have been improperly adjusted, or any damage caused by failure to follow the maintenance procedures outlined in the applicable manuals and technical bulletins issued by the company.

4. This warranty and the company's obligation hereunder is in lieu of all other warranties, expressed or implied without limitation, the implied warranties of merchant ability and fitness for a particular purpose and all other obligations or liabilities, including liability for direct, indirect or consequential damages with respect to the sale or the use of the product.

5. The company shall not be liable under any circumstances for any incidental, consequential or special damages, including without limitation any lost profits or labour costs, arising from the sale of use of the equipment, whether based on warranty (expressed or implied) or otherwise based on contract, tort or on any other theory of liability, and regardless of any advice or representations that may have been rendered by the company concerning the sale or use of the equipment.

6. Any repair or replacement, as the company may elect shall be done at an establishment authorized by it. This warranty does not apply to normal maintenance service (such as engine tune-up) or to normal replacement of service items (such as service filters), nor does it apply to conditions resulting from misuse, negligence, alteration, lack of specified maintenance, or accident. Loss of time, inconvenience, loss of use of equipment, other consequential damages or other matters not specifically included are NOT covered by this warranty.

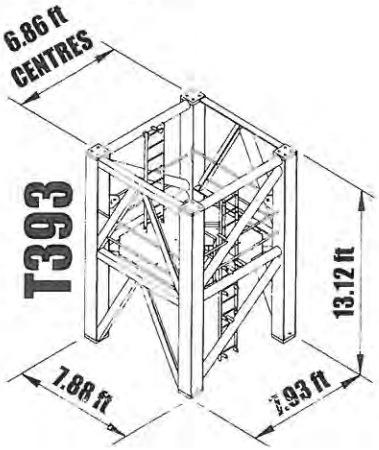
7. No person is authorized to change or otherwise modify this warranty or assume any other liability on behalf of the company unless such change, modification or assumption is made in writing and signed by an authorized officer of the company.



TOWER CRANE M440D

TECHNICAL DATA SHEET

BOOM	LOAD @ RADIUS
105 ft	55.1 ton @ 43 ft 21.5 ton @ 98 ft
120 ft	55.1 ton @ 43 ft 17.7 ton @ 115 ft
135 ft	55.1 ton @ 43 ft 14.4 ton @ 131 ft
150 ft	55.1 ton @ 43 ft 12.9 ton @ 139 ft
165 ft	55.1 ton @ 39 ft 10.5 ton @ 156 ft
180 ft	48.5 ton @ 46 ft 8.8 ton @ 172 ft
195 ft	35.3 ton @ 33 ft 7.3 ton @ 180 ft
210 ft	35.3 ton @ 28 ft 5.3 ton @ 197 ft
225 ft	27.6 ton @ 38.7 ft 3.0 ton @ 213 ft



FAVELLE FAVCO

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M440D MAIN HOIST RADIUS AND CAPACITY

FAVELLE FAVCO

1-FALL										
Boom Length (feet)			225	210	195	180	165	150	135	120	105
Min Radius (feet)			20	17	16	14	14	13	12	11	10
SWL at Min Radius (ton)			27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
	20		27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
	30		27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
	40		27.2	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
	50		24.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
	60		22.6	26.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
	70		20.8	24.5	27.2	27.6	27.6	27.6	27.6	27.6	27.6
	80		19.3	22.5	24.5	26.1	26.3	26.9	27.2	27.4	27.6
	90		17.8	20.4	21.7	22.6	22.8	23.3	23.7	24.0	24.2
	100		16.3	18.3	18.9	19.6	19.8	20.3	20.6	21.0	-
	110		14.7	16.1	16.7	17.2	17.5	18.1	18.3	18.8	-
	120		13.1	14.2	14.8	15.2	15.6	16.1	16.3	-	-
	130		11.5	12.6	13.2	13.5	13.9	14.3	14.7	-	-
	140		10.1	11.2	11.8	12.1	12.5	-	-	-	-
	150		8.9	10.0	10.4	10.8	11.2	-	-	-	-
	160		8.0	8.9	9.3	9.8	-	-	-	-	-
	170		7.1	7.9	8.3	9.0	-	-	-	-	-
	180		6.1	7.0	-	-	-	-	-	-	-
	190		5.3	6.0	-	-	-	-	-	-	-
	200		4.4	-	-	-	-	-	-	-	-
	210		3.3	-	-	-	-	-	-	-	-
Max Radius (feet)			213	197	180	172	156	139	131	115	98
SWL at Max Radius (ton)			3.0	5.3	7.3	8.8	10.5	12.9	14.4	17.7	21.5

2-FALL										
Boom Length (feet)			225	210	195	180	165	150	135	120	105
Min Radius (feet)			20	17	16	14	14	13	12	11	10
SWL at Min Radius (ton)			27.6	35.3	35.3	48.5	55.1	55.1	55.1	55.1	55.1
	20		27.6	35.3	35.3	48.5	55.1	55.1	55.1	55.1	55.1
	30		27.6	34.7	35.3	48.5	55.1	55.1	55.1	55.1	55.1
	40		27.2	31.6	34.2	48.5	54.5	55.1	55.1	55.1	55.1
	50		24.6	28.8	32.6	44.6	45.7	46.0	46.5	47.1	47.3
	60		22.6	26.6	29.9	37.1	37.7	38.1	38.4	38.7	39.1
	70		20.8	24.5	27.2	30.8	31.2	31.6	31.8	31.9	32.4
	80		19.3	22.5	24.5	26.1	26.3	26.9	27.2	27.4	27.6
	90		17.8	20.4	21.7	22.6	22.8	23.3	23.7	24.0	24.2
	100		16.3	18.3	18.9	19.6	19.8	20.3	20.6	21.0	-
	110		14.7	16.1	16.7	17.2	17.5	18.1	18.3	18.8	-
	120		13.1	14.2	14.8	15.2	15.6	16.1	16.3	-	-
	130		11.5	12.6	13.2	13.5	13.9	14.3	14.7	-	-
	140		10.1	11.2	11.8	12.1	12.5	-	-	-	-
	150		8.9	10.0	10.4	10.8	11.2	-	-	-	-
	160		8.0	8.9	9.3	9.8	-	-	-	-	-
	170		7.1	7.9	8.3	9.0	-	-	-	-	-
	180		6.1	7.0	-	-	-	-	-	-	-
	190		5.3	6.0	-	-	-	-	-	-	-
	200		4.4	-	-	-	-	-	-	-	-
	210		3.3	-	-	-	-	-	-	-	-
Max Radius (feet)			213	197	180	172	156	139	131	115	98
SWL at Max Radius (ton)			3.0	5.3	7.3	8.8	10.5	12.9	14.4	17.7	21.5

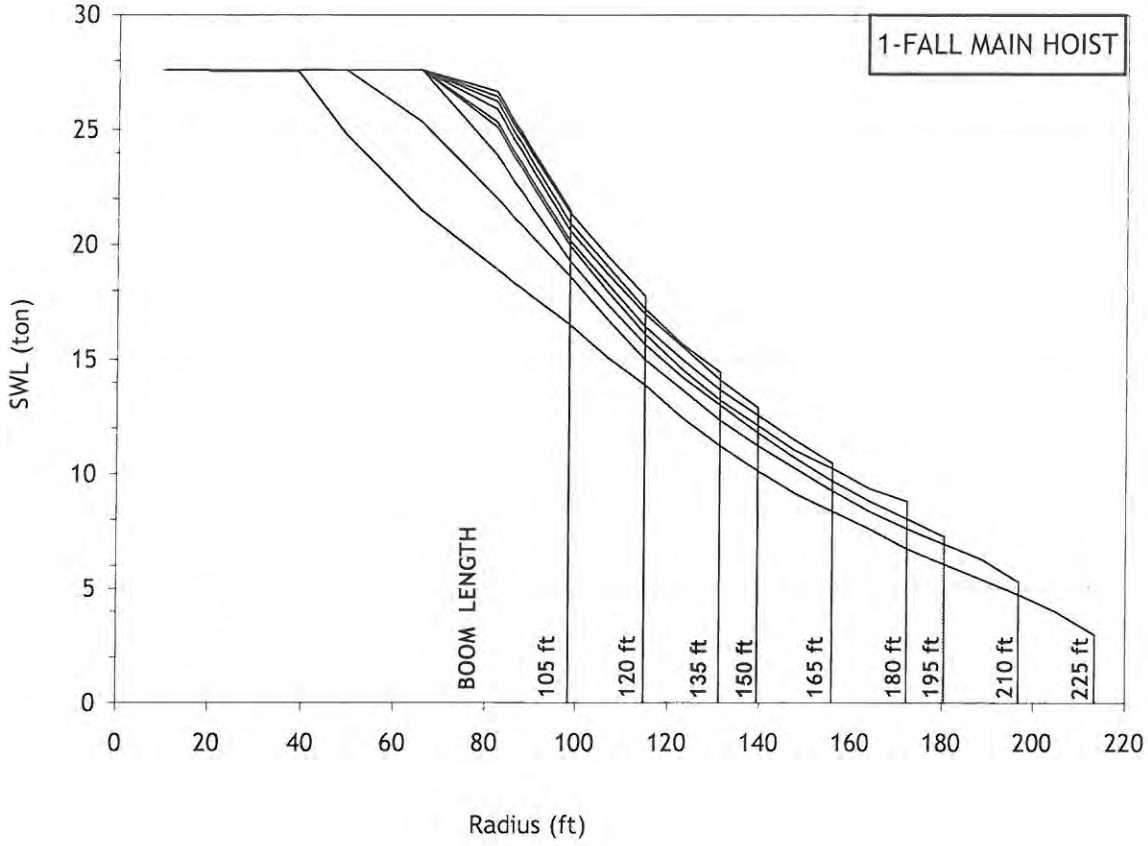
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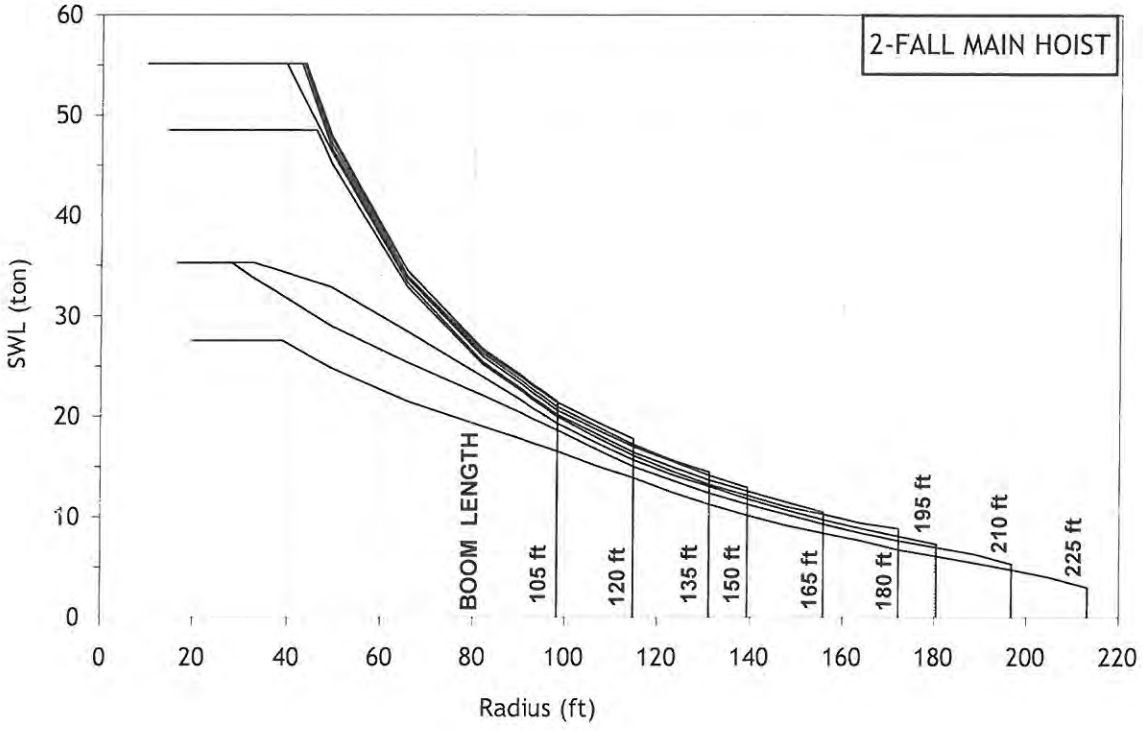
M440D AUXILIARY HOIST RADIUS AND CAPACITY

FAVELLE FAVCO

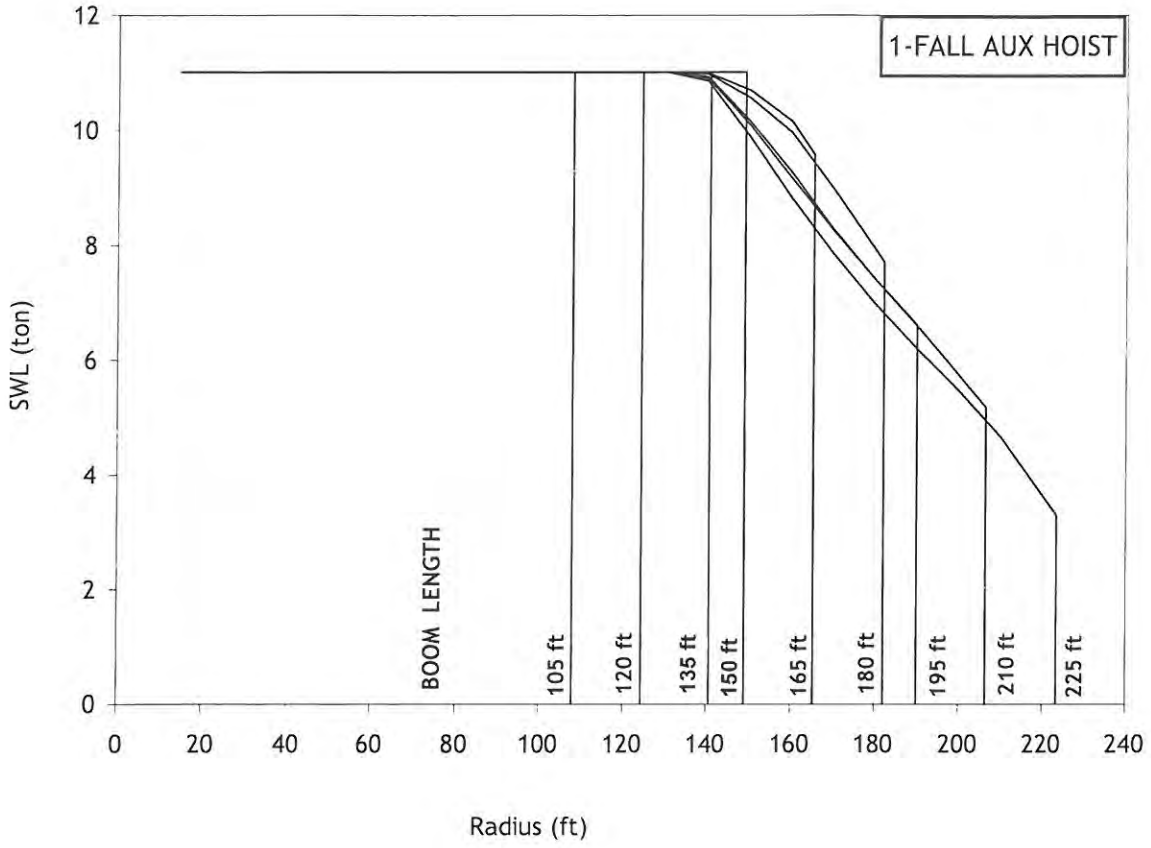
1-FALL									
Boom Length (feet)	225	210	195	180	165	150	135	120	105
Min Radius (feet)	25	22	21	19	19	18	17	16	15
SWL at Min Radius (ton)	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
30	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
40	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
50	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
60	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
70	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
80	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
90	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
100	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
110	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	-
120	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	-
130	11.0	11.0	11.0	11.0	11.0	11.0	11.0	-	-
140	10.9	10.9	10.9	11.0	11.0	11.0	11.0	-	-
150	9.9	10.1	10.2	10.6	10.7	-	-	-	-
160	8.8	9.2	9.3	10.0	10.2	-	-	-	-
170	7.9	8.3	8.3	9.0	-	-	-	-	-
180	7.0	7.4	7.4	7.9	-	-	-	-	-
190	6.2	6.6	6.6	-	-	-	-	-	-
200	5.5	5.7	-	-	-	-	-	-	-
210	4.7	-	-	-	-	-	-	-	-
220	3.6	-	-	-	-	-	-	-	-
Max Radius (feet)	223	206	190	182	165	149	141	124	108
SWL at Max Radius (ton)	3.3	5.2	6.6	7.7	9.6	11.0	11.0	11.0	11.0

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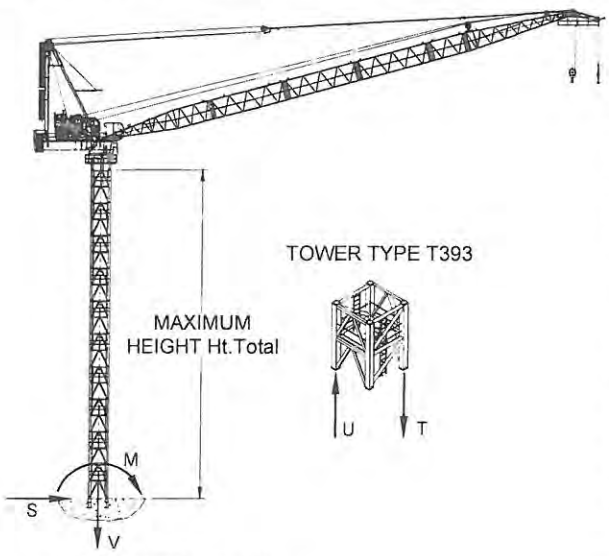

1-FALL MAIN HOIST
SWL (ton)
Radius (ft)
BOOM LENGTH
105 ft
120 ft
135 ft
150 ft
165 ft
180 ft
195 ft
210 ft
225 ft
0
5
10
15
20
25
30
0
20
40
60
80
100
120
140
160
180
200
220


2-FALL MAIN HOIST
SWL (ton)
Radius (ft)
BOOM LENGTH
105 ft
120 ft
135 ft
150 ft
165 ft
180 ft
195 ft
210 ft
225 ft
0
10
20
30
40
50
60
0
20
40
60
80
100
120
140
160
180
200
220

M440D AUXILIARY HOIST LOAD CHART



M440D TYPICAL FOUNDATION & BUILDING REACTION (CRANE REEVED 2-FALLS AT 165 ft BOOM LENGTH)



*:IN SERVICE WIND = 45 mph

‡:OUT OF SERVICE WIND = 95 mph

Notes:

1 Structure is designed using permissible stress method.

2 These loads will vary by change of boom length, height and type of tower, actual site wind conditions, no of falls and change of wind speed.

3 To calculate alternative options for M440D refer to Favelle Favco Design Sheet named "Crane Weight Wind Chart".

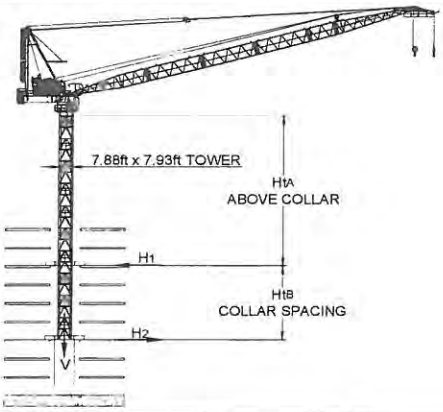
FREE STANDING BUILDING REACTION

WITHOUT CLIMBING FRAME			
No. of Towers		12	
Design Load	Unit	I/S*	O/S‡
M	lb.ft	5,938,243	7,630,751
V	lb	478,398	381,396
S	lb	15,432	66,138
T	lb	731,927	881,840
U	lb	493,830	692,244
Ht_{Total}	ft	157	

WITH EXTERNAL CLIMBING FRAME			
No. of Towers		11	
Design Load	Unit	I/S*	O/S‡
M	lb.ft	6,314,356	7,659,683
V	lb	487,221	368,172
S	lb	17,637	74,957
T	lb	767,208	881,848
U	lb	535,723	696,660
Ht_{Total}	ft	144	

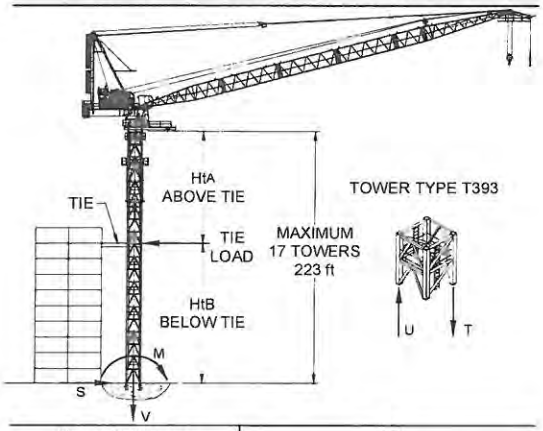
WITH INTERNAL CLIMBER			
No. of Towers		12	
Design Load	Unit	I/S*	O/S‡
M	lb.ft	6,242,027	4,166,173
V	lb	491,630	396,832
S	lb	15,432	46,297
T	lb	767,208	529,109
U	lb	520,290	330,693
Ht_{Total}	ft	157	

INTERNAL CLIMBER ON COLLARS



No. of Towers		12	
Design Load	Unit	I/S*	O/S‡
V	lb	478,398	381,396
H_1	lb	185,186	238,097
H_2	lb	169,754	171,959
Max Ht_A	ft	125	
Min Ht_B	ft	31	
Ht_{Total}	ft	157	

EXTRENAL CLIMBER + ONE TIE

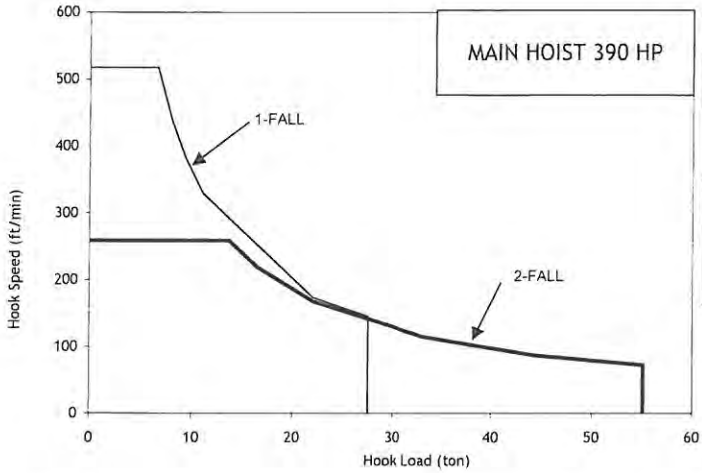


No. of Towers		17	
Design Load	Unit	I/S*	O/S‡
TIE	lb	103,616	178,573
M	lb.ft	2,835,304	3,254,813
V	lb	559,968	465,171
S	lb	83,775	88,184
T	lb	432,102	451,943
U	lb	152,117	220,460
Max Ht_A	ft	125	
Max Ht_B	ft	98	
Ht_{Total}	ft	223	

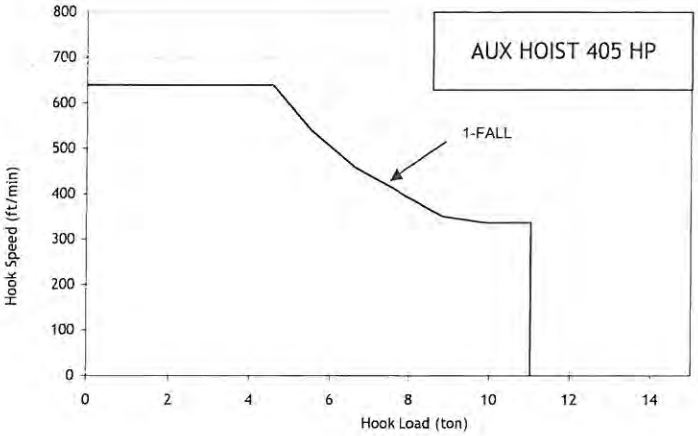
M440D SPEED PERFORMANCE

FAVELLE FAVCO

HOIST SPEED

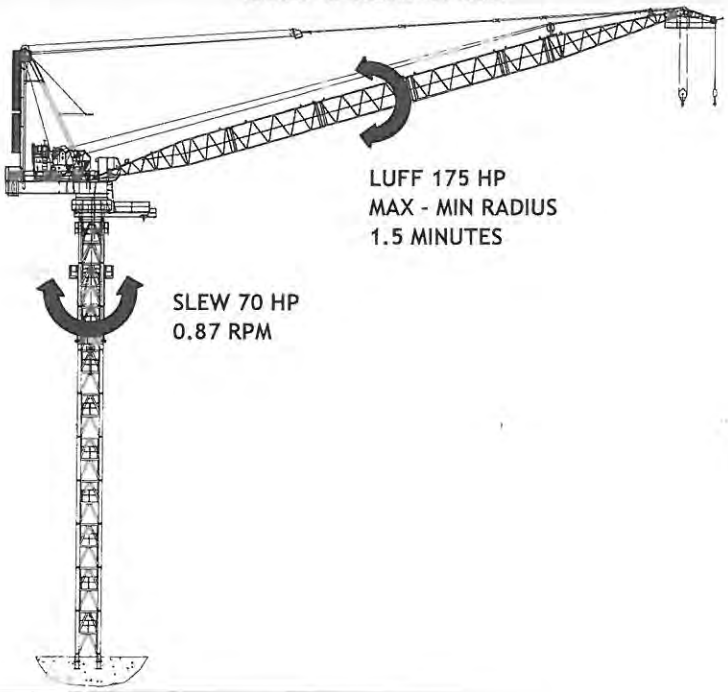


	LOAD (ton)	SPEED (ft/min)
1-FALL	6.6	517
	8.0	437
	9.4	381
	11.0	330
	22.0	174
	27.6	145
2-FALL	13.7	259
	16.5	219
	22.0	168
	33.1	115
	44.1	87
	55.1	73

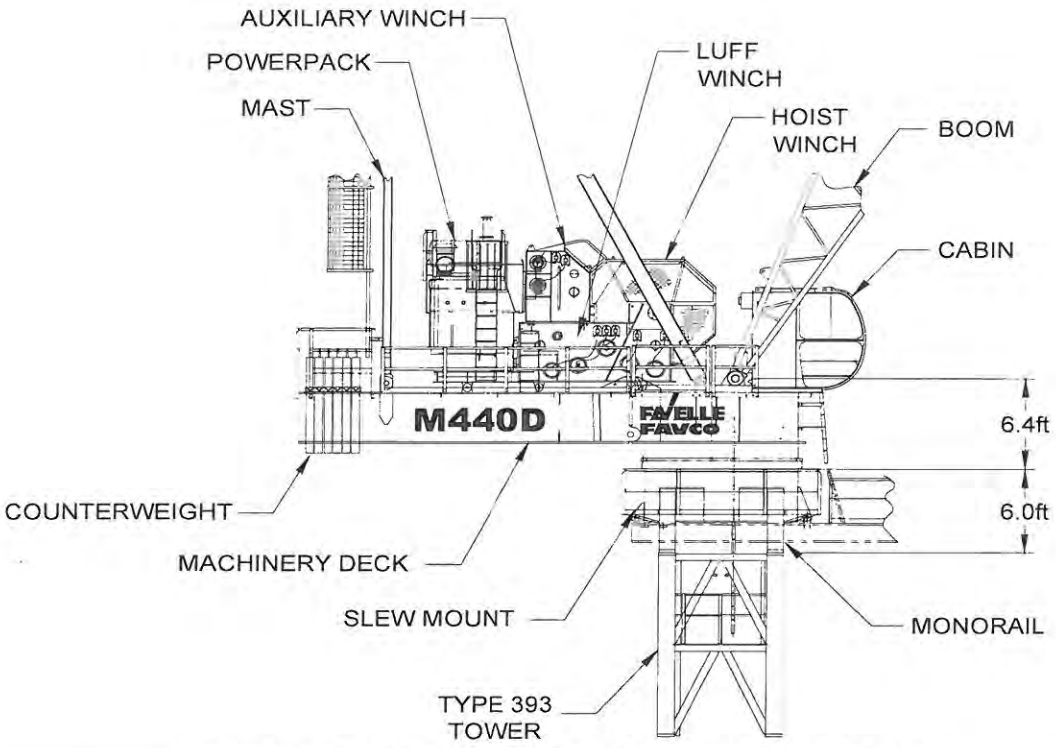


	LOAD (ton)	SPEED (ft/min)
1-FALL	4.6	640
	5.5	541
	6.6	458
	8.8	351
	9.9	337
	11.0	337

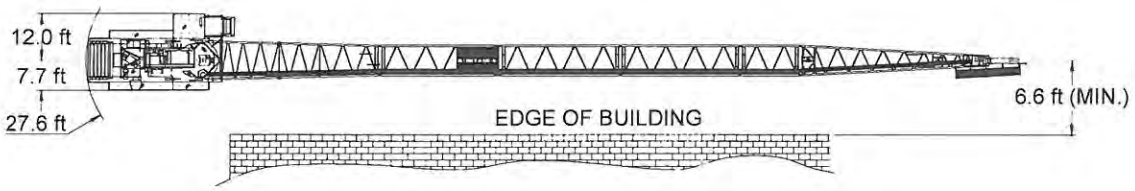
LUFF & SLEW SPEED



TYPICAL CRANE ASSEMBLY



EXTERNAL CLIMBING INSTALLATION CLEARANCE



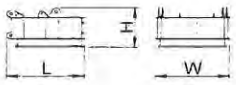
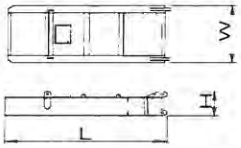
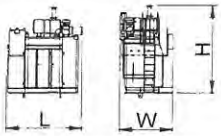
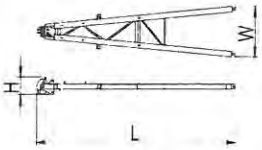
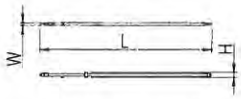
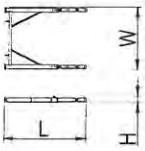
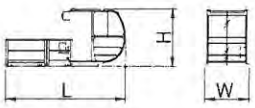
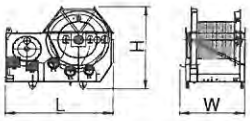
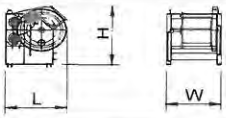
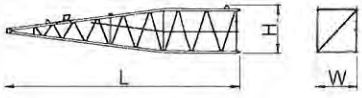
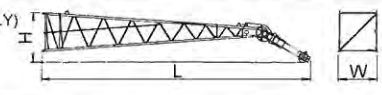
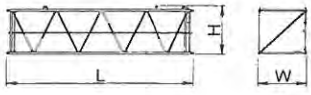
OUT OF SERVICE CONFIGURATION

Boom Length (ft)	Minimum weathervaning*	
	Radius (ft)	Angle (°)
225	41	80.1
210	43	78.7
195	46	76.9
180	50	74.7
165	53	71.9
150	58	68.2
135	63	63.2
120	69	56.0
105	76	44.7

*: Minumum weathervaning position is based on a wind speed of 45 mph.

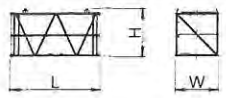
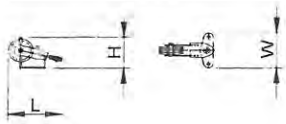
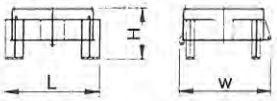
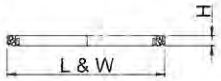
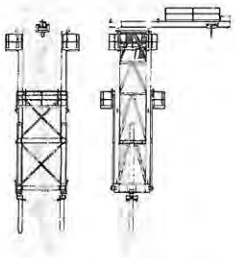
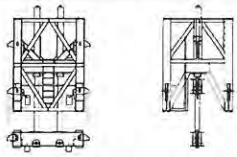
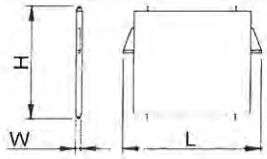
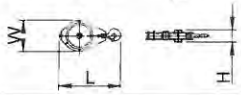
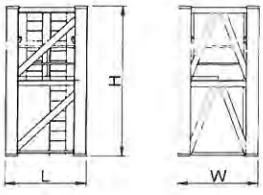
M440D TRANSPORTATION & ERECTION

FAVELLE FAVCO

ITEM	QTY	DESCRIPTION		LENGTH L (feet)	HEIGHT H (feet)	WIDTH W (feet)	WEIGHT PER ITEM (ton)
1	1	SPLIT DECK-FRONT (INCL. SLEW DRIVE, PINS & HANDRAILS)		11.8	6.5	11.0	7.50
2	1	SPLIT DECK-REAR		21.8	4.7	11.0	8.27
3	1	POWERPACK (INCL. 850L OF OIL)		10.4	11.8	7.2	5.57
4	1	MAST FRONT LEG (INCL. MAST HEAD SHEAVES & PIN)		42.2	1.6	1.1	1.38
	2	MAST BACK LEG		38.3	0.5	1.1	0.55
	1	BOOM BUFFER		12.0	0.8	9.2	0.20
		MAST ASSEMBLY (INC. SHEAVES, HEAD PIN, LADDERS,BUFFER AND PLATFORMS)					6.65
5	1	CABIN & PLATFORM ASSEMBLY		14.9	7.8	5.4	1.57
6	1	HOIST/LUFF WINCH ASSY (WITHOUT ROPE)		12.9	9.6	6.0	12.02
7	1	FLY WINCH ASSEMBLY (EMPTY DRUM)		5.2	5.8	4.7	3.20
8	1	BOOM BOTTOM (INC. WALKWAY & PINS)		45.6	8.6	7.9	2.53
9	1	BOOM TOP ASSY (WITH FLY) (INC. ACCESSORIES)		55.1	7.9	10.0	5.15
10	1	BOOM EXTENSION 30.18 ft		30.6	8.6	7.9	1.96

M440D TRANSPORTATION & ERECTION

FAVELLE FAVCO

ITEM	QTY	DESCRIPTION		LENGTH L (feet)	HEIGHT H (feet)	WIDTH W (feet)	WEIGHT PER ITEM (ton)
11	1	BOOM EXTENSION 15.09 ft		15.5	8.6	7.9	1.12
12	1	BRIDLE		5.2	3.3	3.8	0.61
13	1	SLEW MOUNT (INCL. PLATFORMS)		11.2	10.9	5.9	5.63
	1	SLEW RING (INCL. BOLTS)		10.2	0.6	10.2	1.93
14	1	EXTERNAL CLIMBER ASSY		32.0	1.0	10.2	23.00
	2	CLIMBING CYLINDER		16.5	1.0	1.0	2.16
	2	SIDE PANEL		37.8	1.2	9.0	5.48
	2	FRAME TIE		23.0	0.6	11.2	1.00
	2	CLIMBING SUPPORT		8.7	1.1	2.6	0.37
	4	ACCESS PLATFORM		11.5	3.5	4.1	0.22
	1	MONORAIL		24.4	5.5	4.6	3.24
15	1	INTERNAL CLIMBER ASSY		10.5	15.6	7.9	11.62
	1	CLIMBING TOWER		10.5	13.1	7.9	8.40
	2	CYLINDER		12.2	0.8	0.8	0.69
	1	CLIMBING FOOT		10.5	2.5	1.8	1.84
16	6	COUNTERWEIGHT		9.6	7.4	0.5	7.2
17	1	10 TONNE SINGLE FALL HOOK BLOCK		8.1	1.3	1.3	0.31
	1	25 TONNE SINGLE FALL HOOK BLOCK		12.5	1.3	1.3	0.99
18	1	TOWER SECTION T393		8.0	13.1	7.9	5.39
19	1	HOIST ROPE 42MM (~1-5/8 in, 5.75 lb / ft)		985.0	N/A	N/A	2.83
20	1	FLY ROPE 24MM (1.89 lb / ft)		492.0	N/A	N/A	0.46
21	1	LUFF ROPE 24MM (1.83 lb / ft)		395.0	N/A	N/A	0.36

SECTION VI

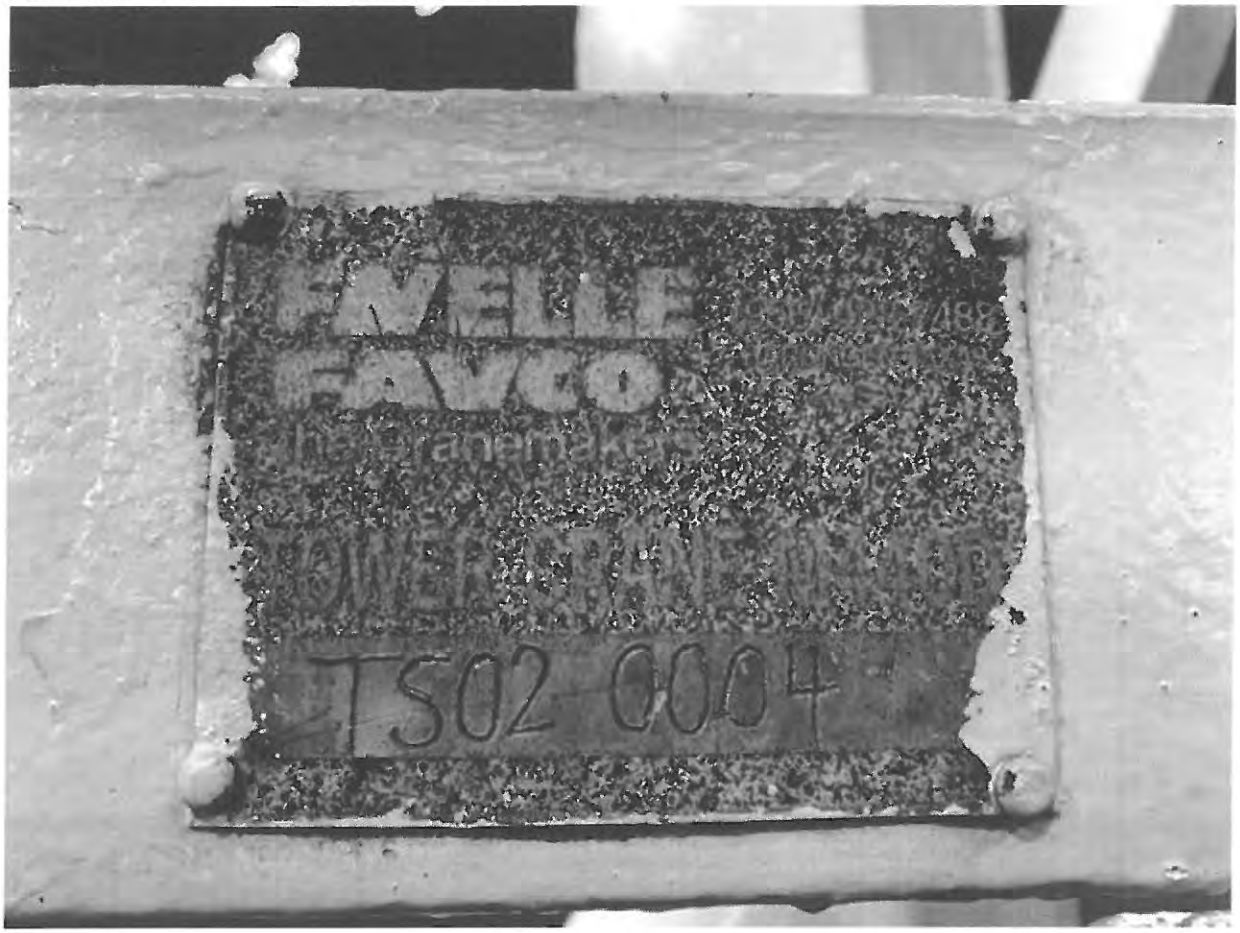
Pictures

CERTIFIED TESTING & INSPECTIONS, INC.

TESTING • INSPECTIONS • ENGINEERING

Photo | 1

Reinforced Tower Section #USA-TS-020004



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Photo | 2

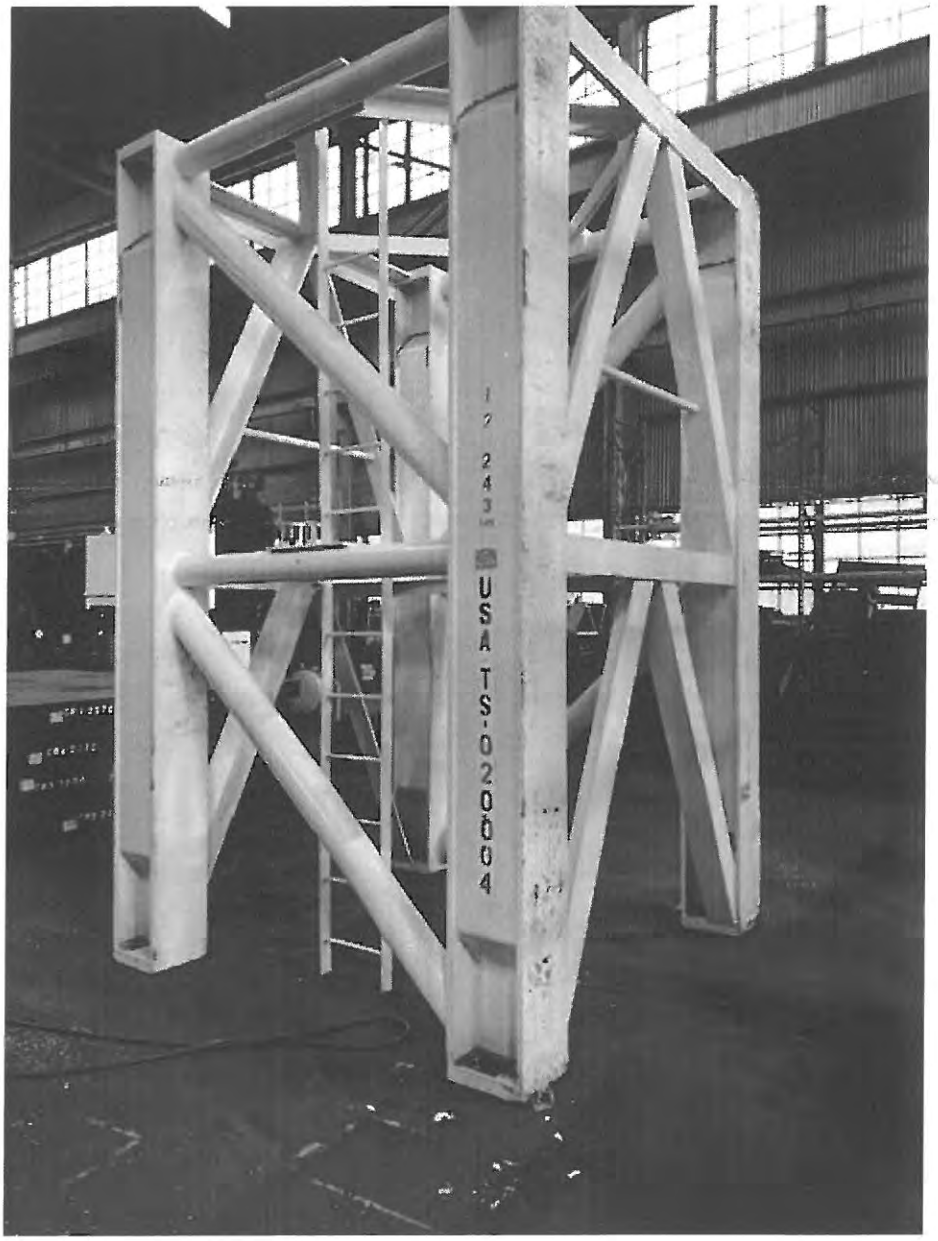


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Photo | 3



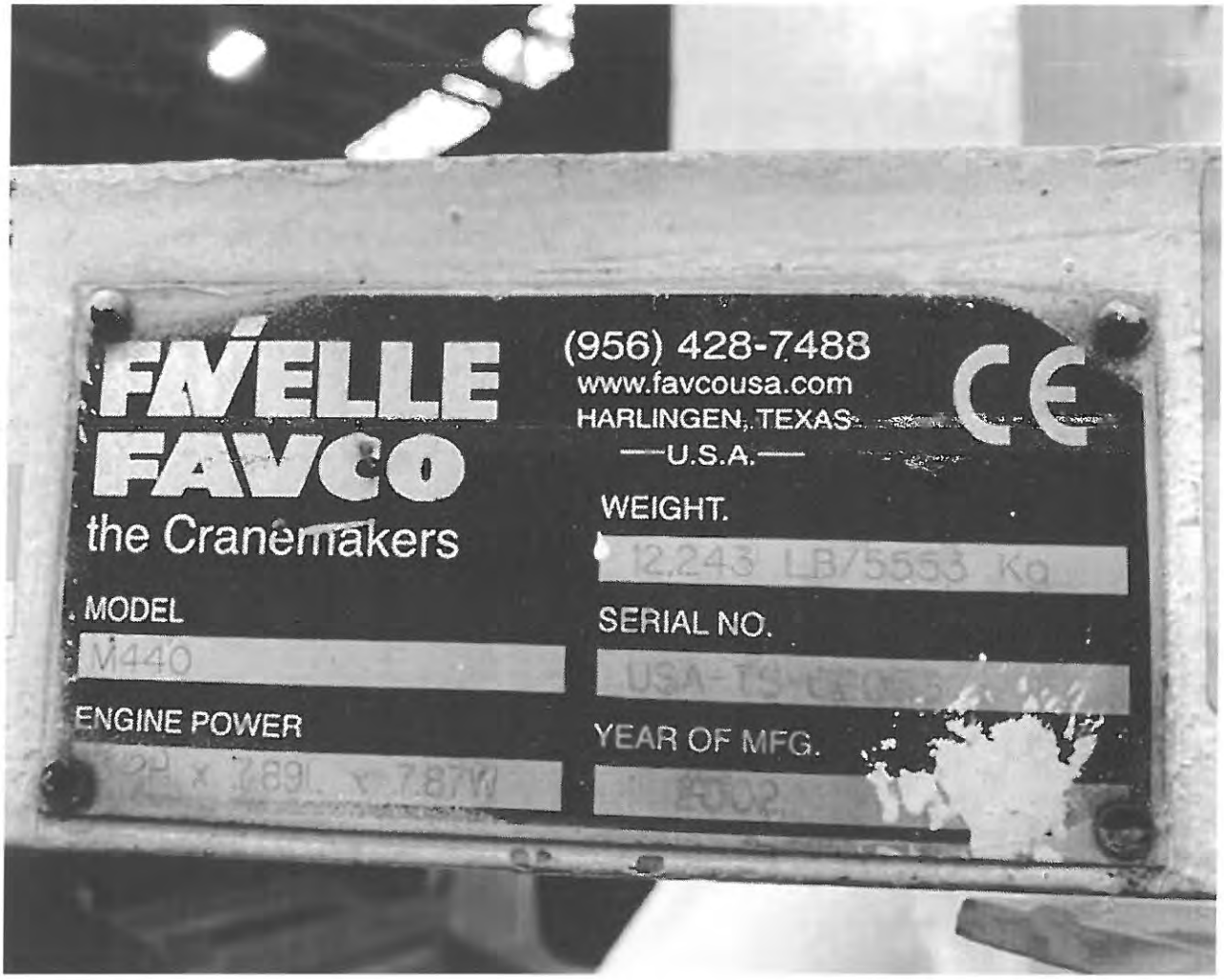
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Photo | 4

Reinforced Tower Section #USA-TS-02033



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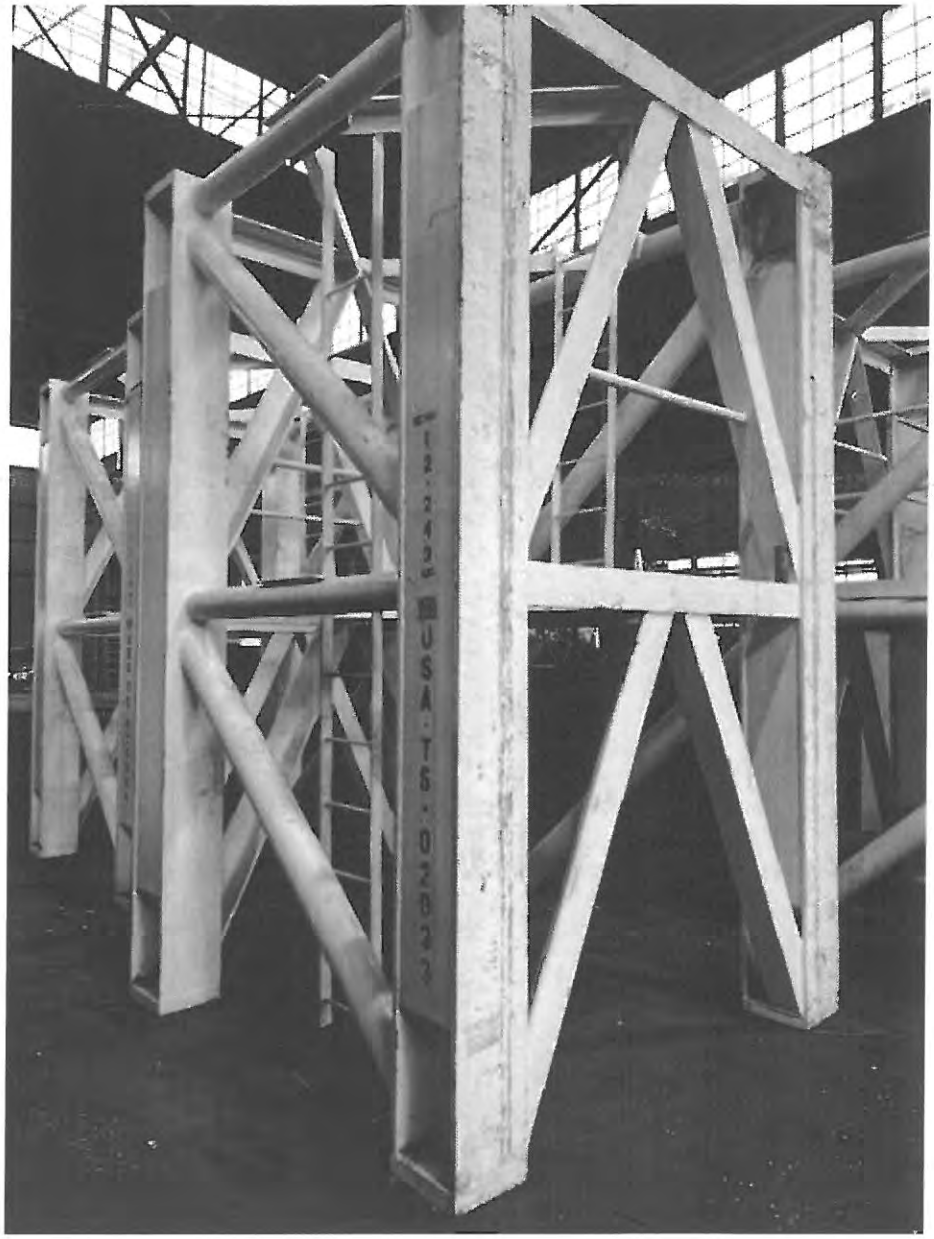
Photo | 5



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Photo | 6



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Photo | 7

Reinforced Tower Section #USA-TS-497-042



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Photo | 8

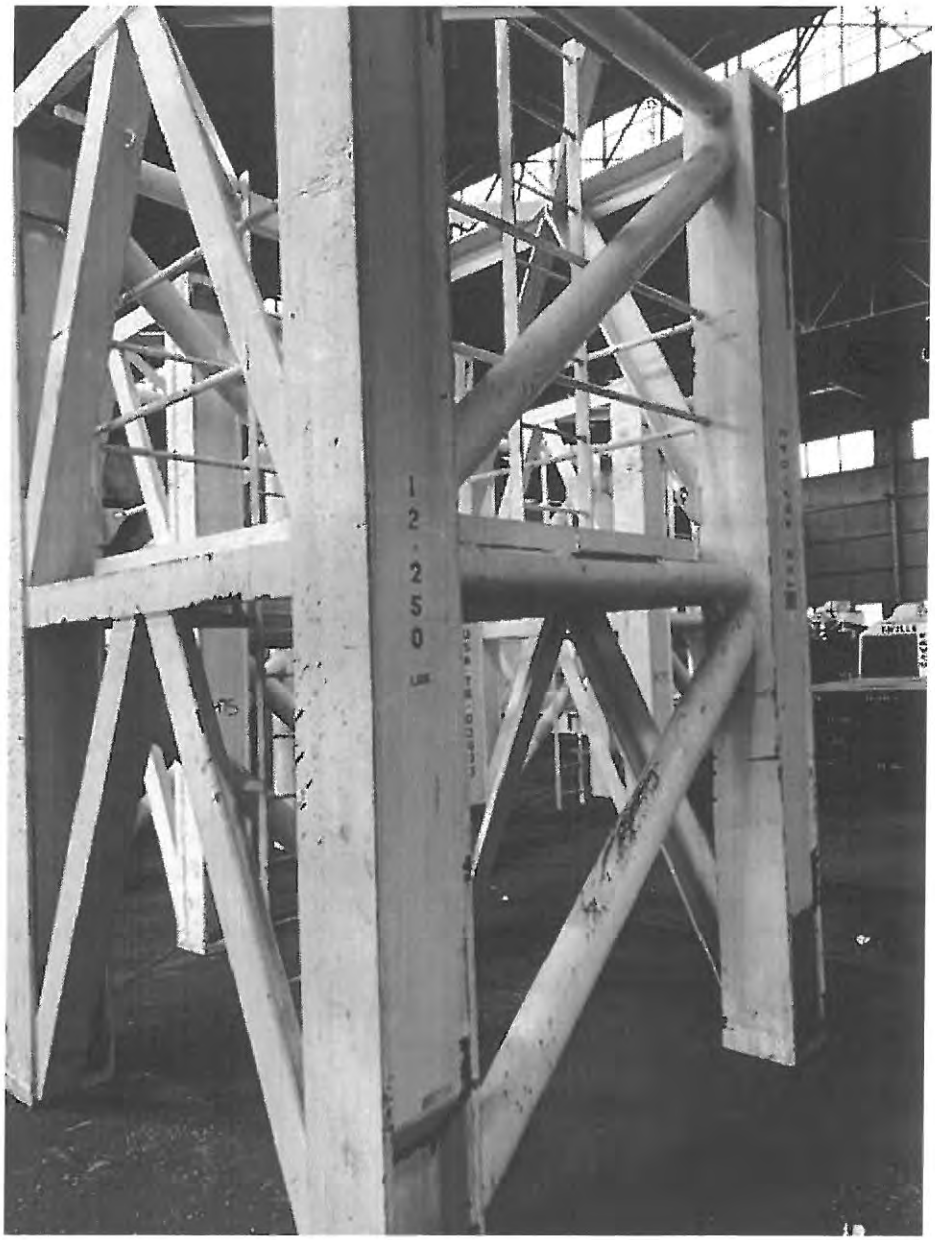


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TESTING • INSPECTIONS • ENGINEERING

Photo | 9



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Photo | 10

Tower Section #USA-TS-07-053



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Photo | 11

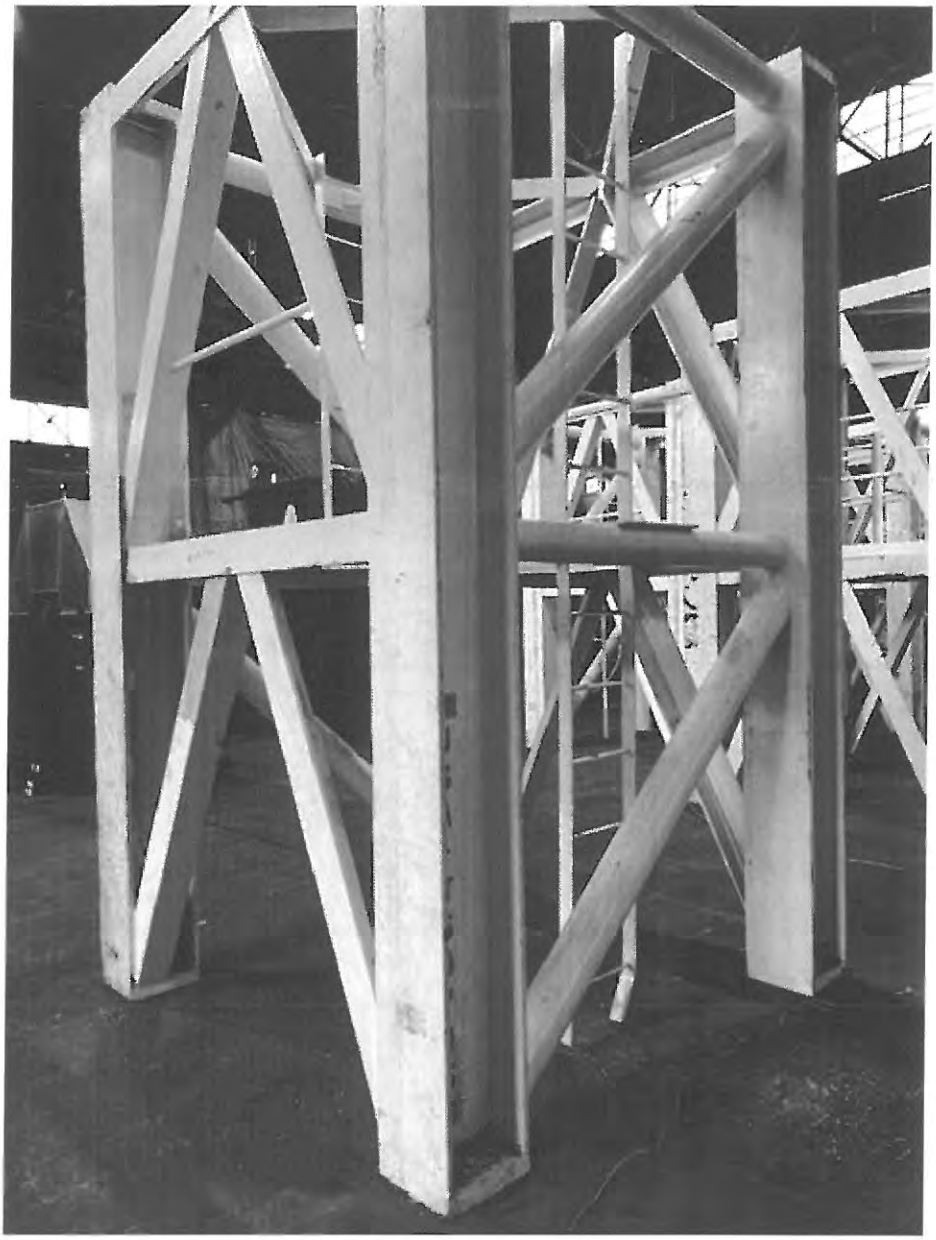


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Photo | 12



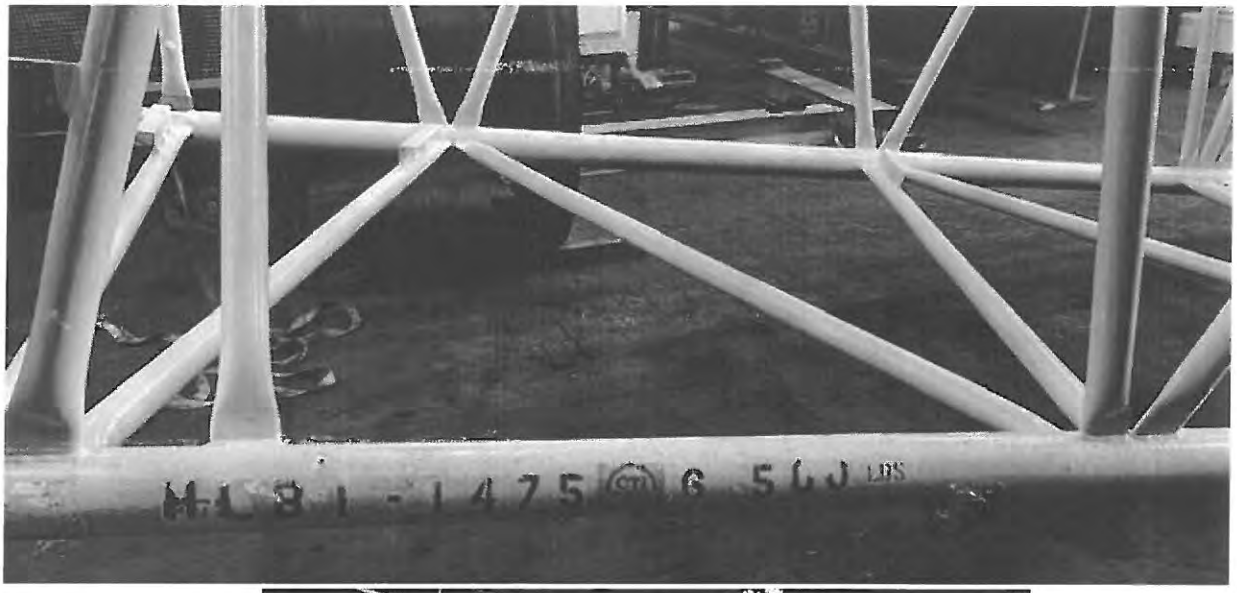
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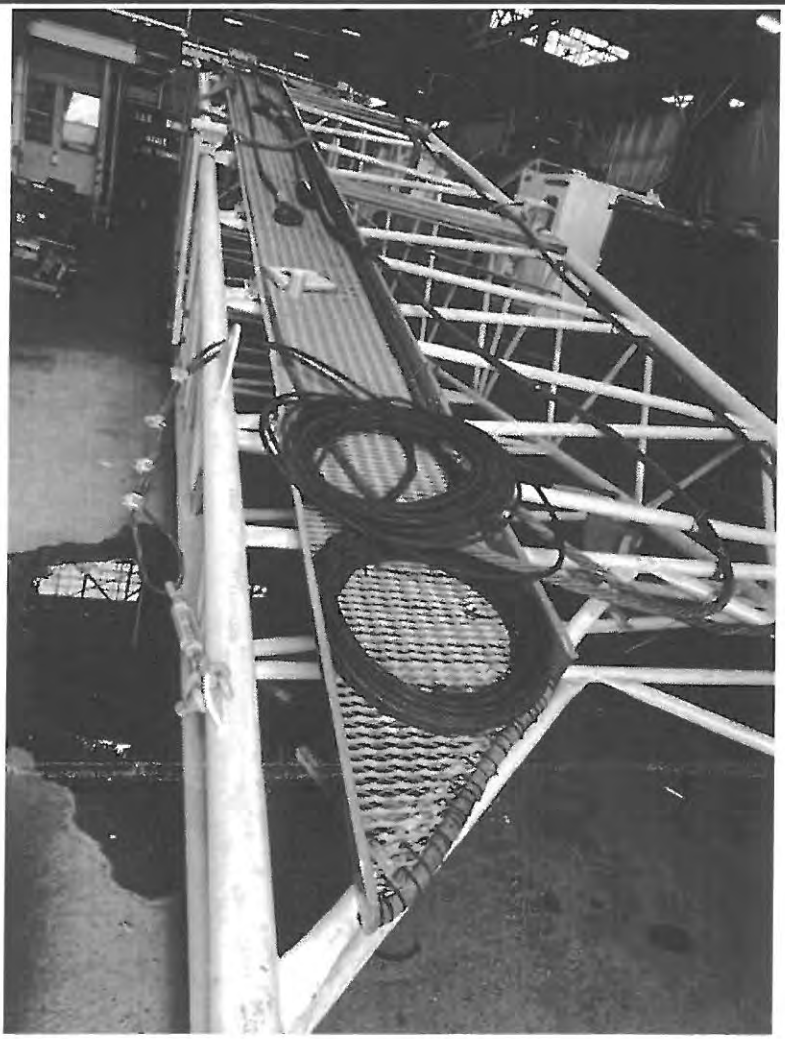
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Photo | 13

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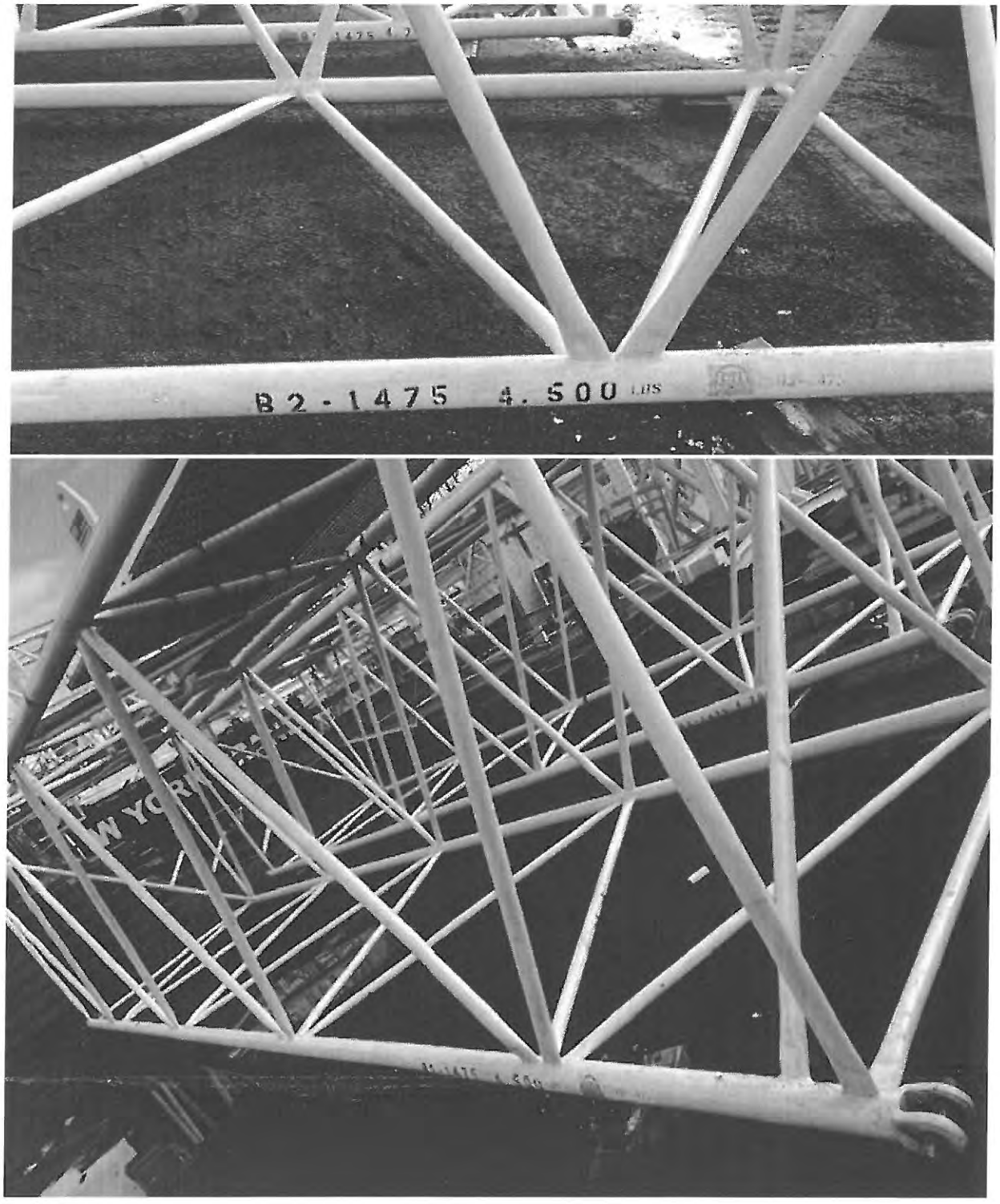


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Photo | 14

Insert #B2-1475



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Photo | 15

Insert #B3-1475





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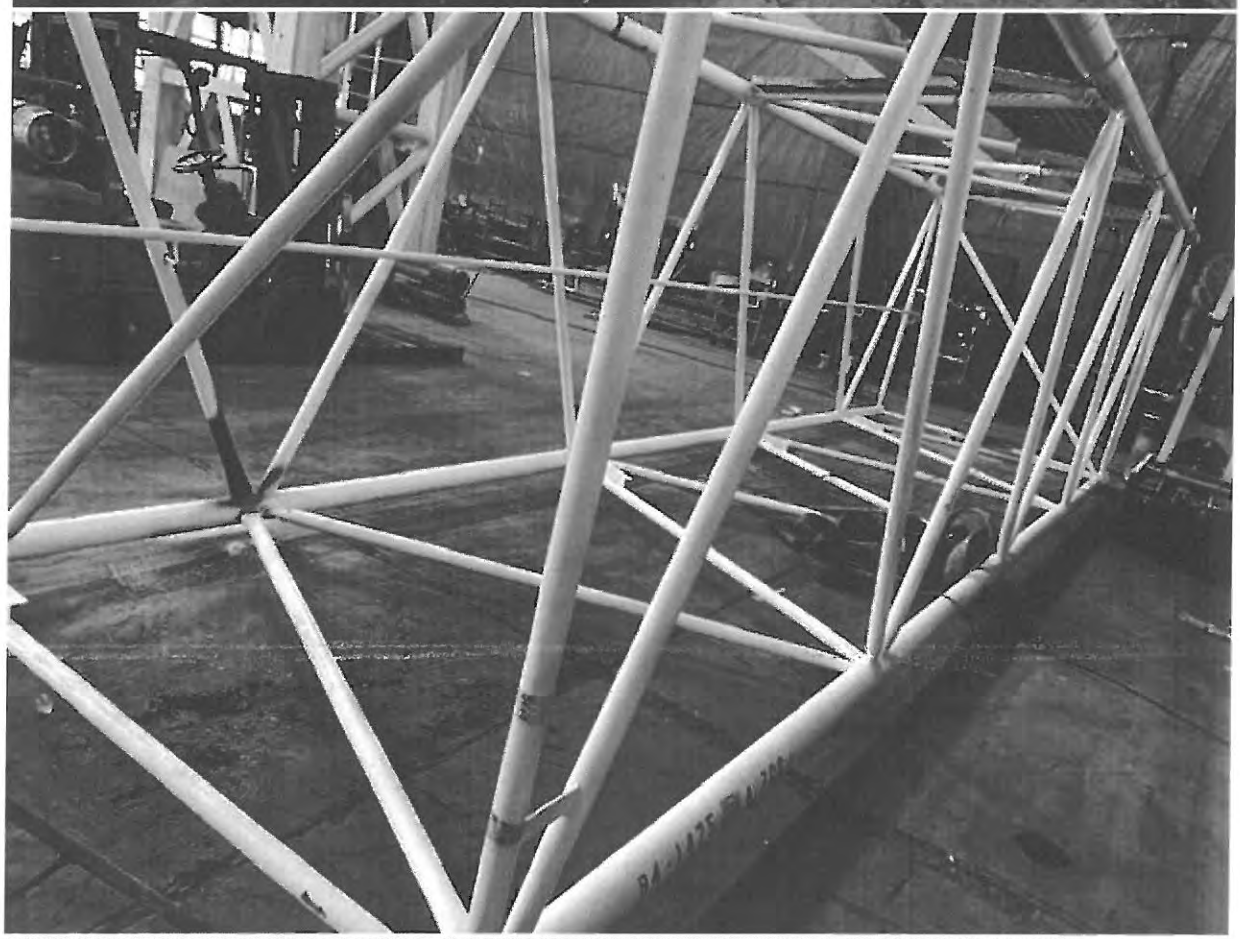
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Photo | 16

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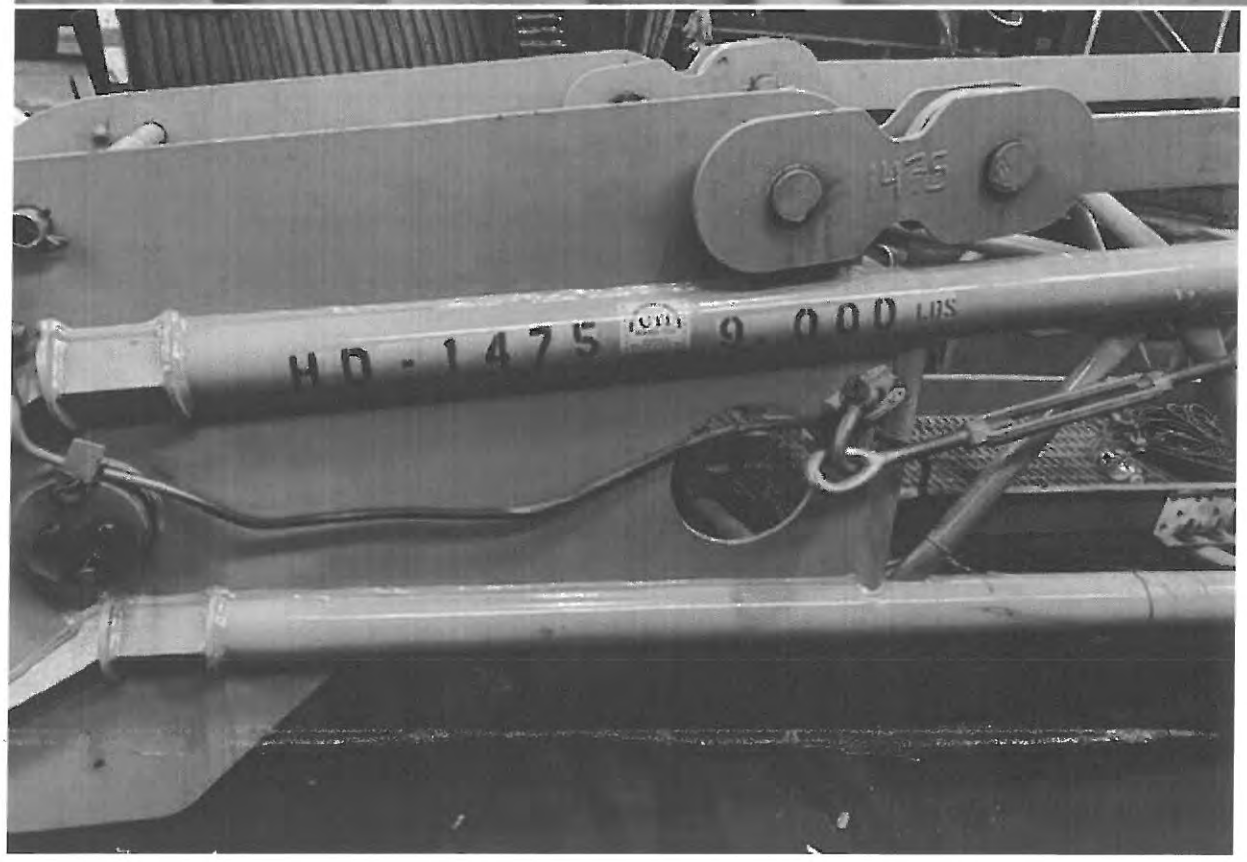
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Photo | 17

Head Section #HD-1475





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Photo | 18



Counterweights



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Photo | 19



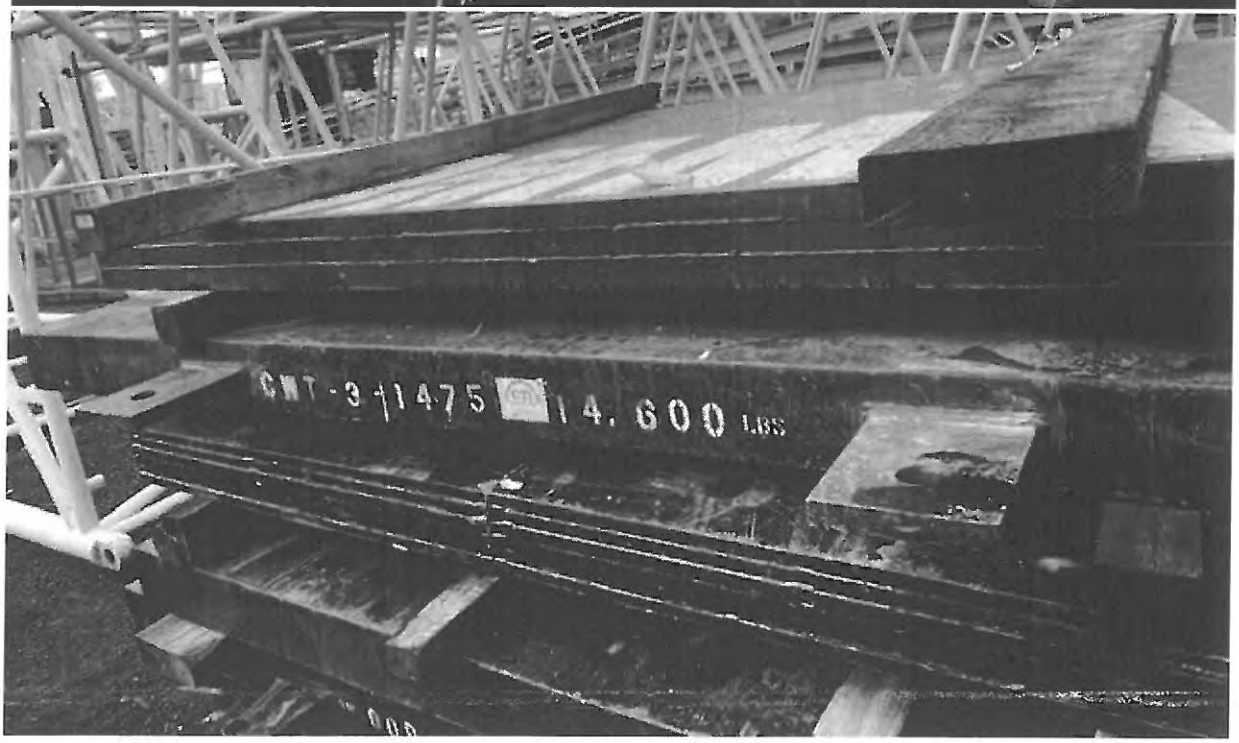


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Photo | 22



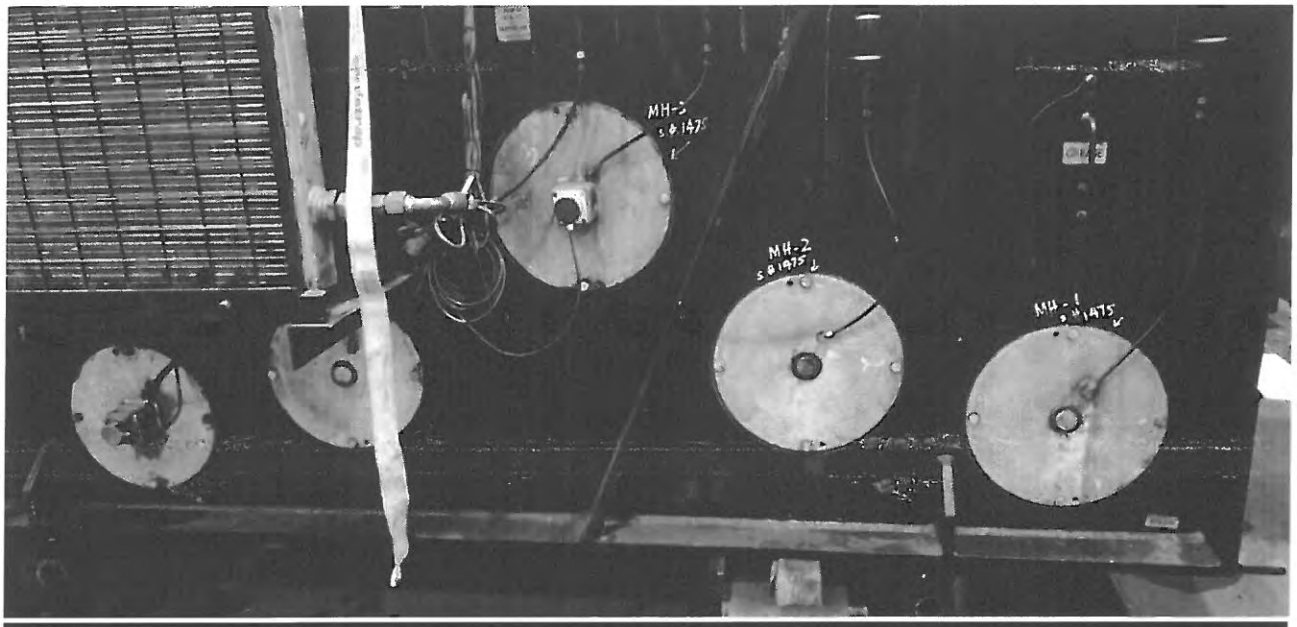
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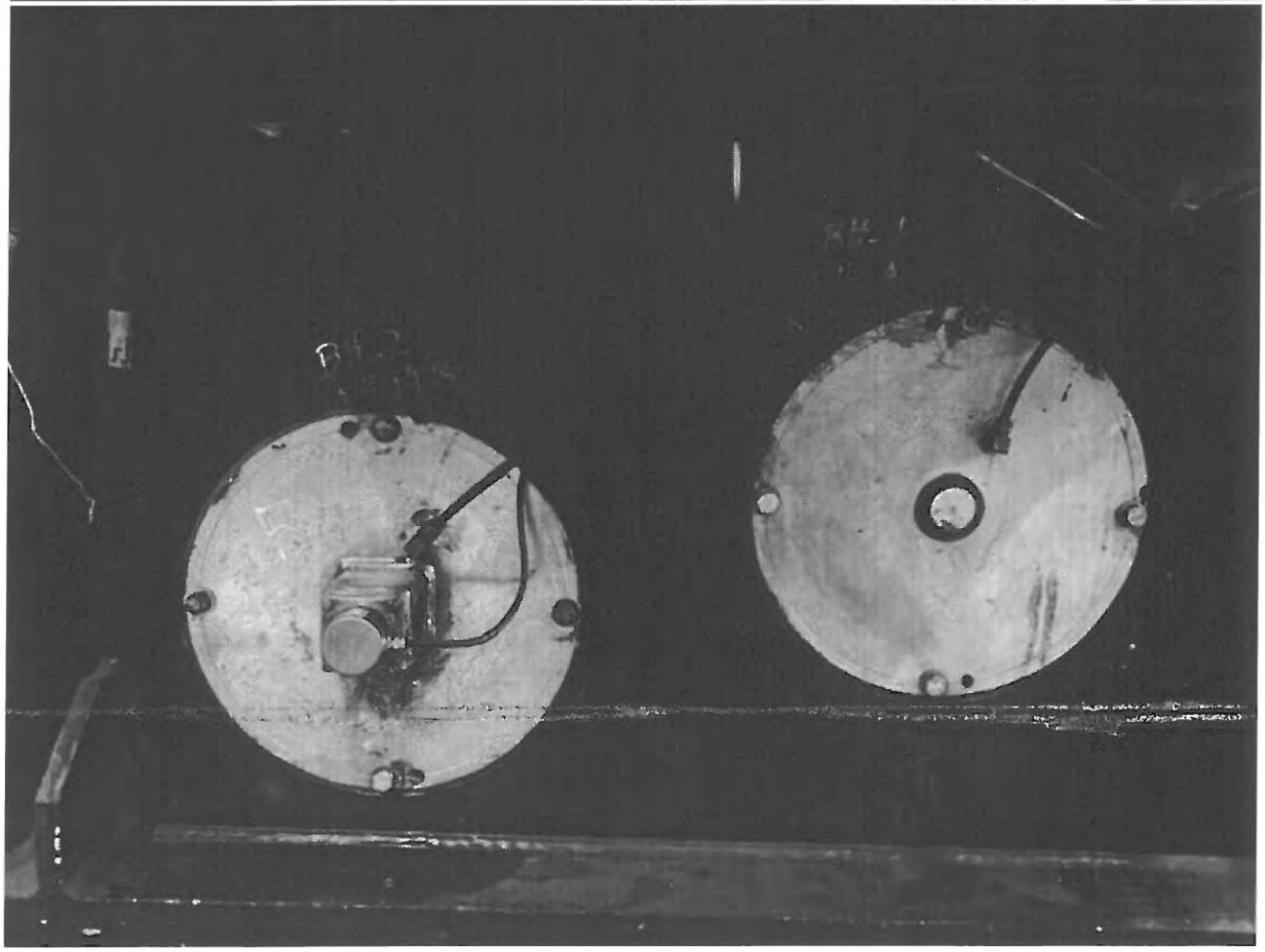
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Pinions

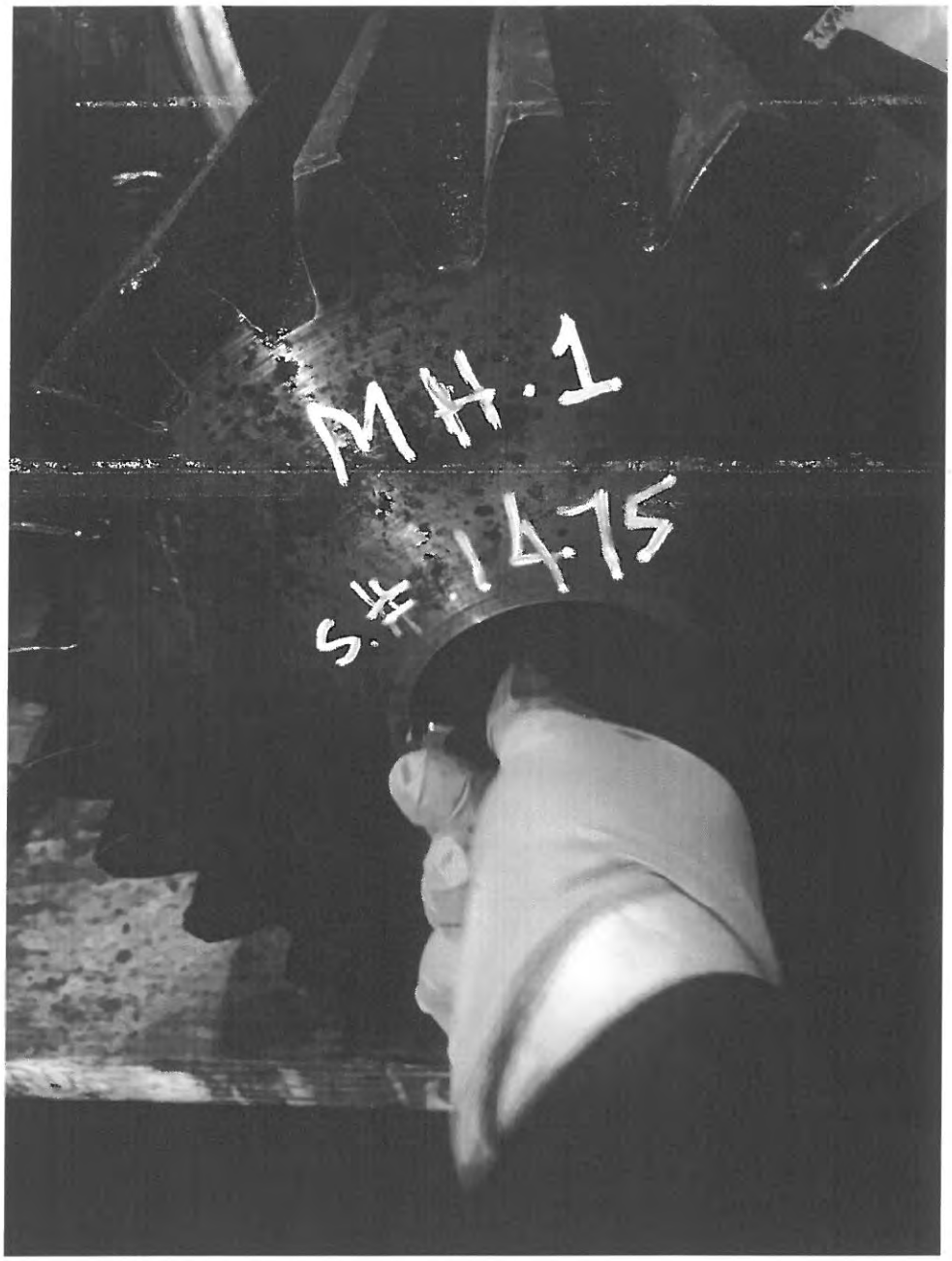




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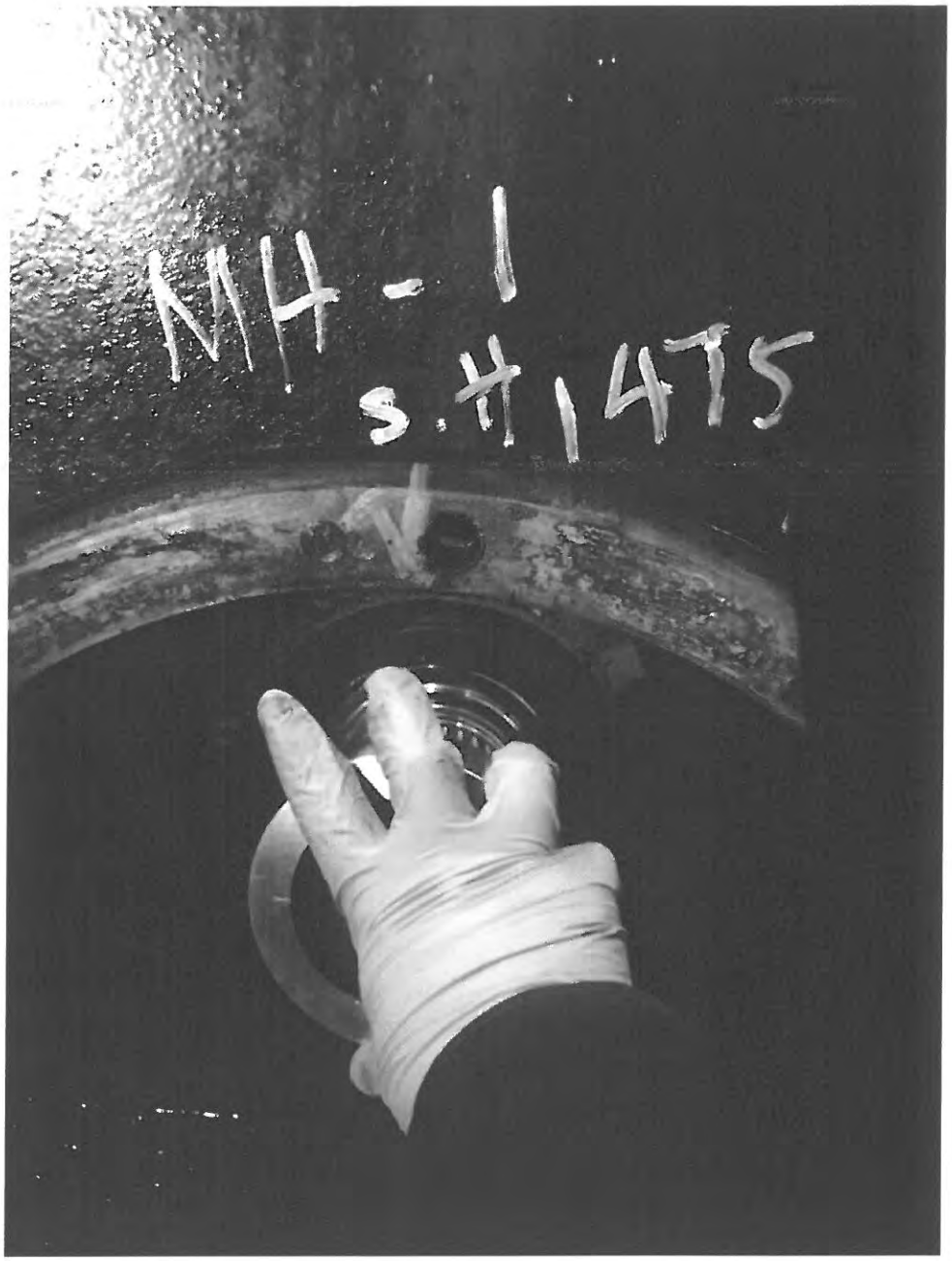


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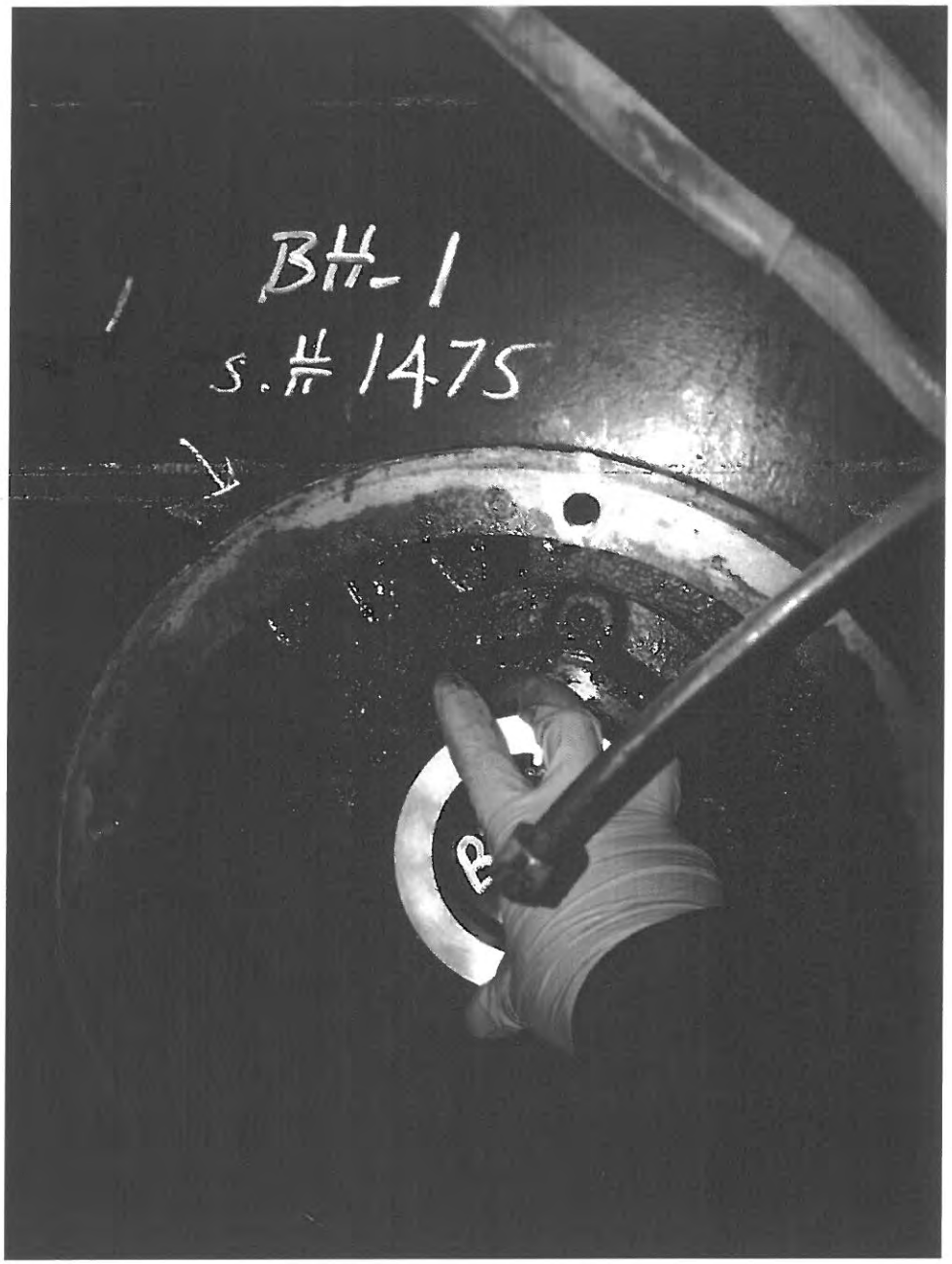
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Photo | 31

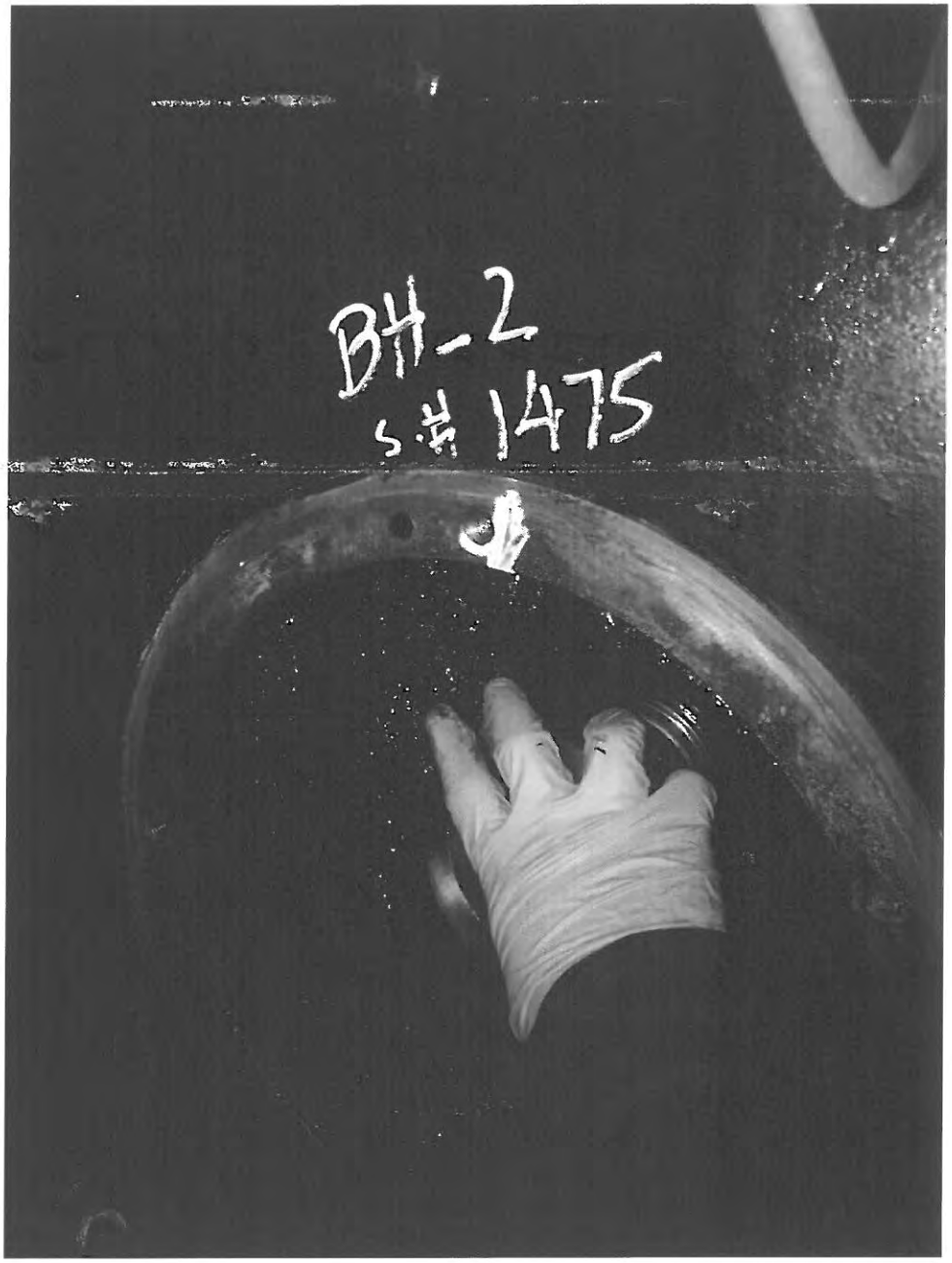


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Photo | 32

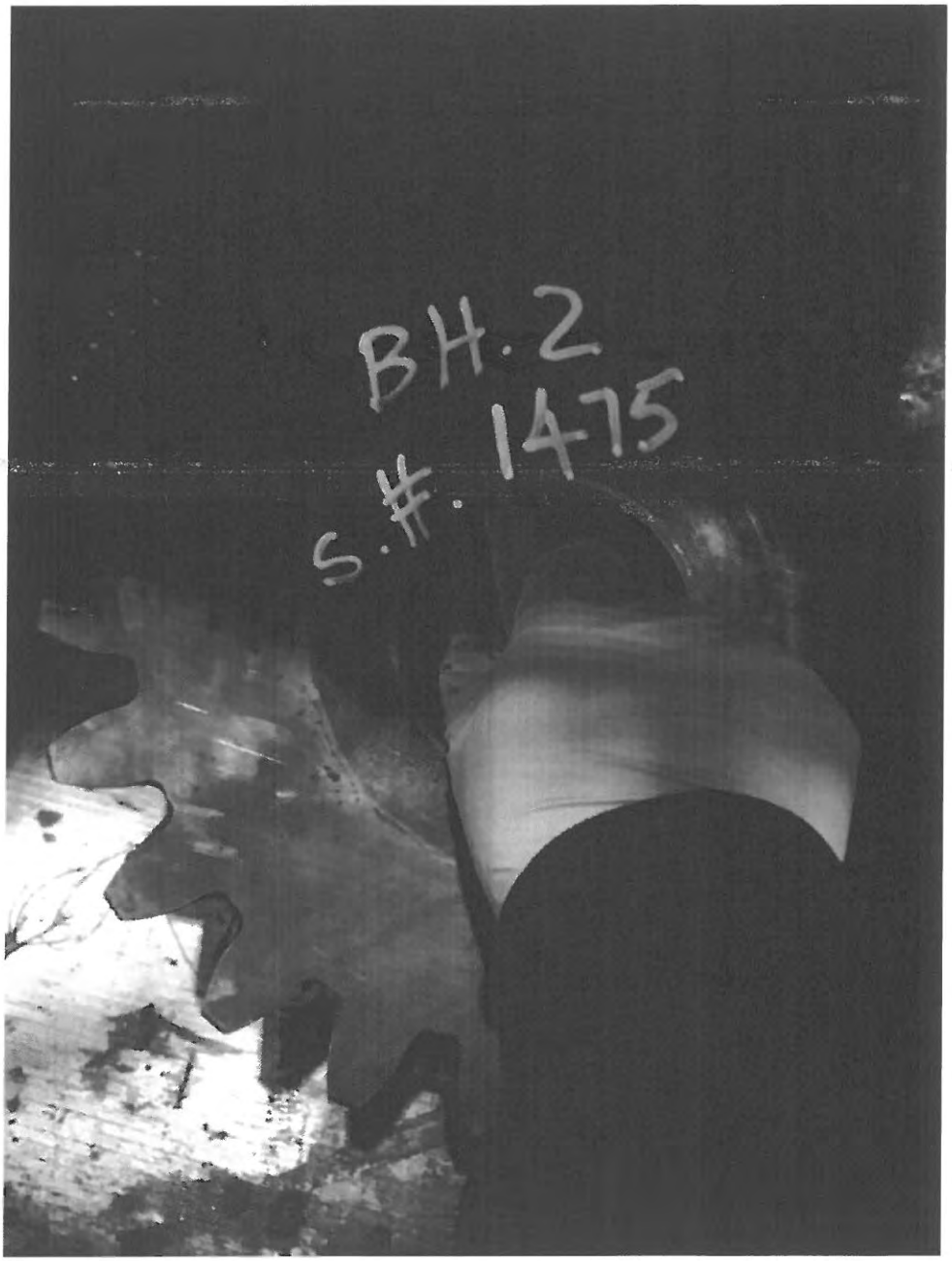


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Photo | 34

Slew Drive



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Photo | 35

Tilt Test



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Photo | 36

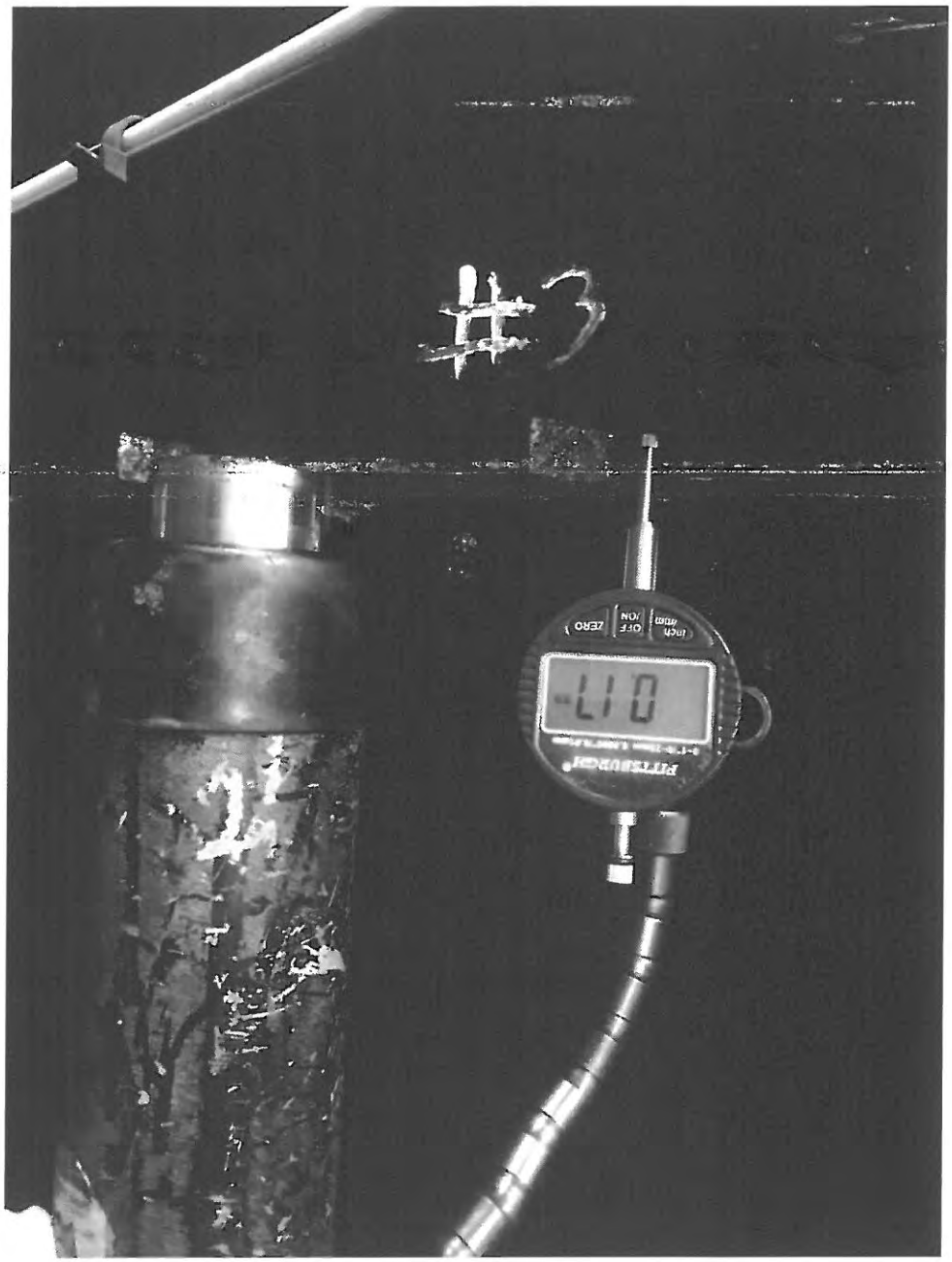


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Photo | 37

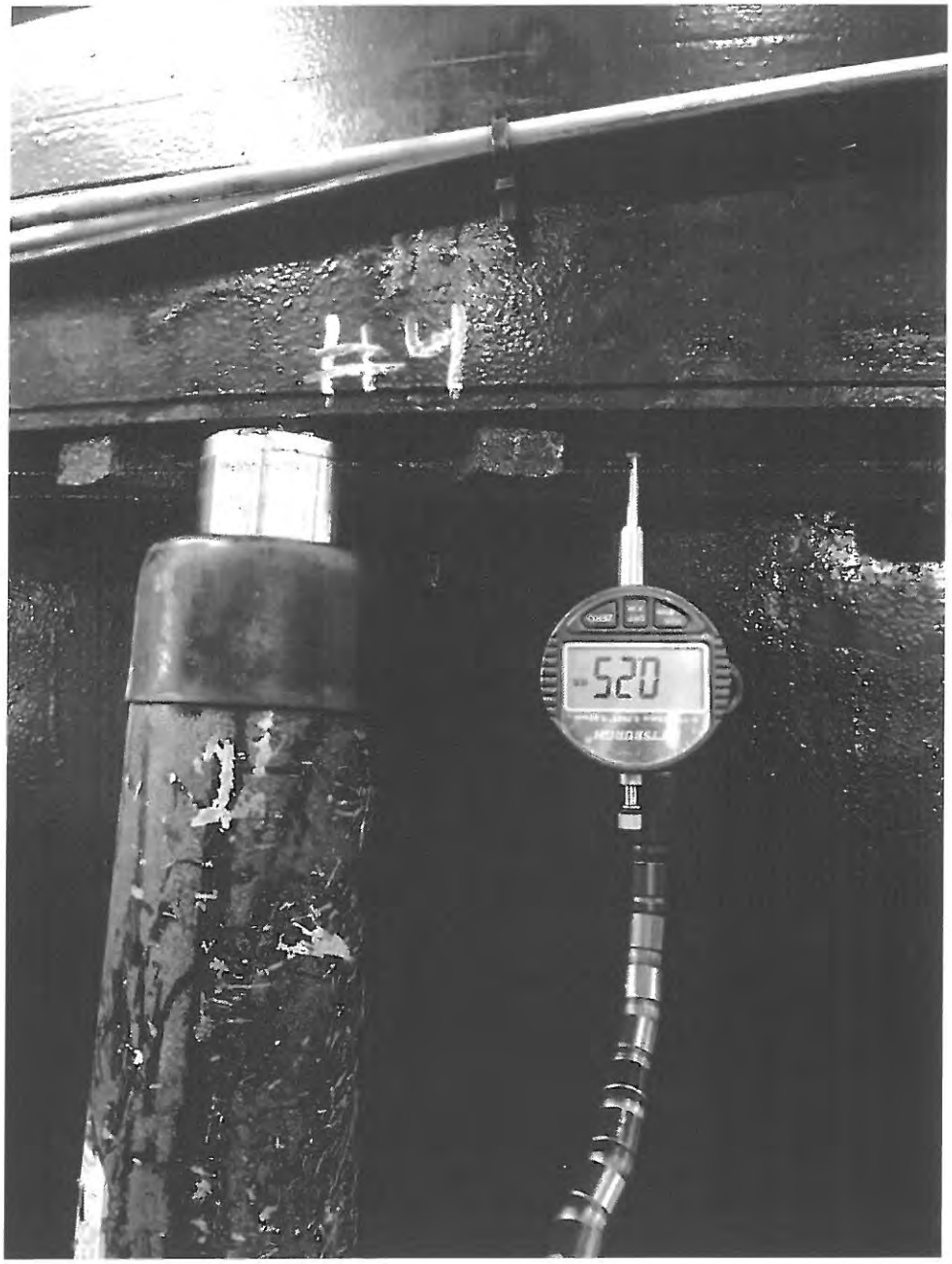


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Photo | 38



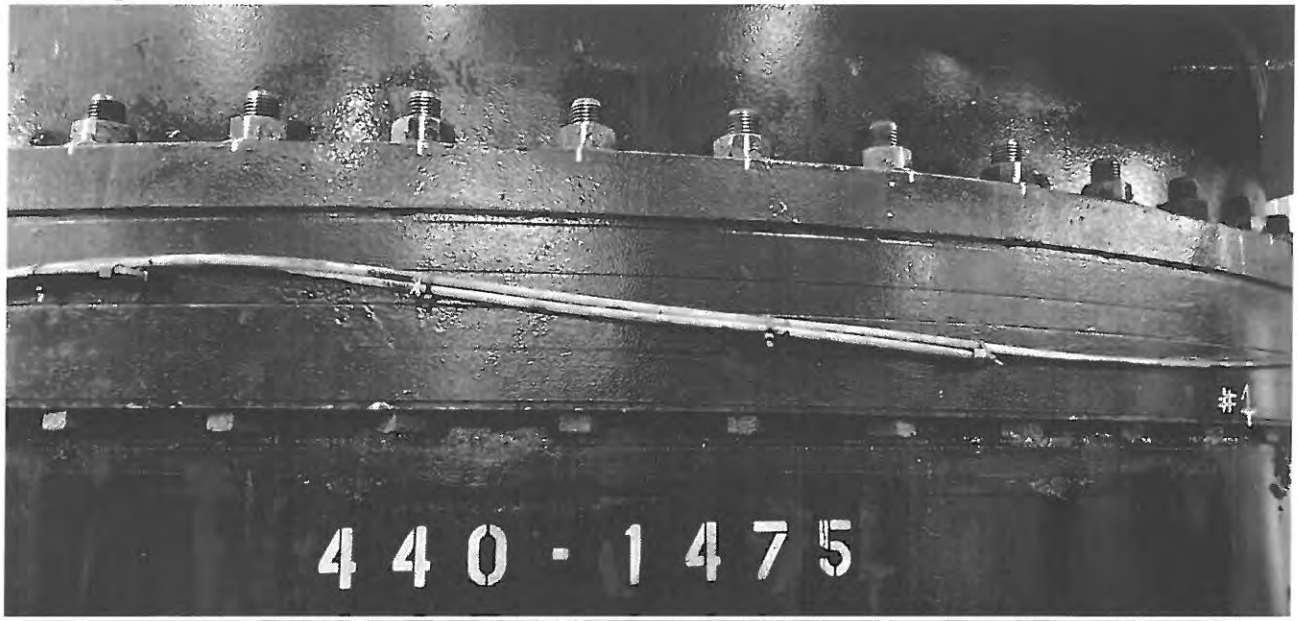
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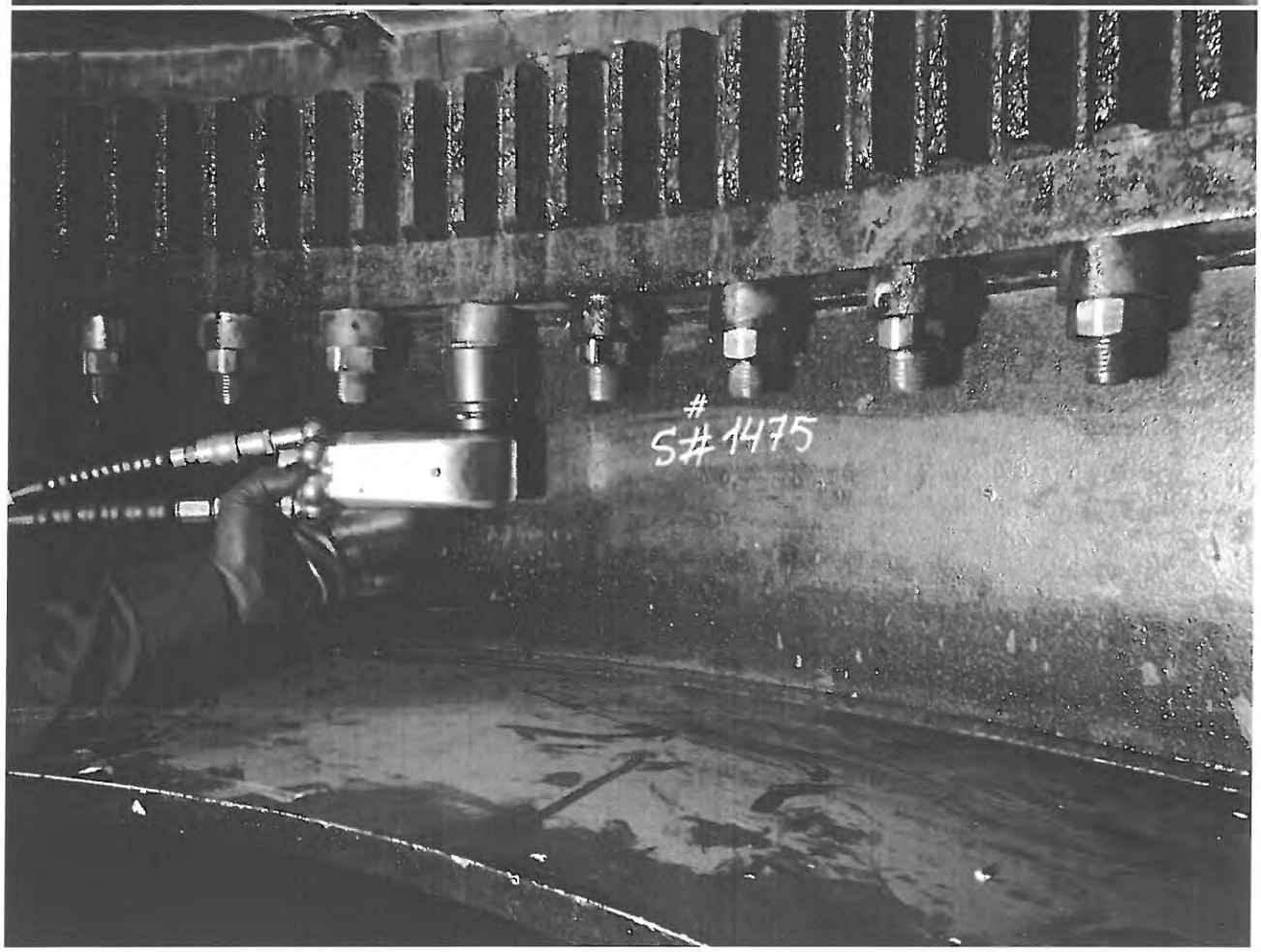
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Photo | 39

Slew Ring Bolts



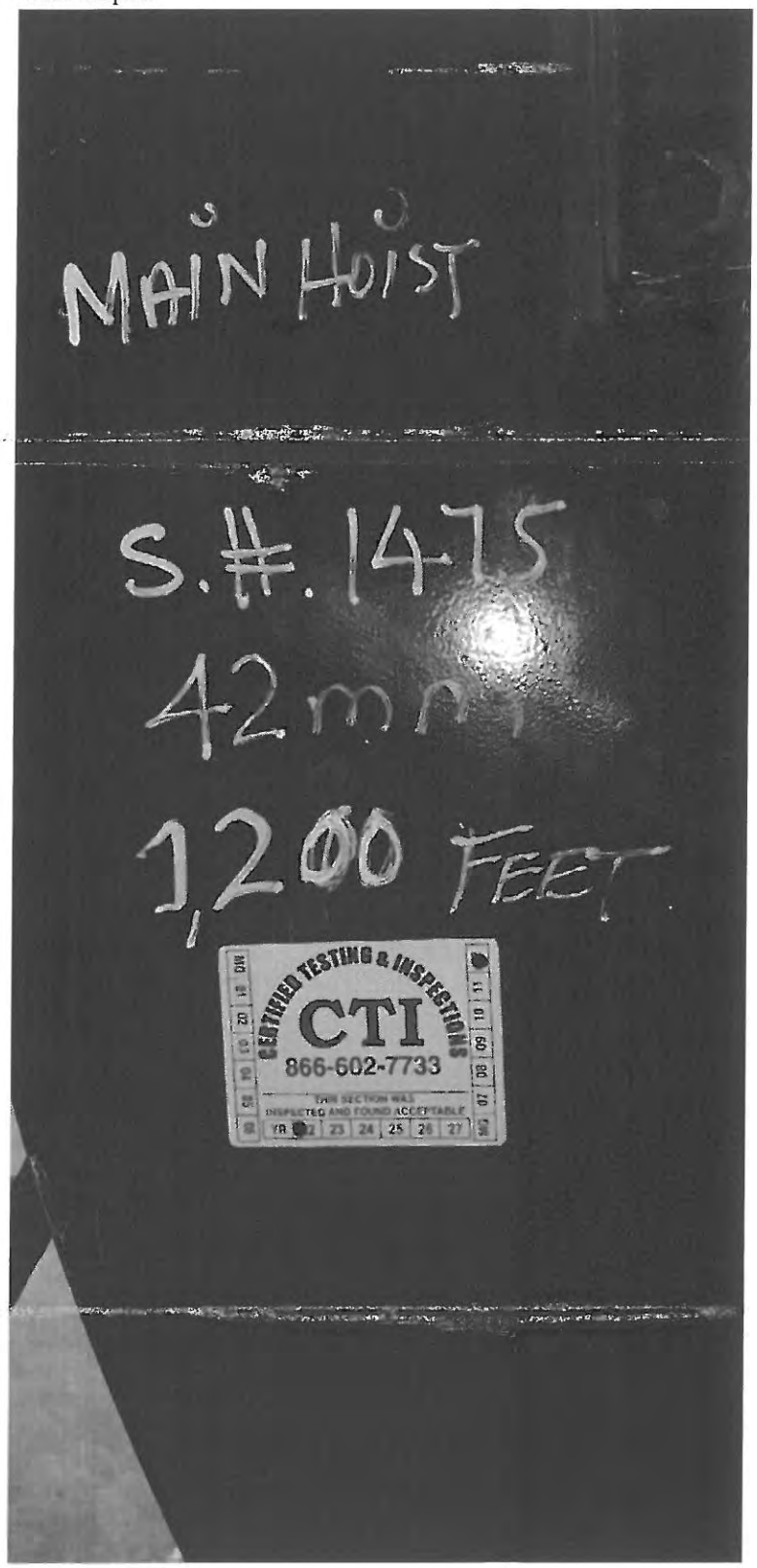


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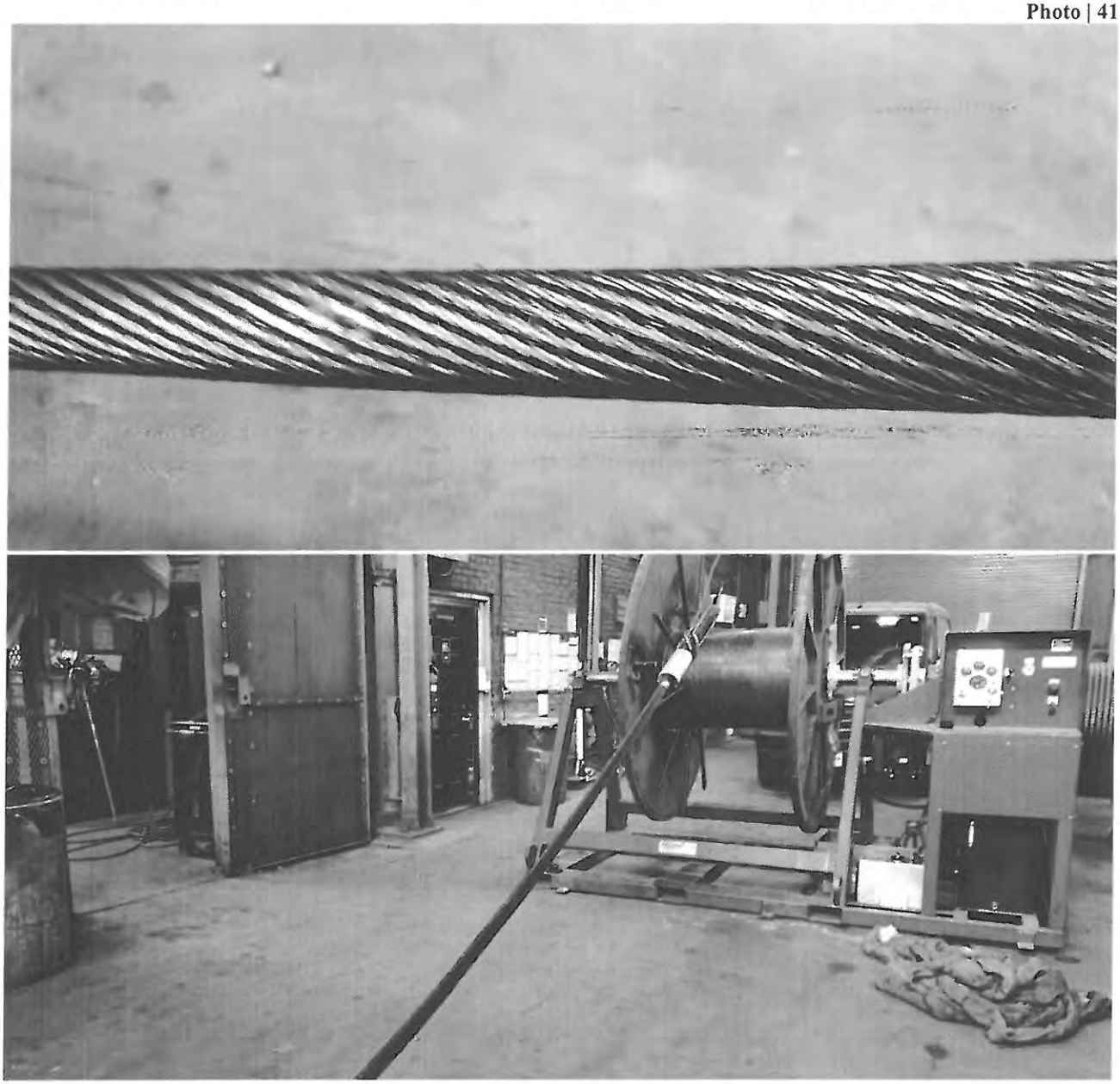
Wire Ropes



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Photo | 41



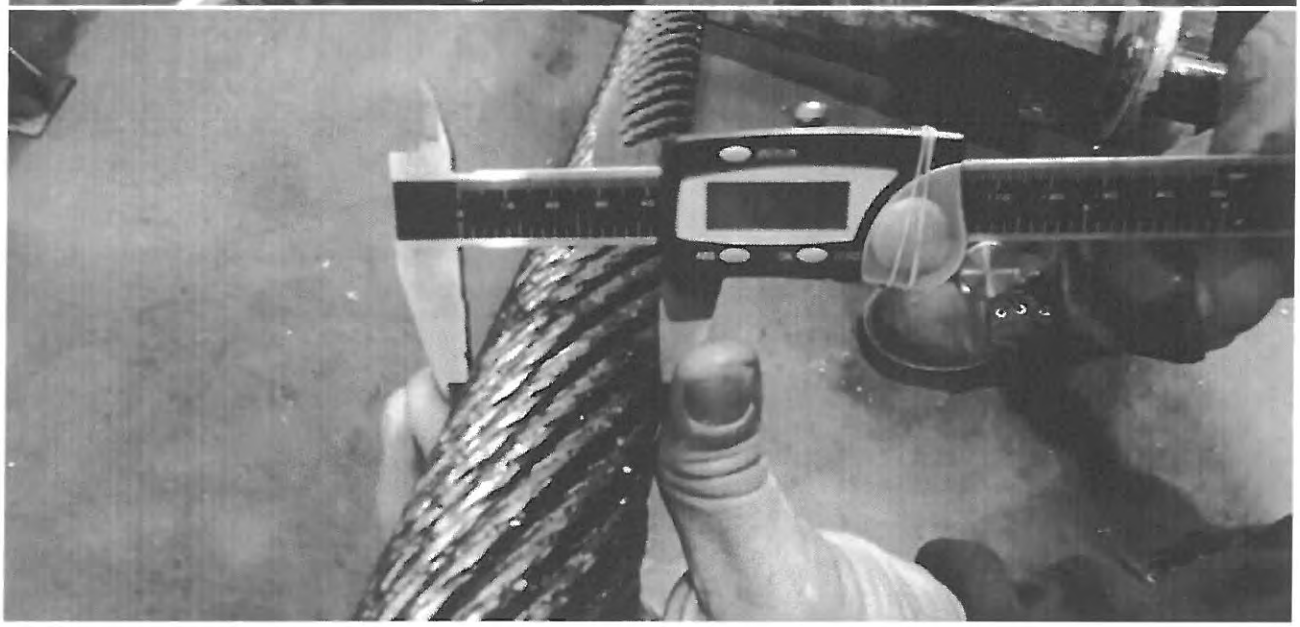
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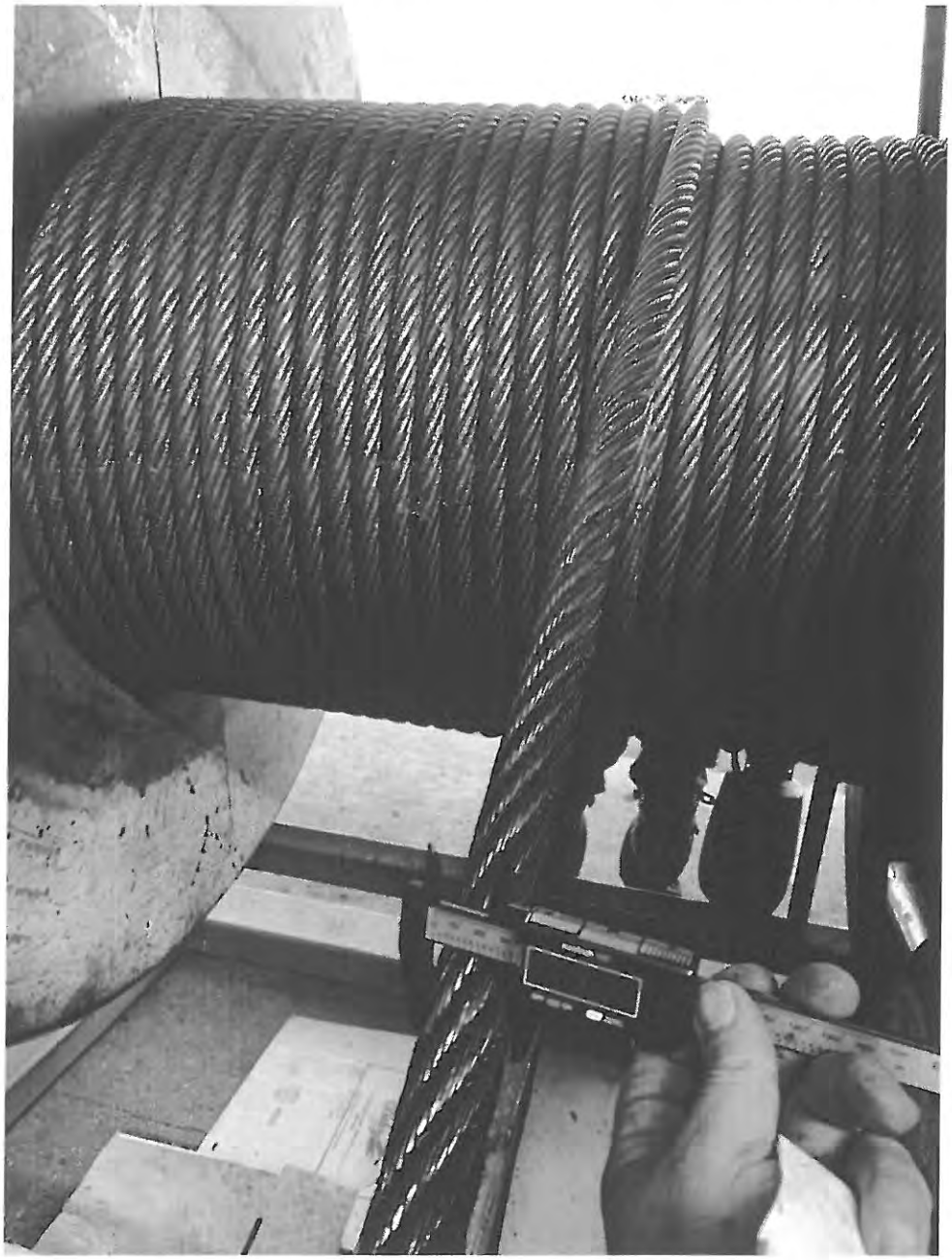


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Photo | 47



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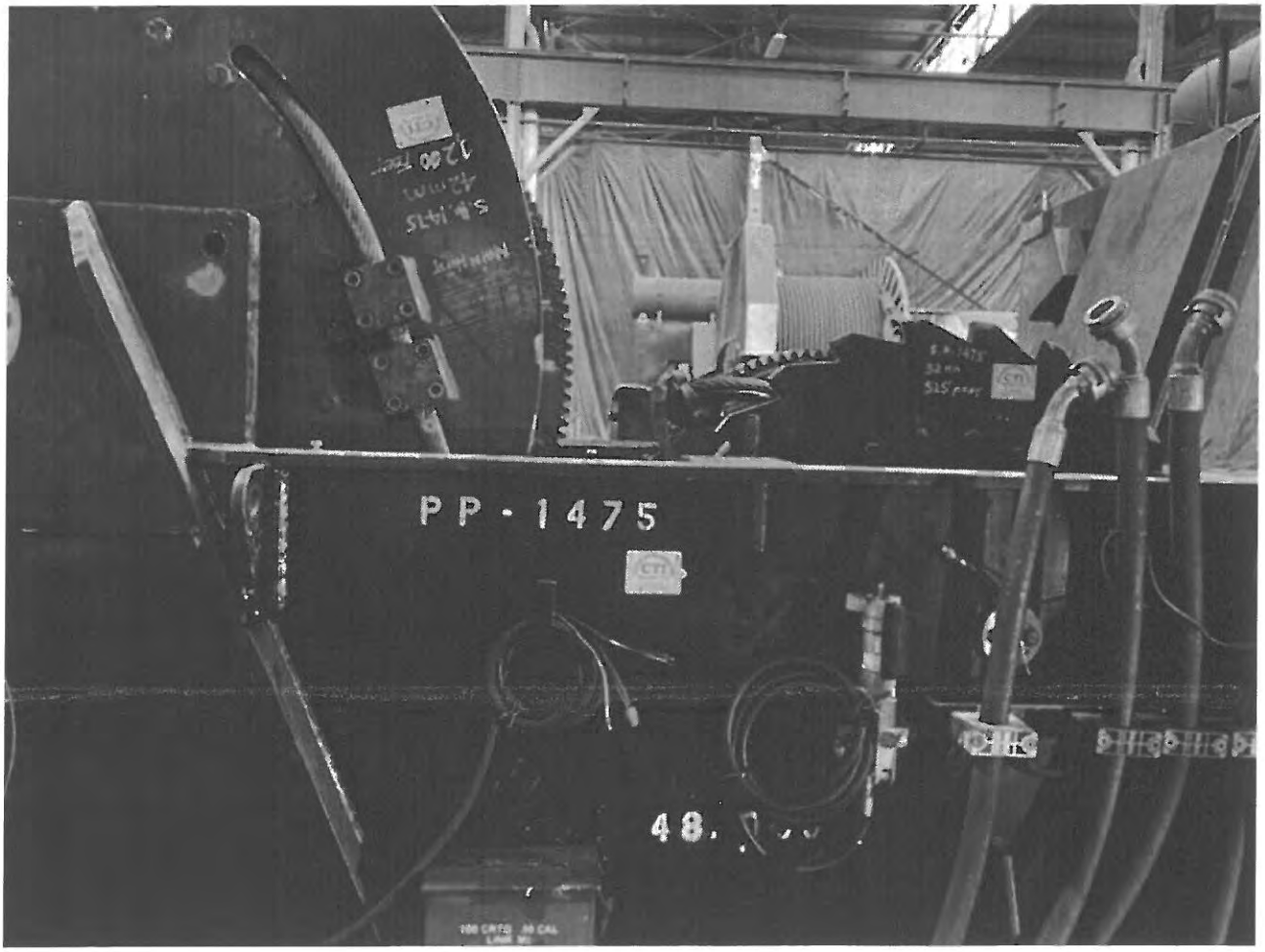
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Photo | 48

Power Pack - #PP-1475





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Photo | 49

Operator's Cab - #CAB-1475



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Photo | 50

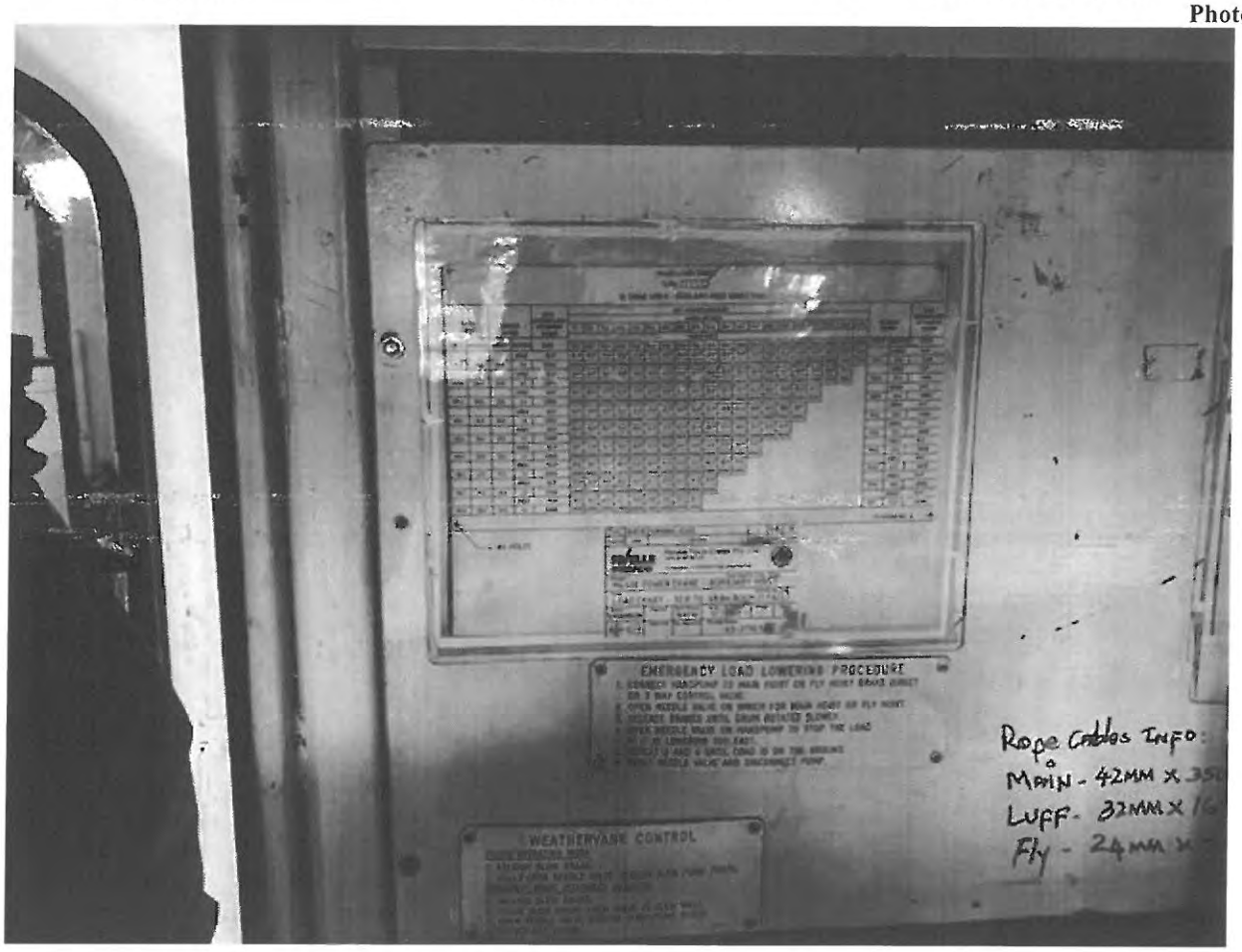


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Photo | 53

25 Ton Double Ball & Hook - #DB-1475



Rear Split Deck - #MD-1475



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Slew Mount (including 4 legs) - #SM-1475



Front Split Deck (including all lugs, mast legs and boom pivot plates) - #FMD-1475



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A-Frame (two sheaves also inspected) - #AF-1475



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Photo | 60

Bridle (two sheaves also inspected) - #BR-1475



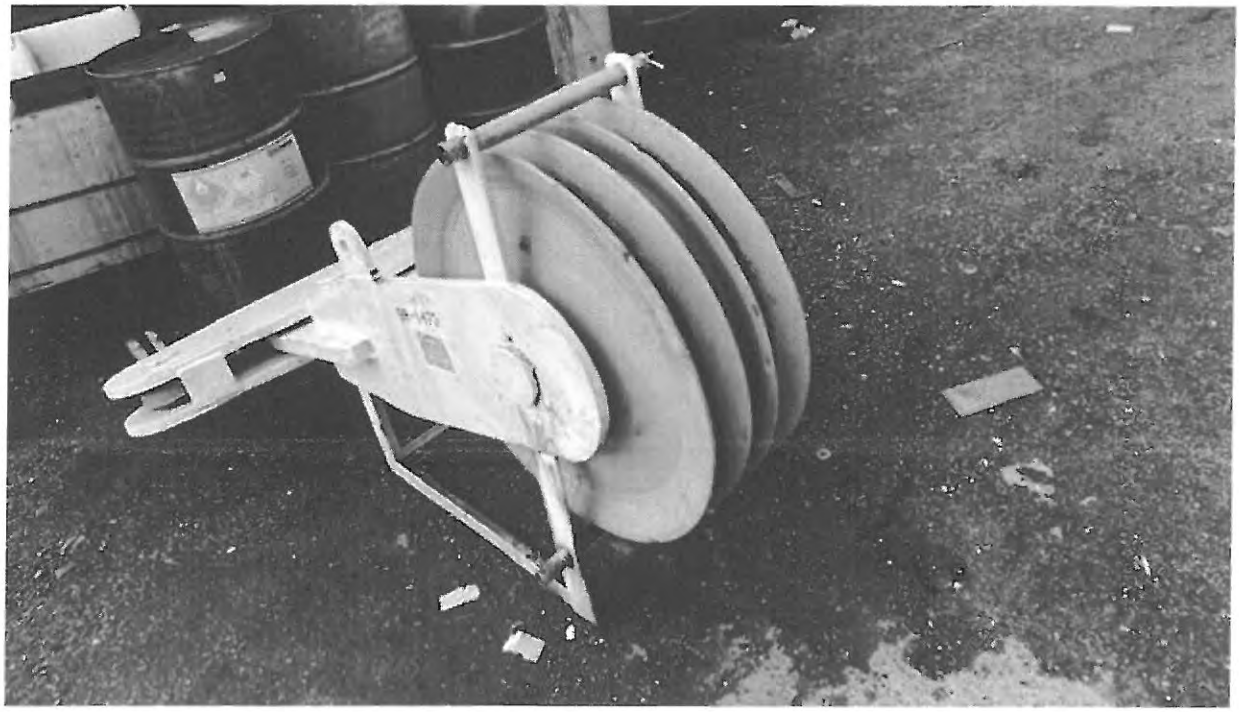
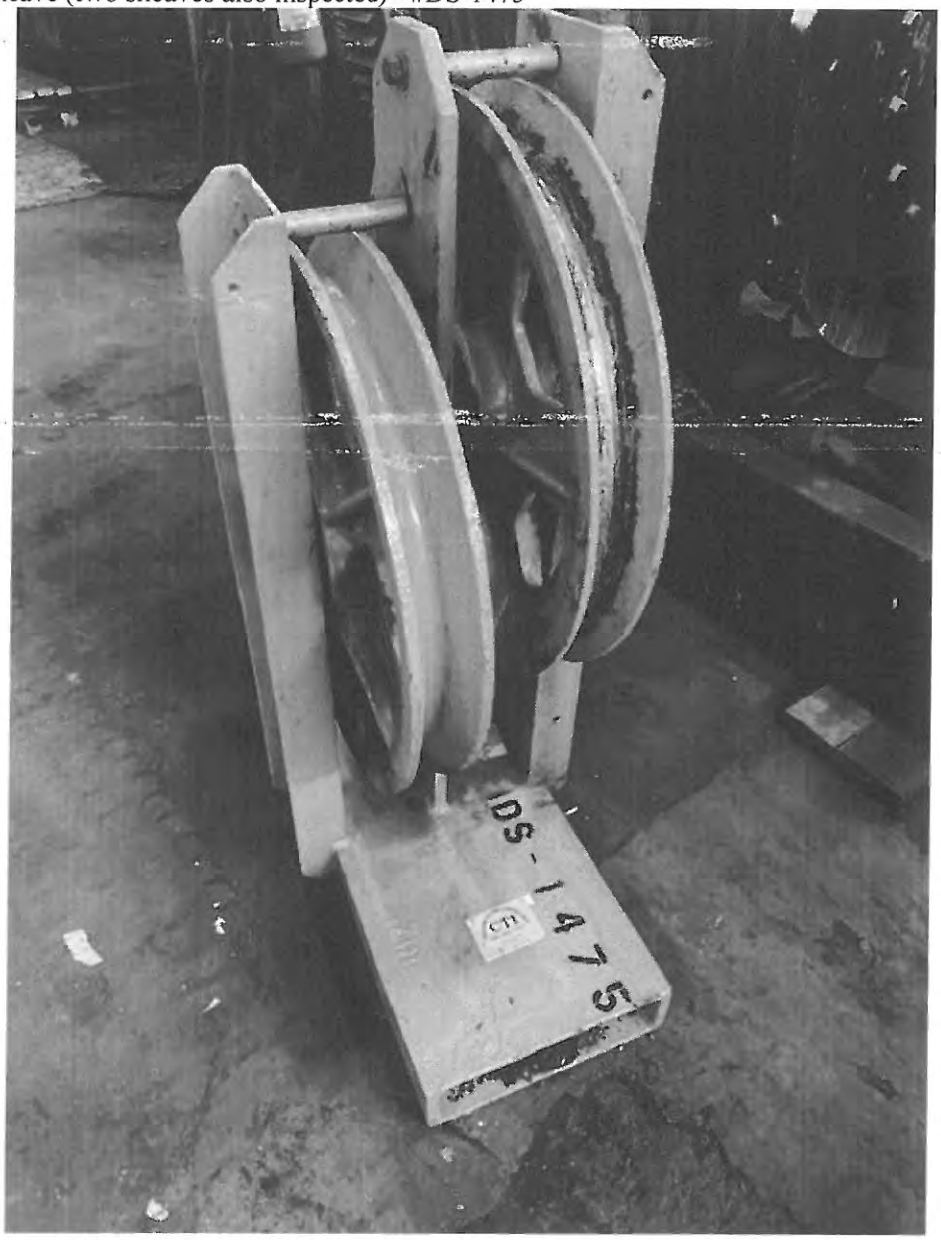


Photo | 61

Deflector Sheave (two sheaves also inspected) - #DS-1475

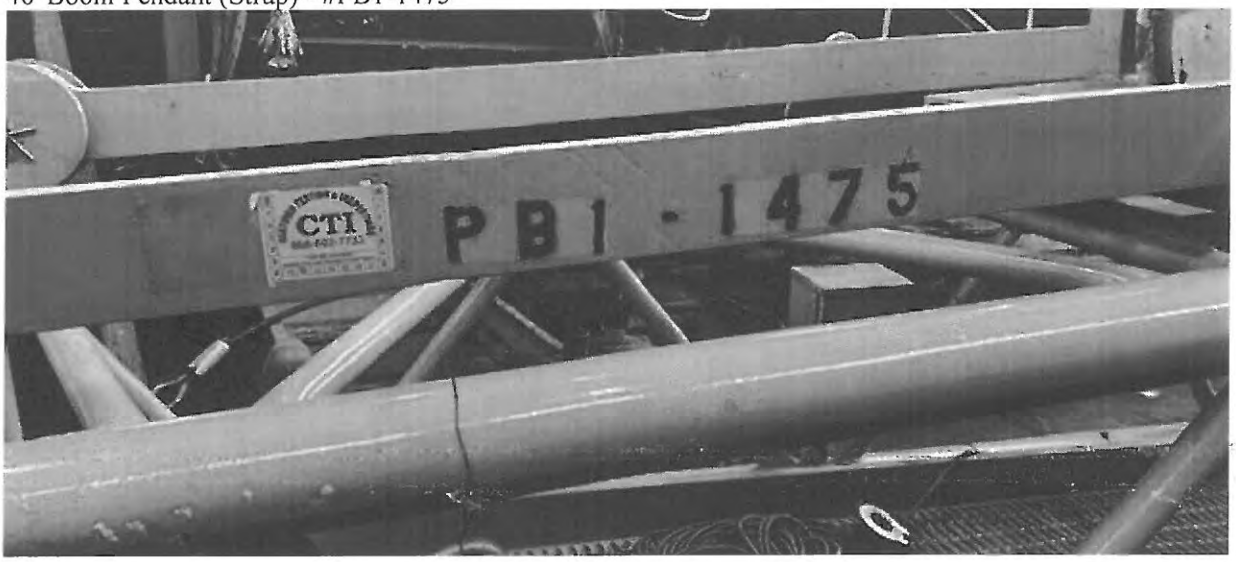


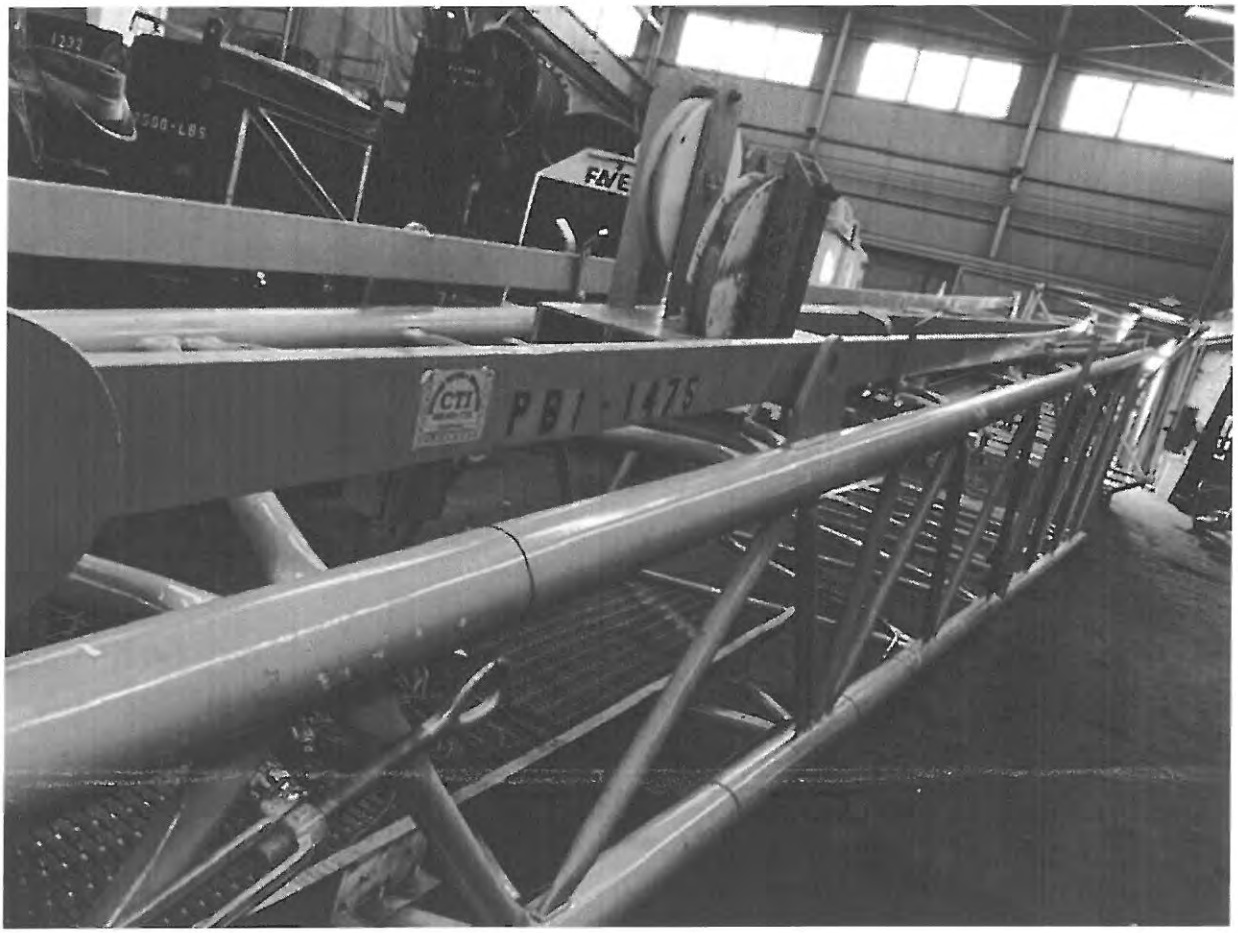
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Photo | 62

40' Boom Pendant (Strap) - #PB1-1475





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Photo | 63

40' Boom Pendant (Strap) - #PB2-1475



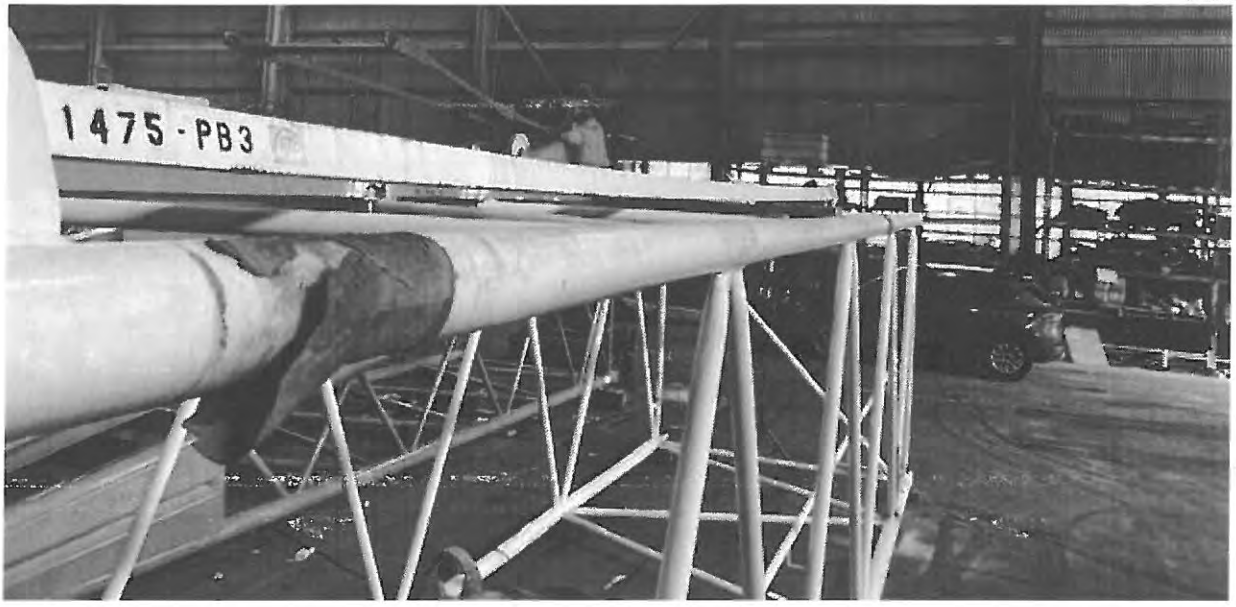
29' Boom Pendant (Strap) - #1475-PB3



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29' Boom Pendant (Strap) - #1475-PB4





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14' Boom Pendant (Strap) - #PB5-1475





14' Boom Pendant (Strap) - #PB6-1475





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Photo | 66

External Climbing Frame - #USA-TSC-04-001-A



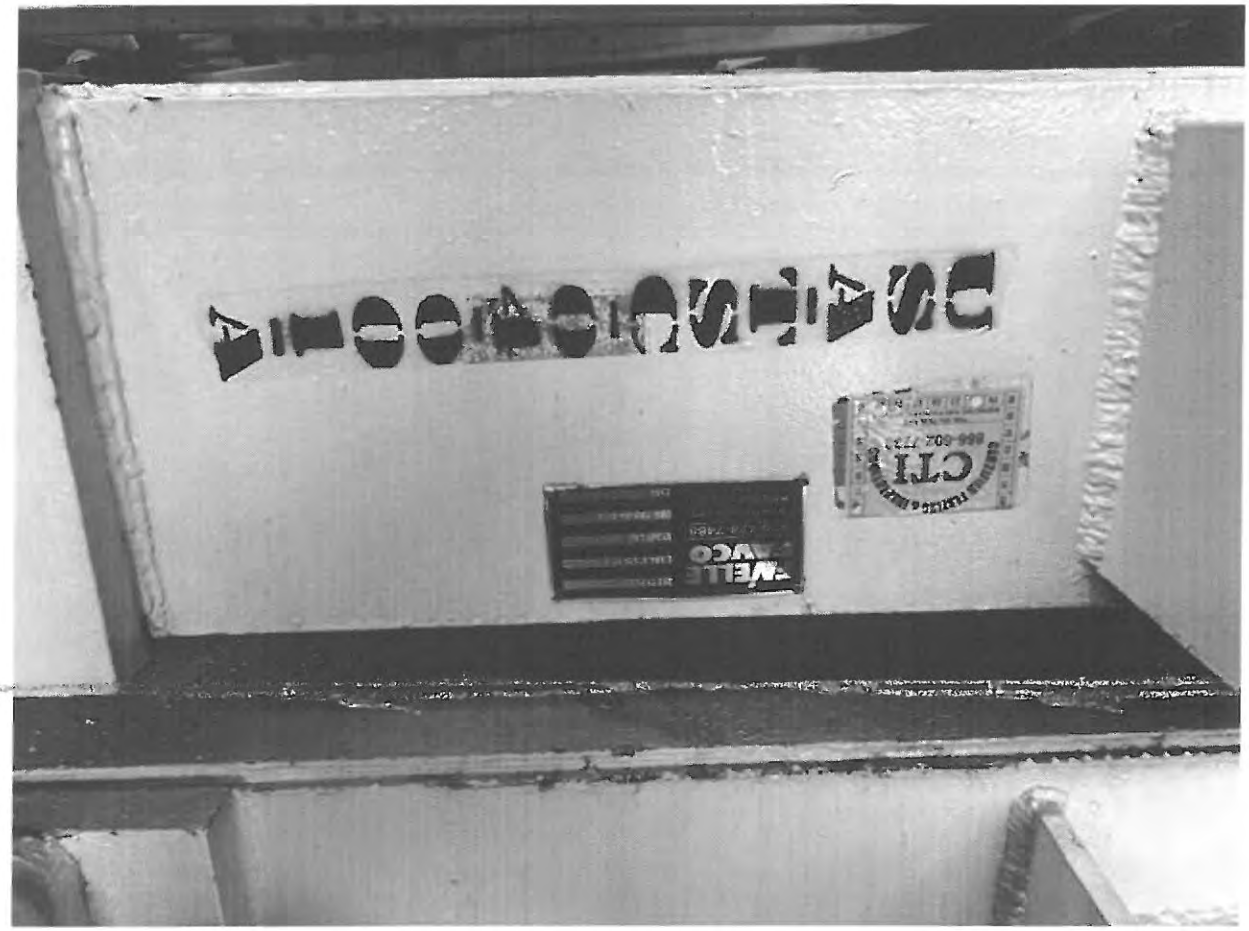


Photo | 67

External Climbing Frame - #USA-TSC-04-001-B



External Climbing Frame Tie - #USA-TS-04-001-C



Photo | 68



External Climbing Frame Tie - #USA-TS-04-001-D



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Photo | 70

Climbing Platform - #USA-TSC-04-001-M



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Photo | 71

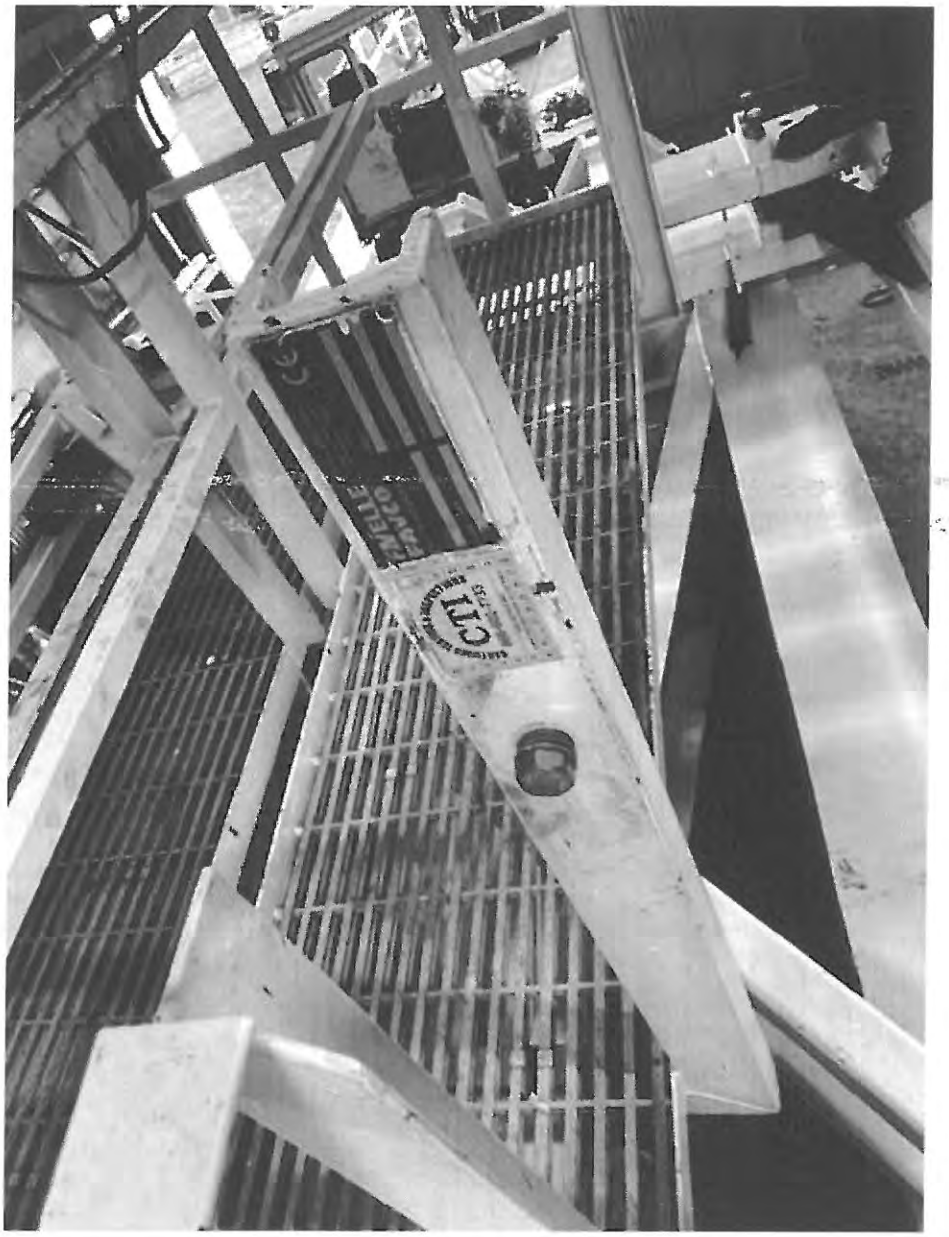
Climbing Platform - #USA-TSC-04-001-K



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Photo | 73

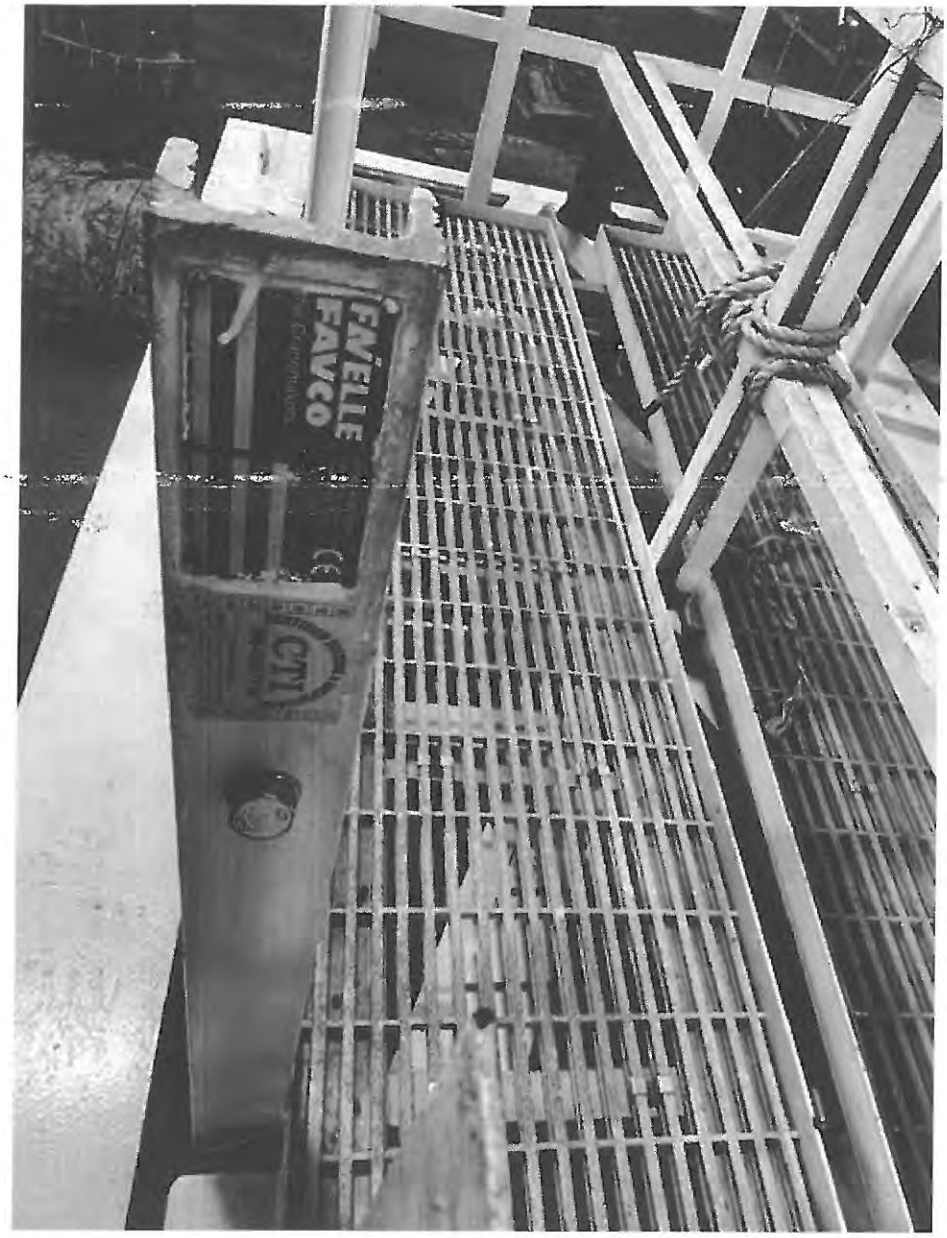
Climbing Platform - #USA-TSC-04-001-L



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Photo | 74



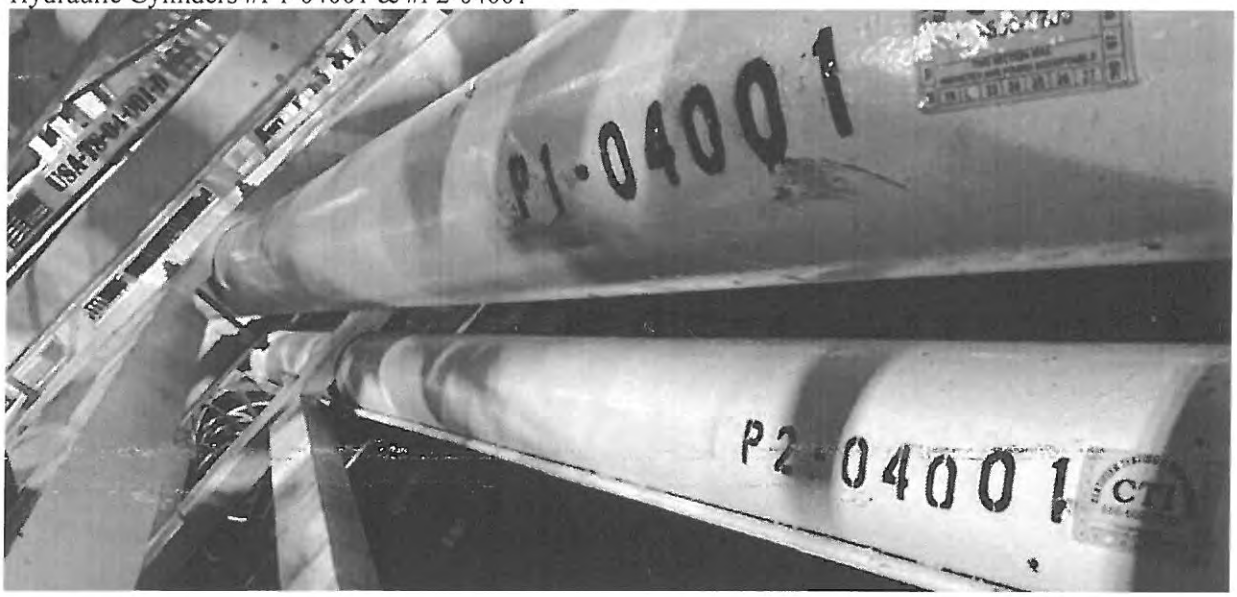
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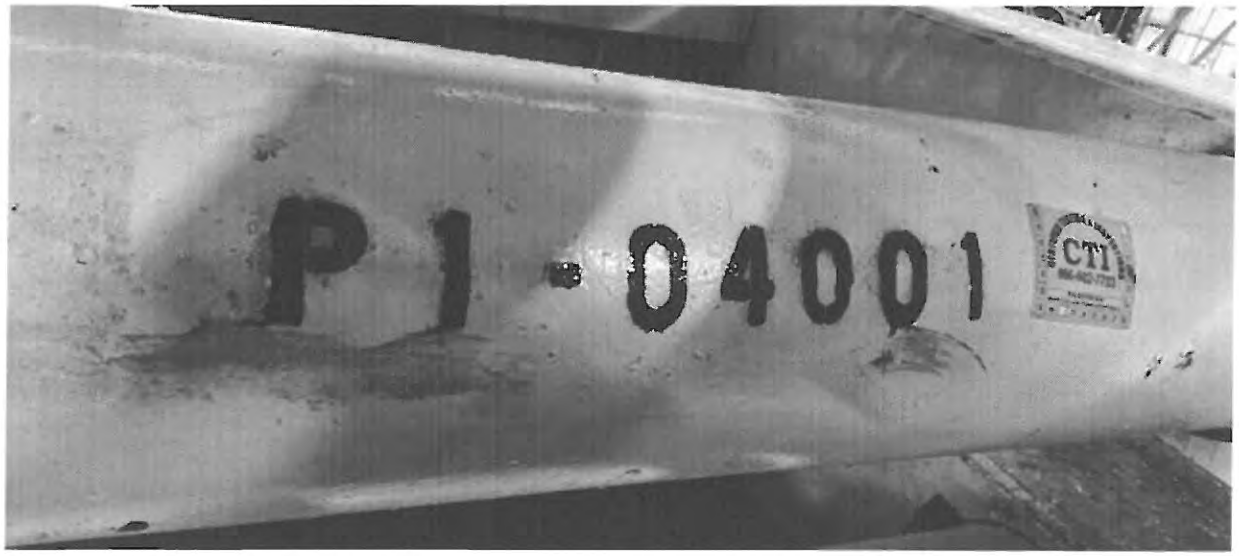
CERTIFIED TESTING & INSPECTIONS, INC.

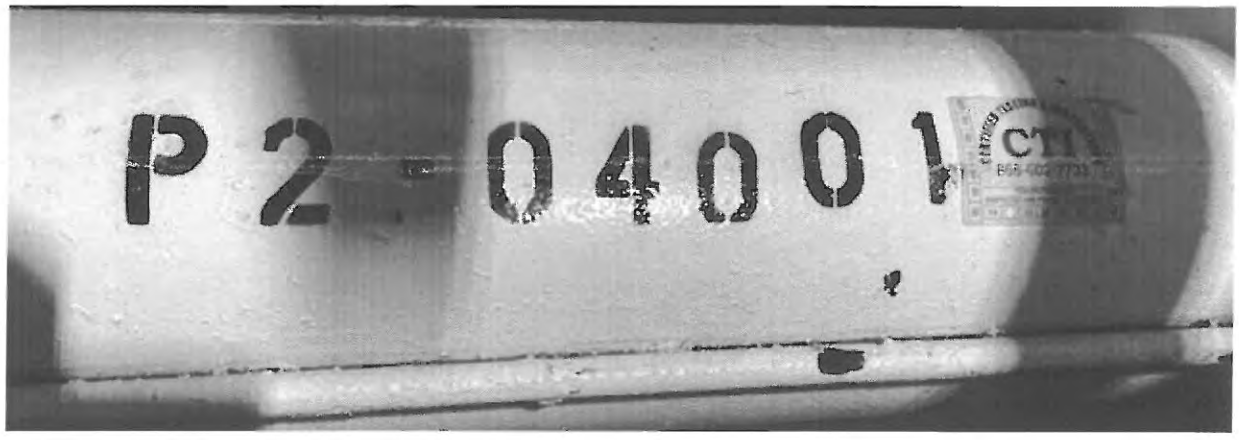
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Photo | 75

Hydraulic Cylinders #P1-04001 & #P2-04001







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Photo | 76

Climbing Support (Jacking Shoe) - #USA-TSC-04-001-JS1



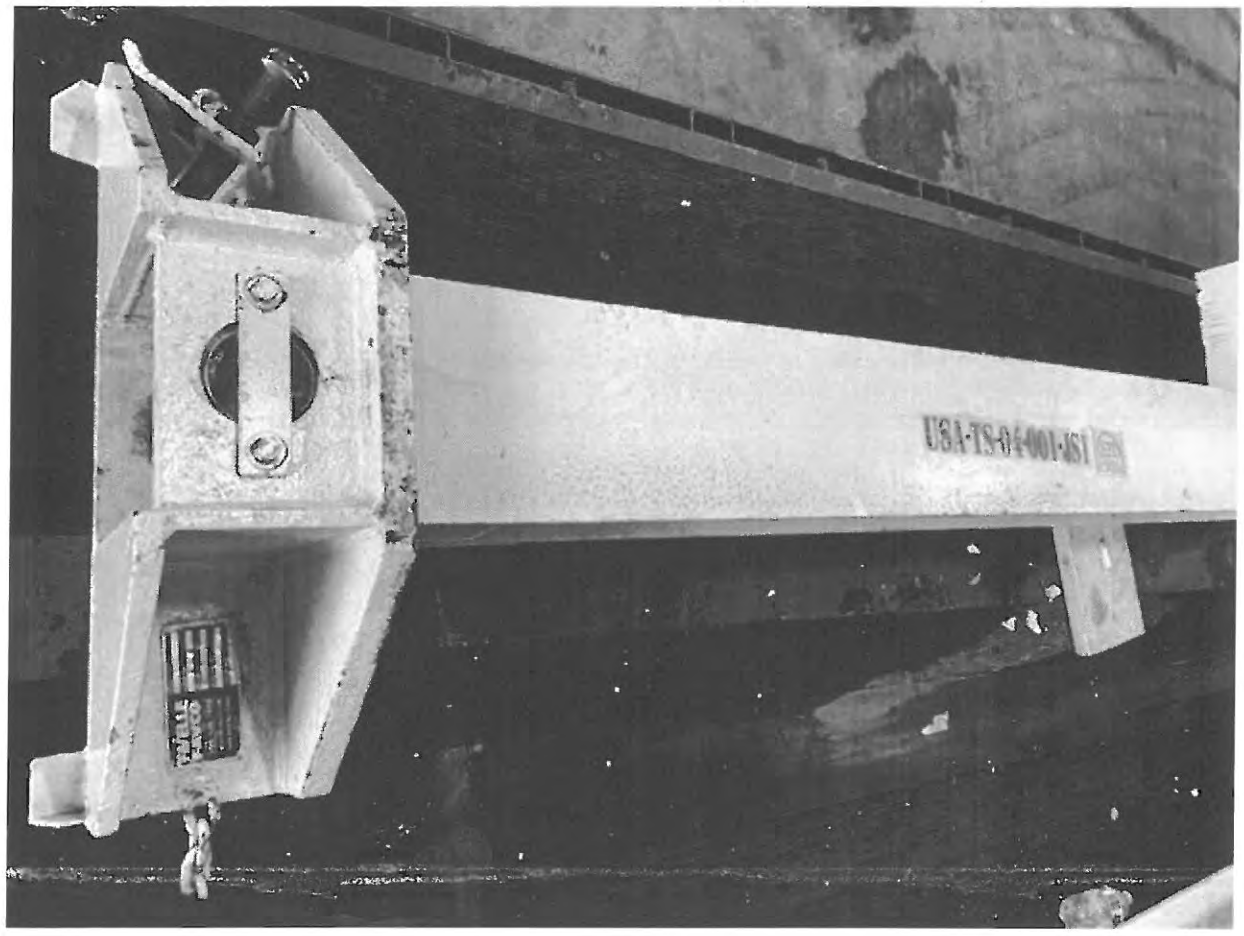
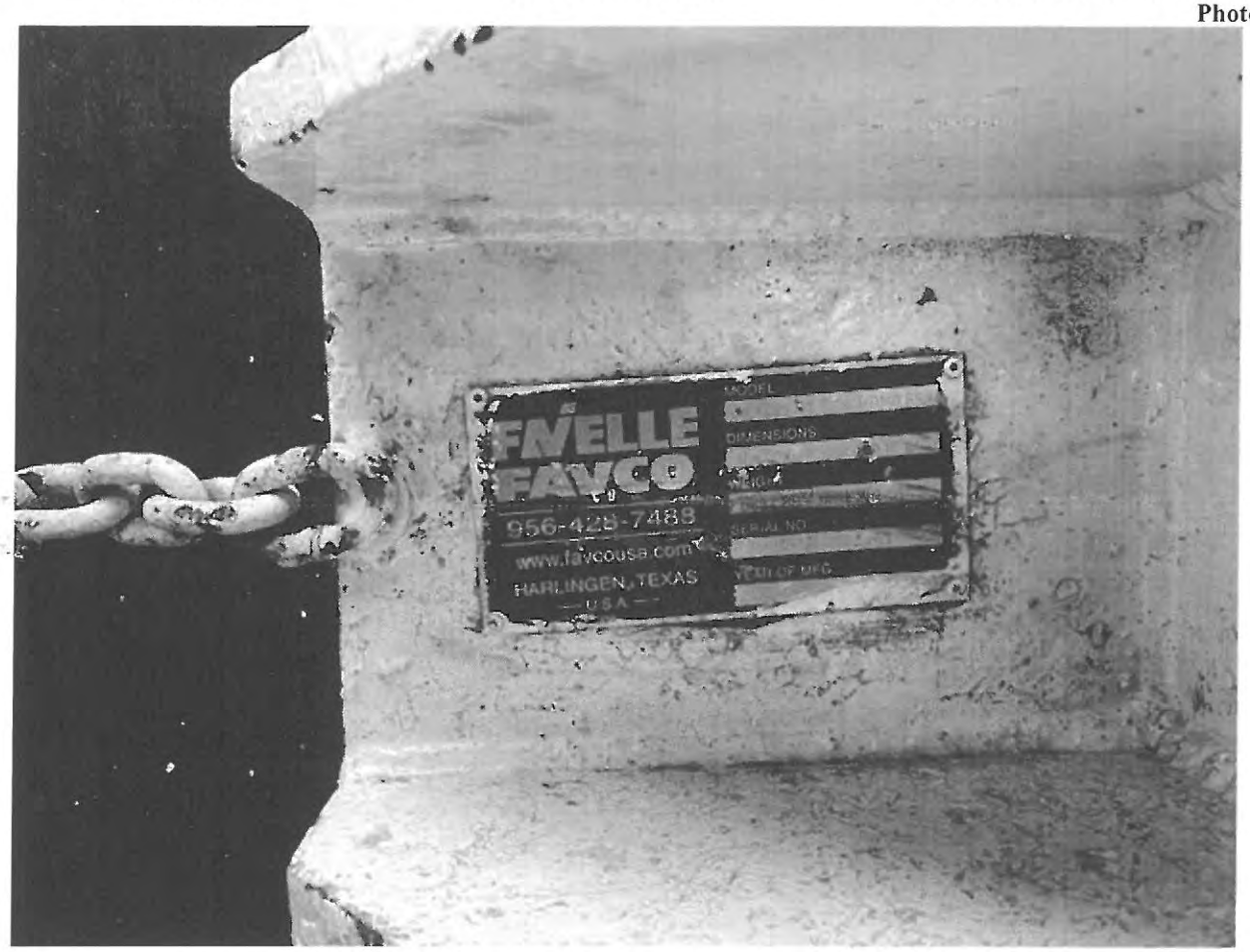
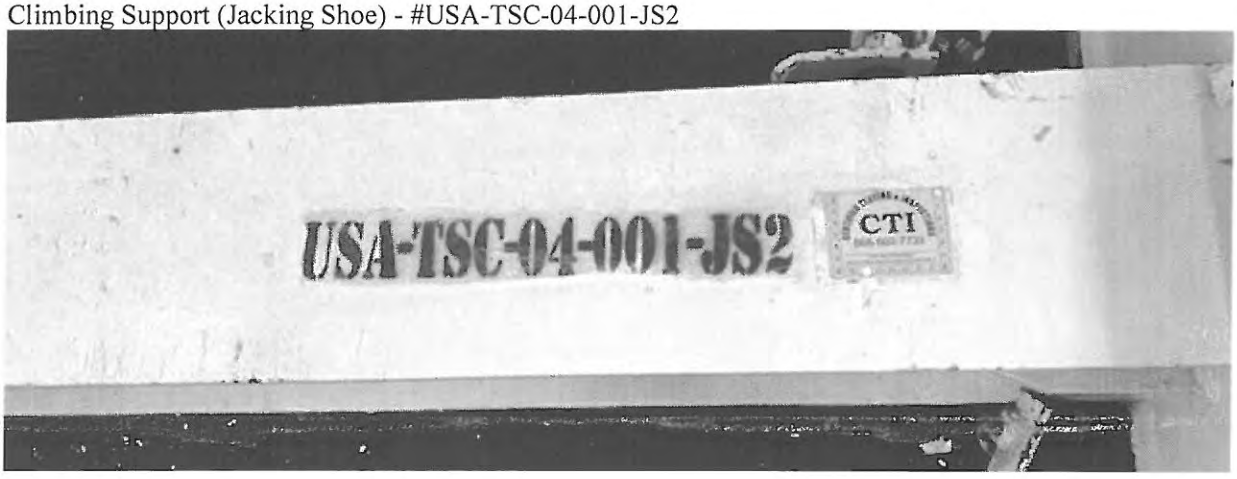


Photo | 77



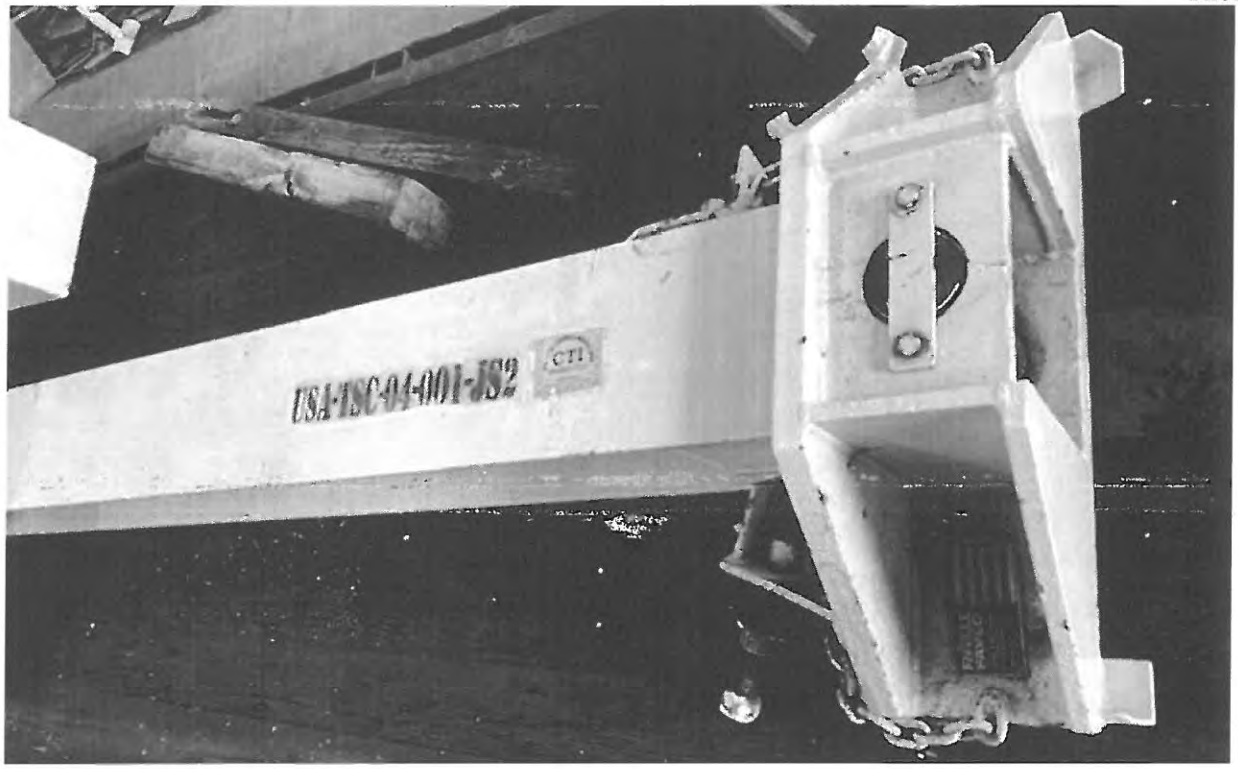
Climbing Support (Jacking Shoe) - #USA-TSC-04-001-JS2



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Monorail - # USA-TSC-04-001-TB





Photo | 80



Monorail Trolley - #USA-TSC-03-001-E



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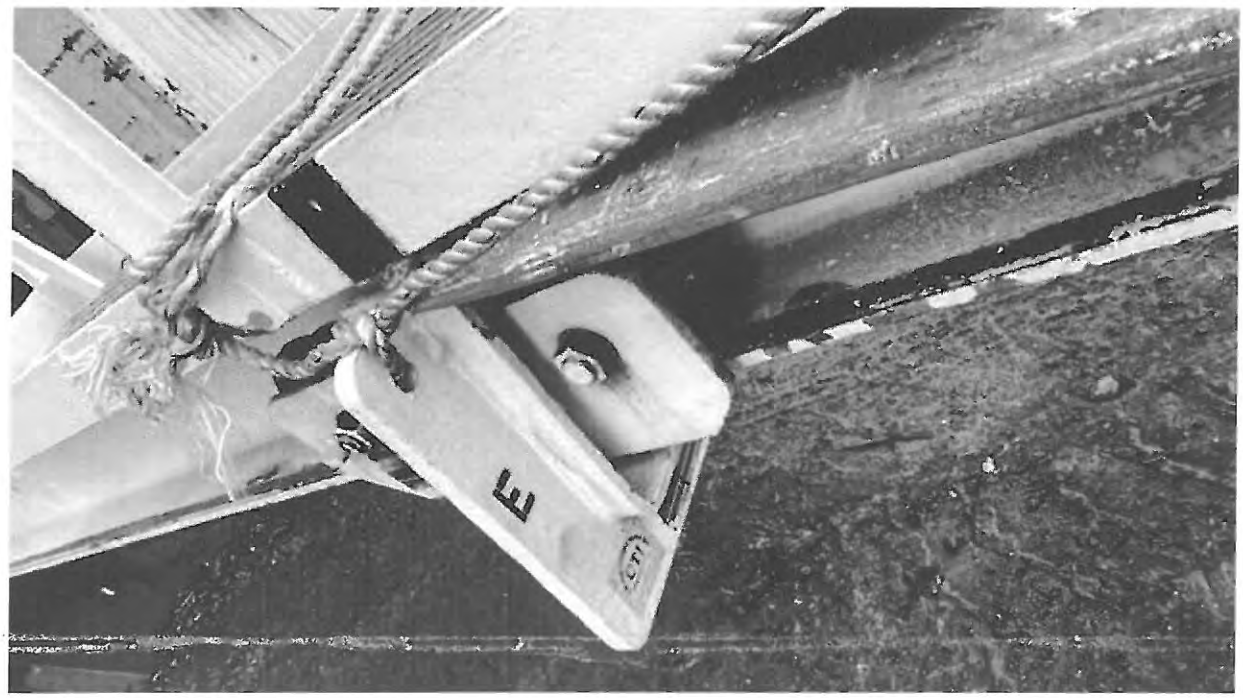


Photo | 82

Hook Adaptor (Monorail Hanger) - #USA-TSC-04-001-F

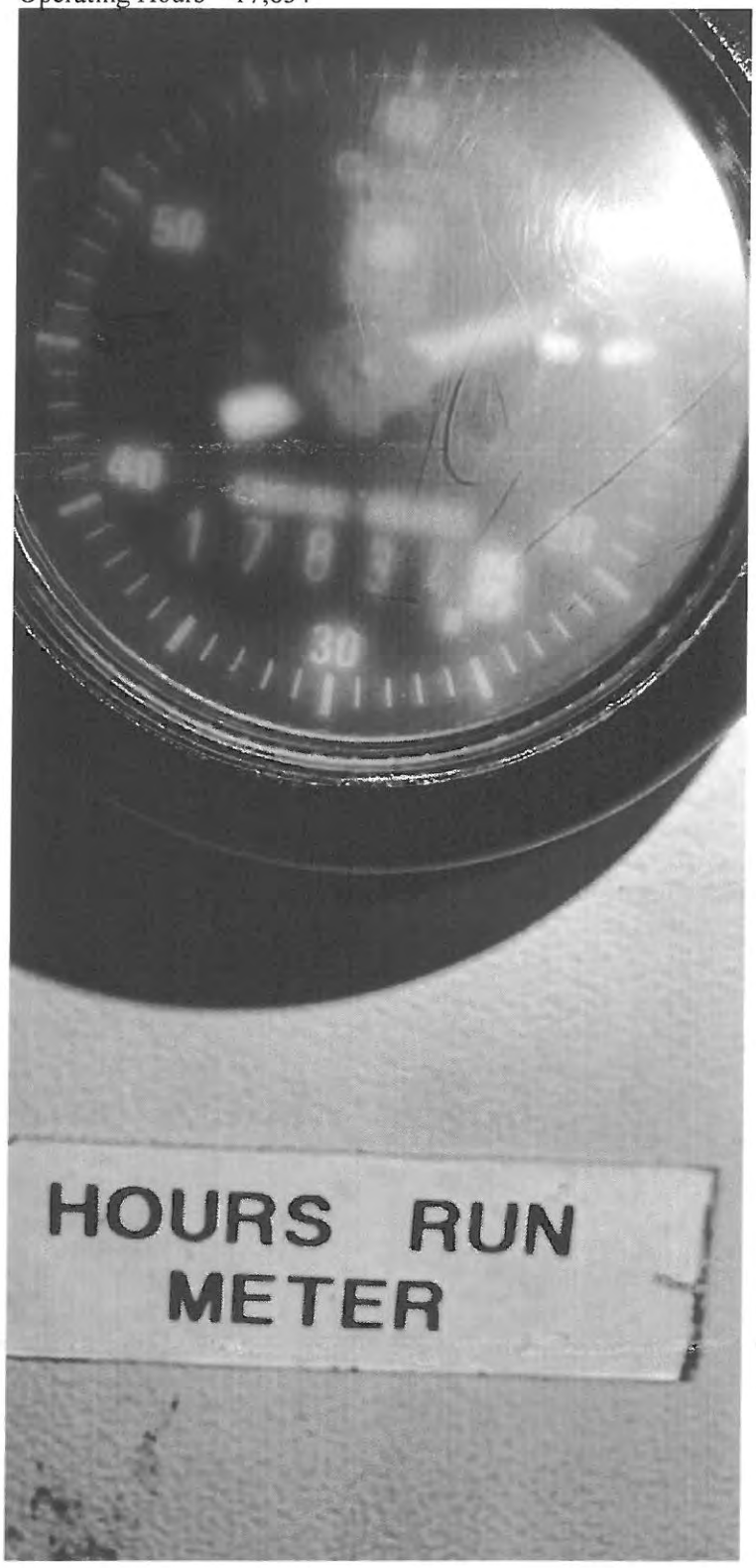


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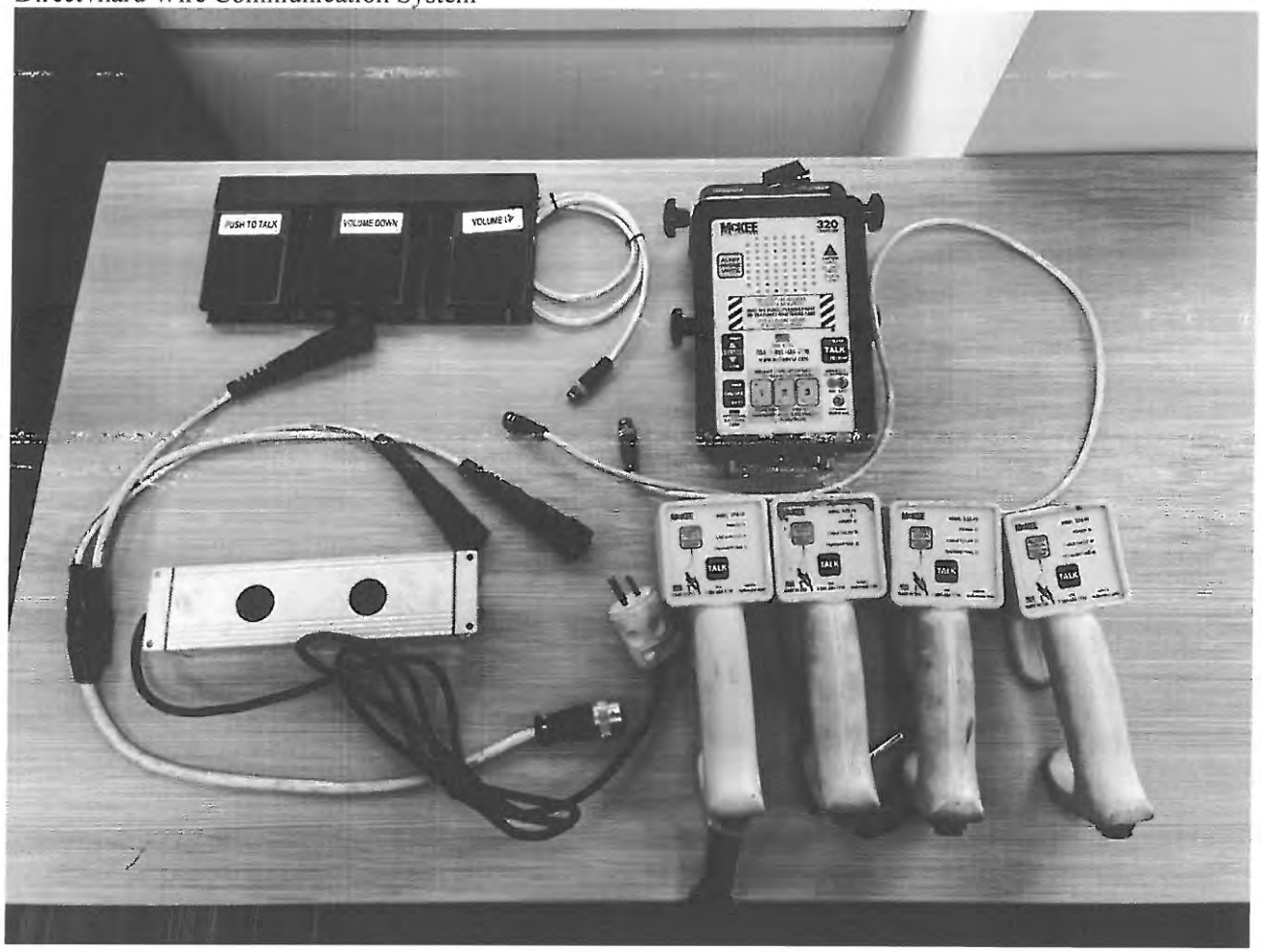
Operating Hours – 17,834



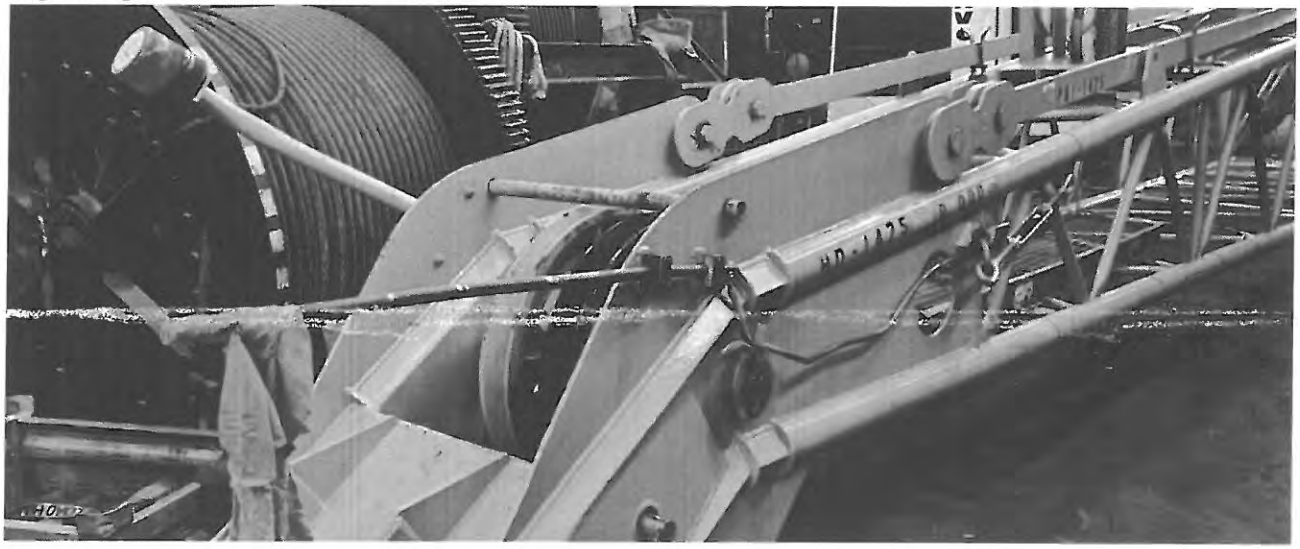
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Photo | 84

Direct /hard Wire Communication System



Lightening Arrestor & Aviation Strobe

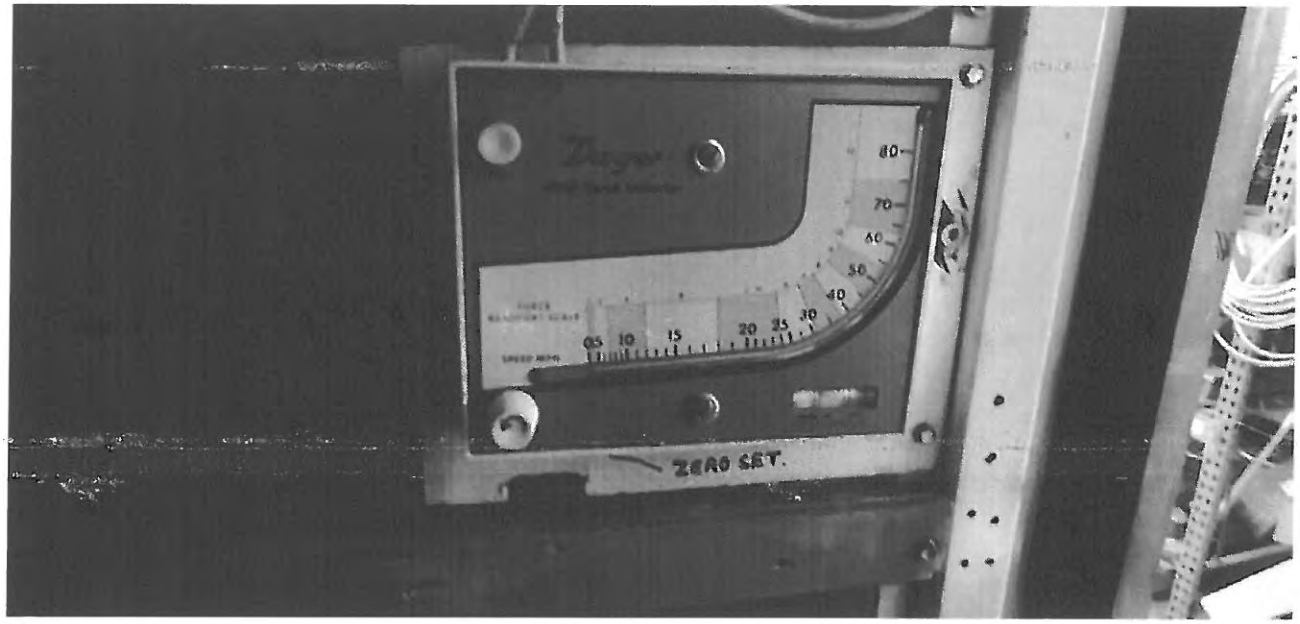


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Photo | 85

Anemometer



LMI

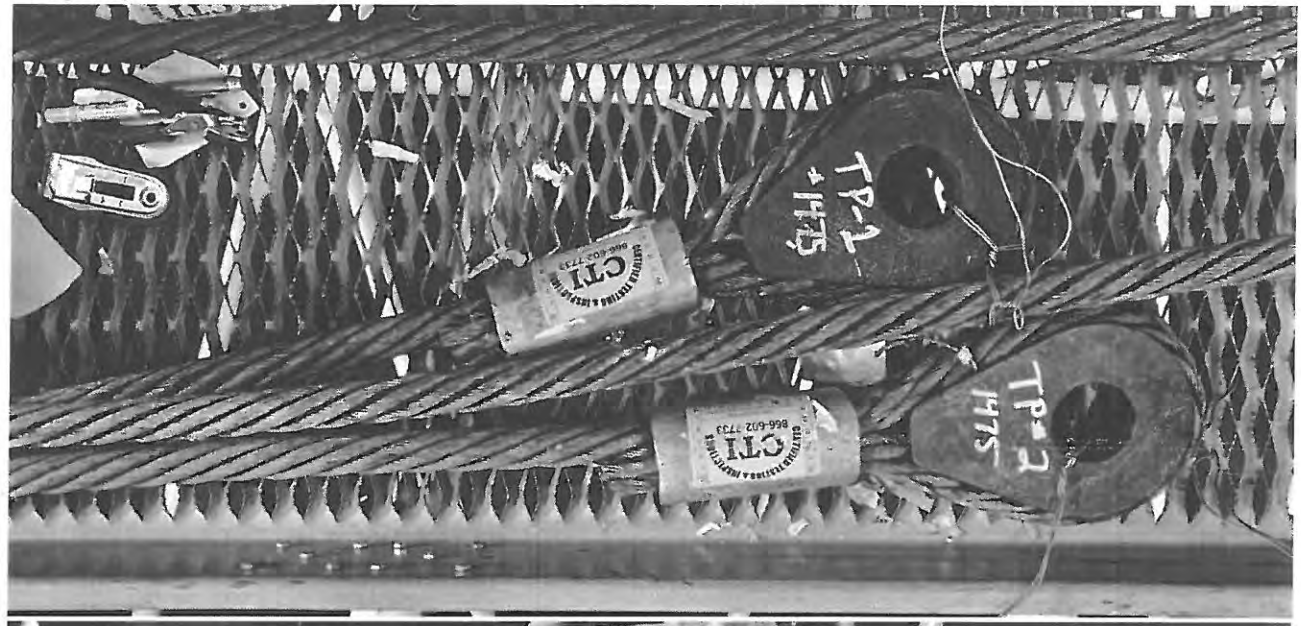


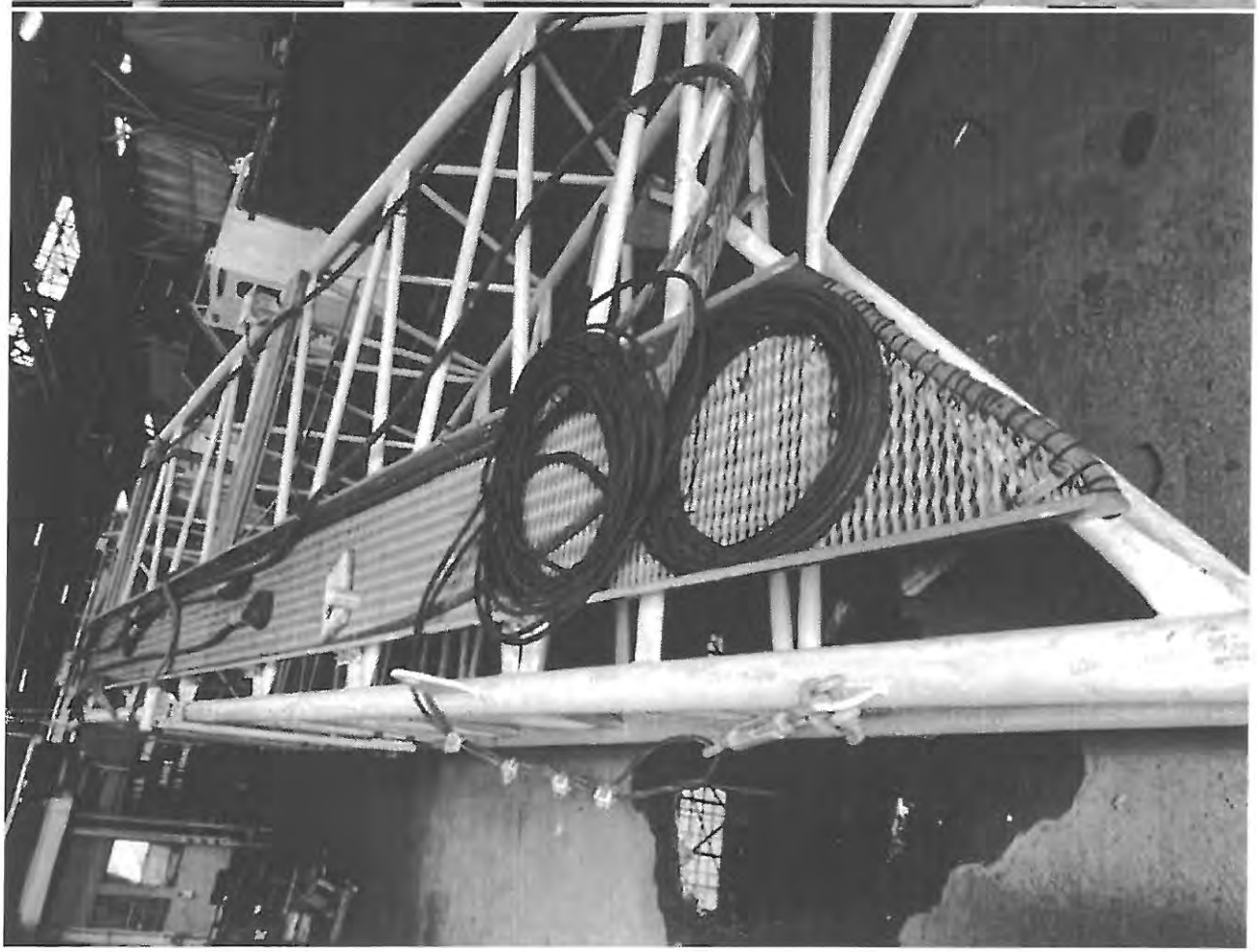
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Photo | 86

Temporary Pendants

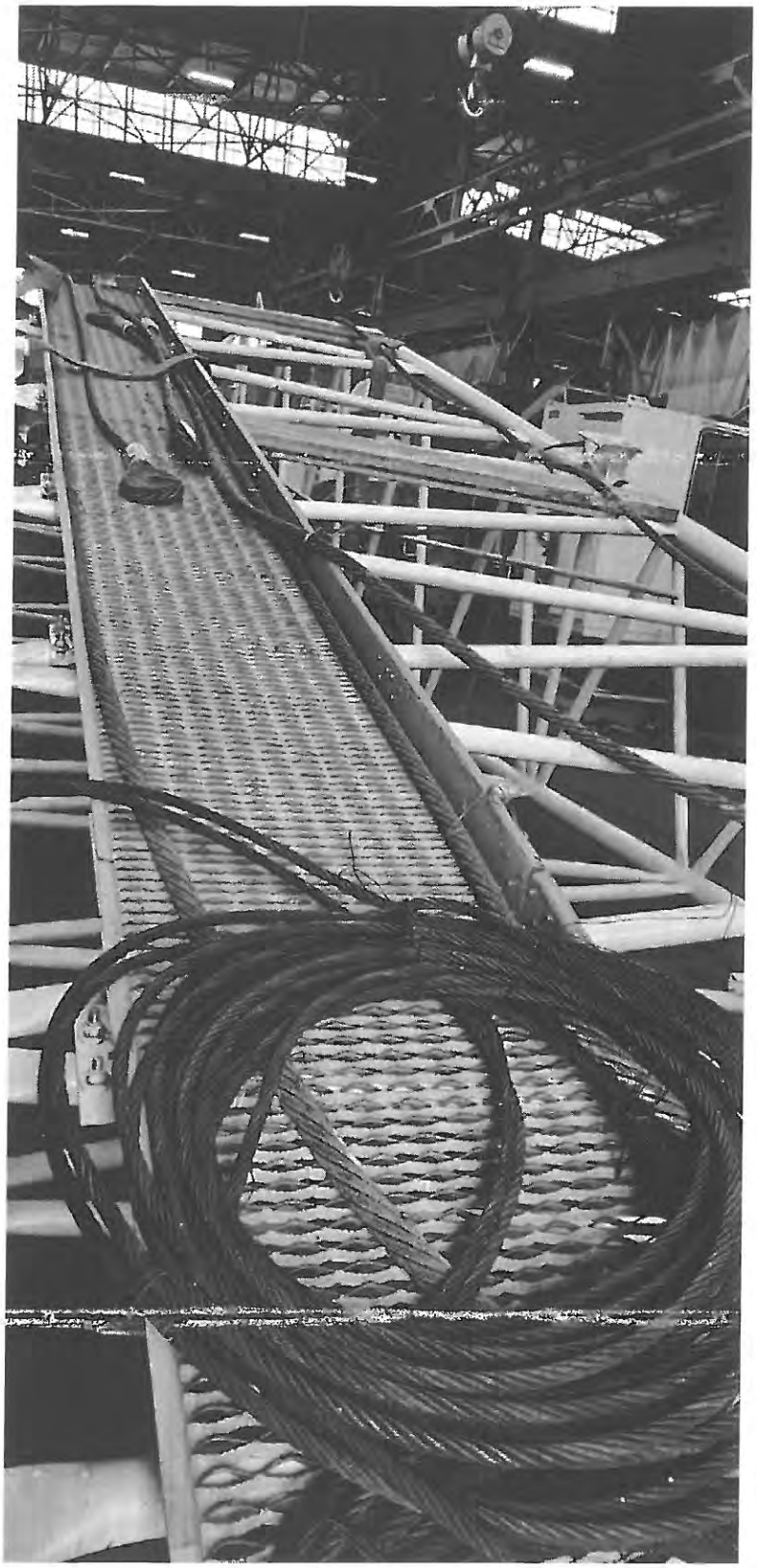




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Photo | 87



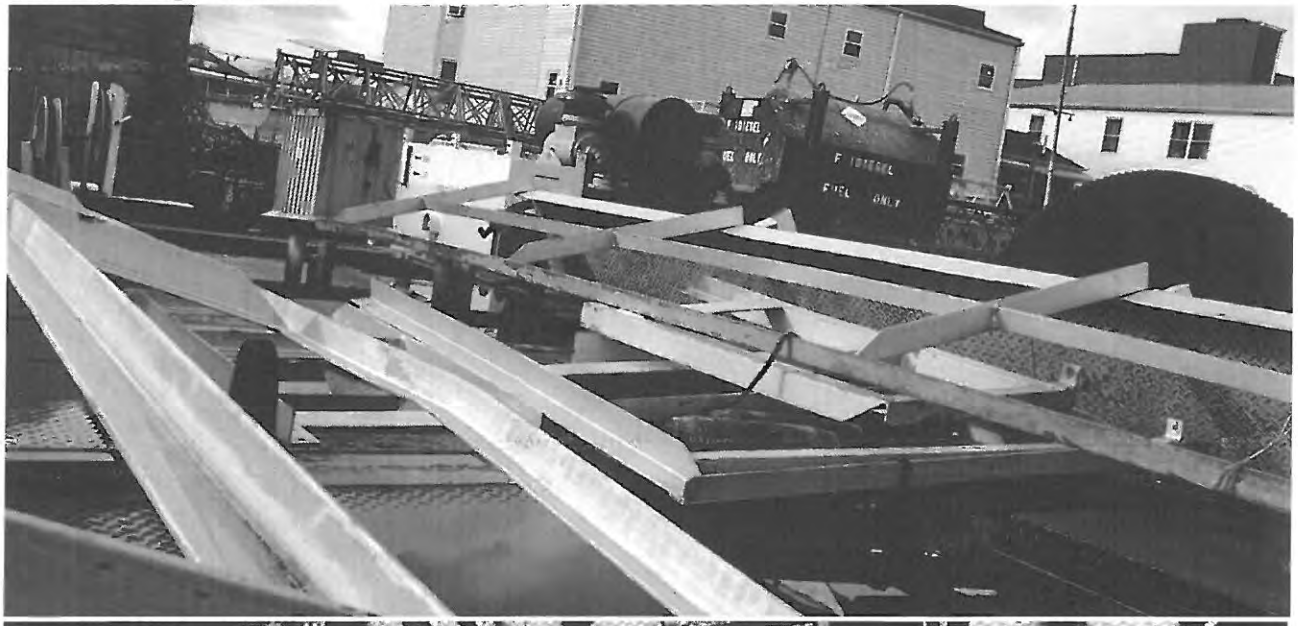
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Photo | 88

Ladder, Railings, Platforms



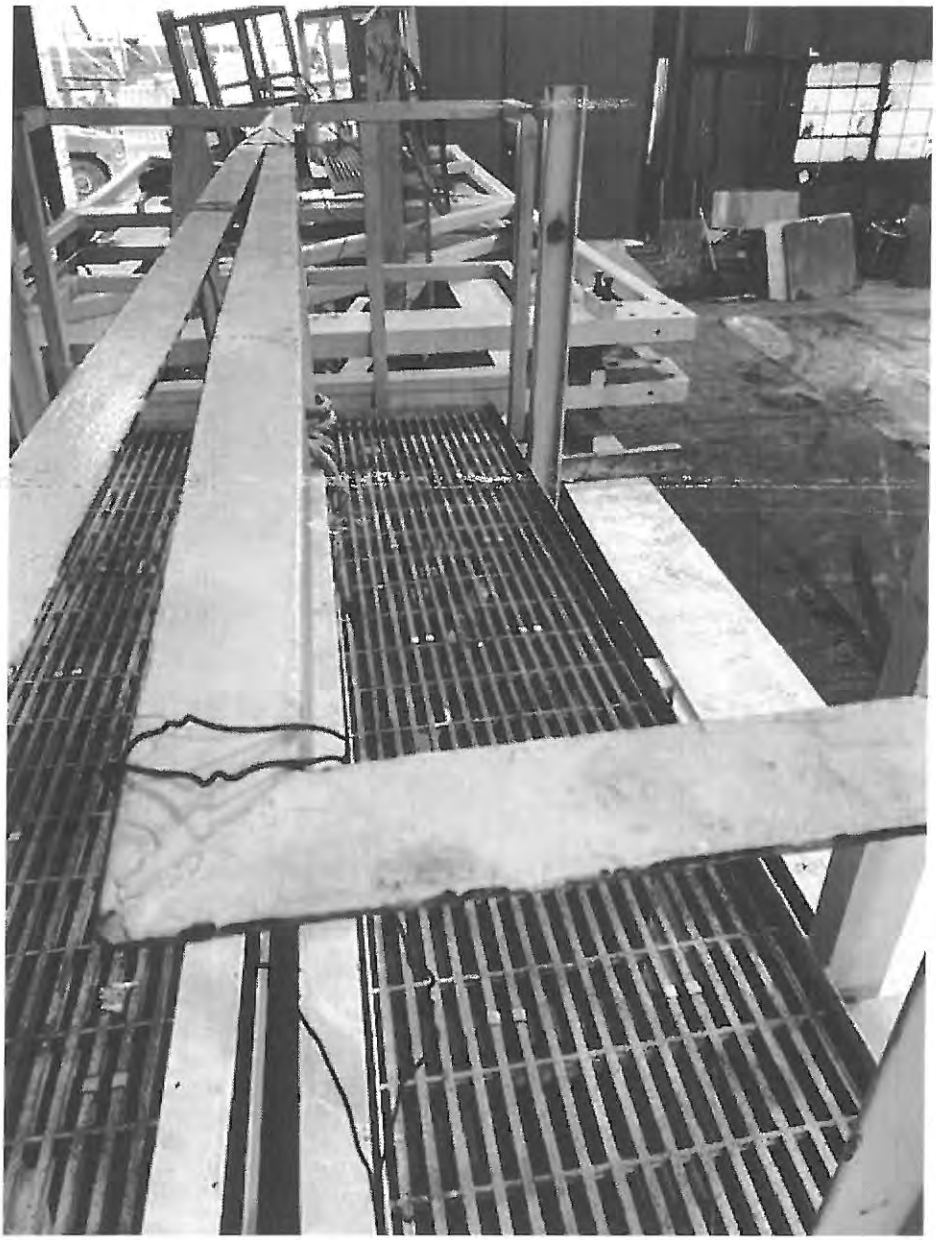


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Photo | 90

Tower Bolts



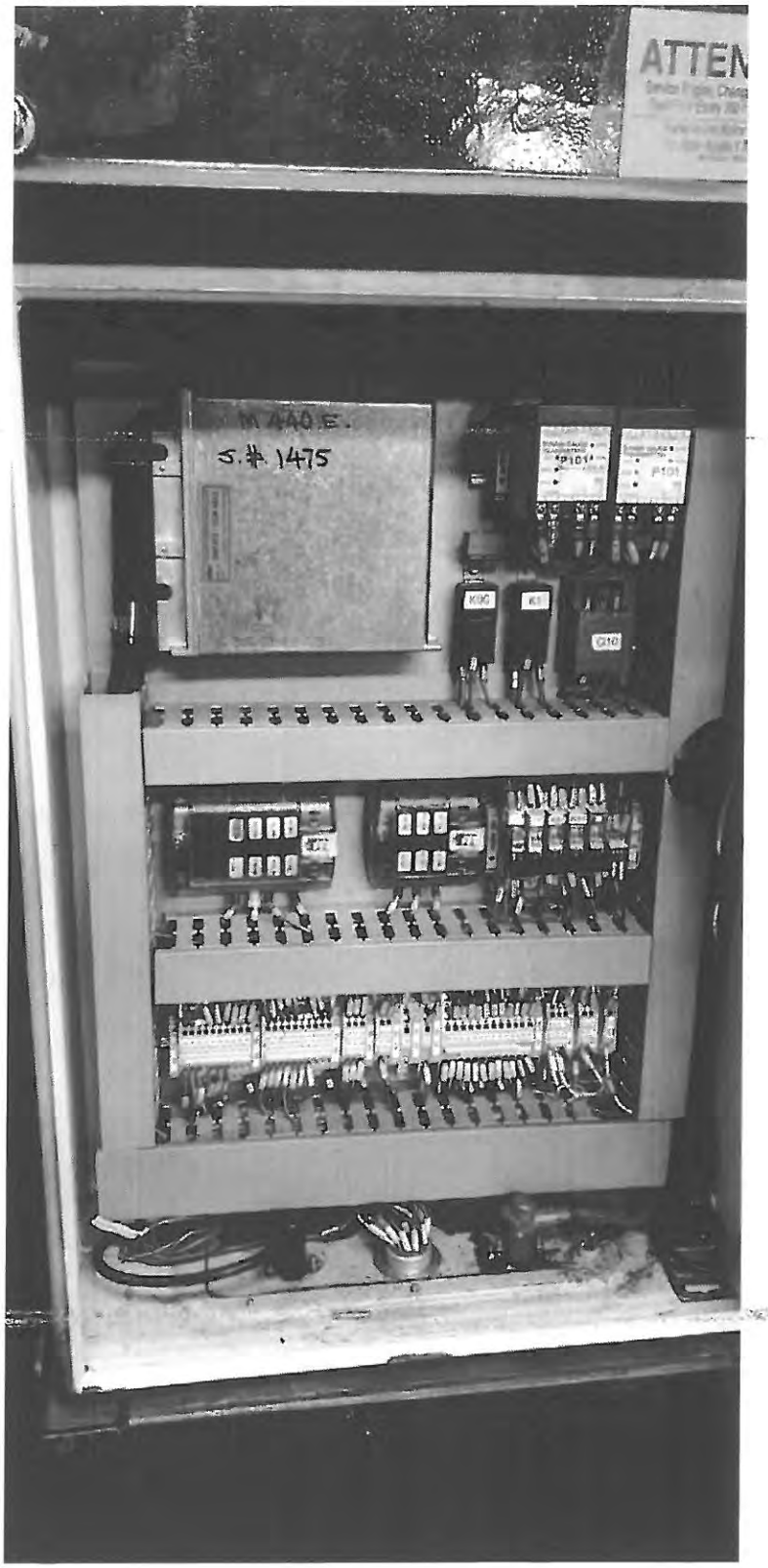
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Photo | 91

Electric



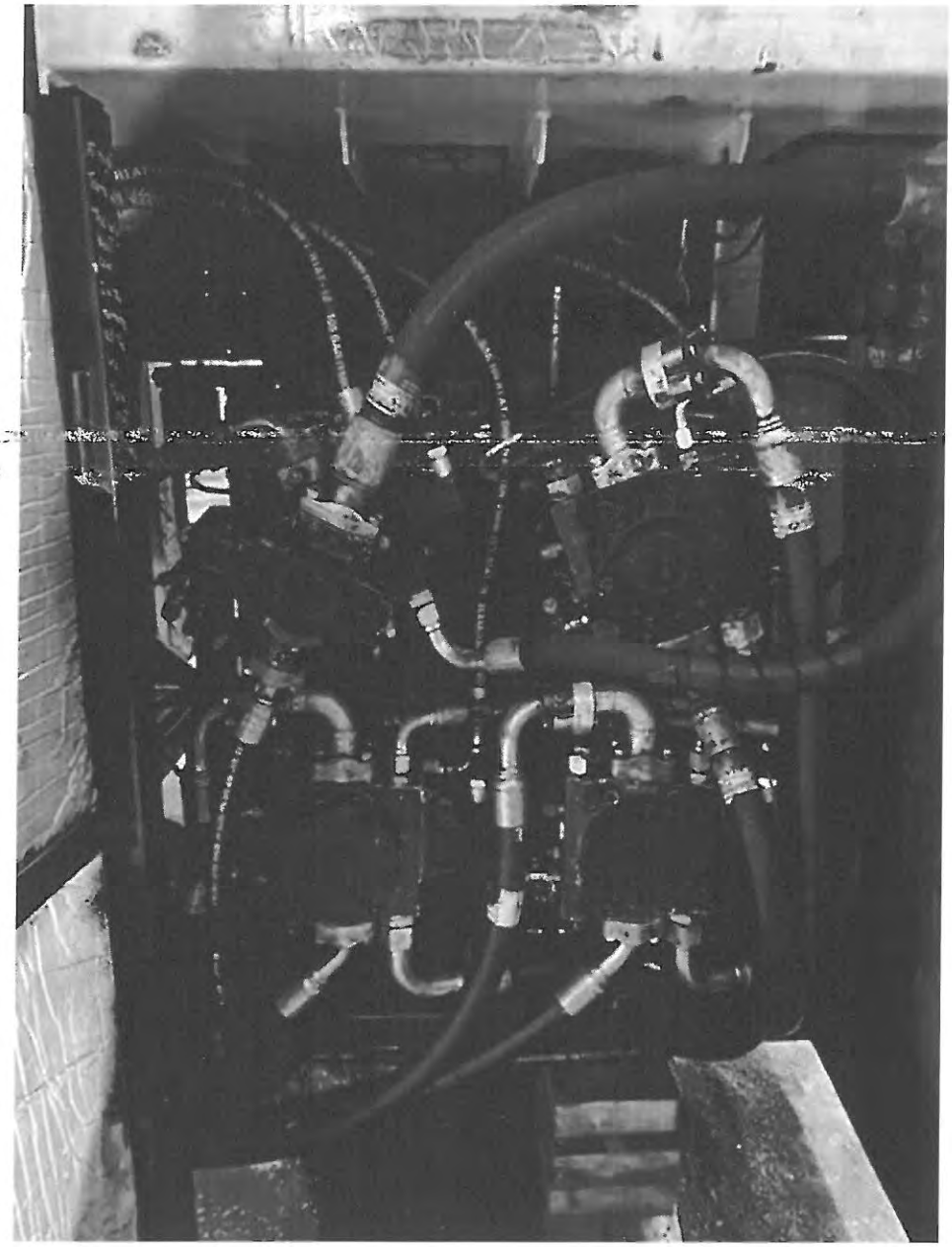
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Photo | 92

Hydraulic

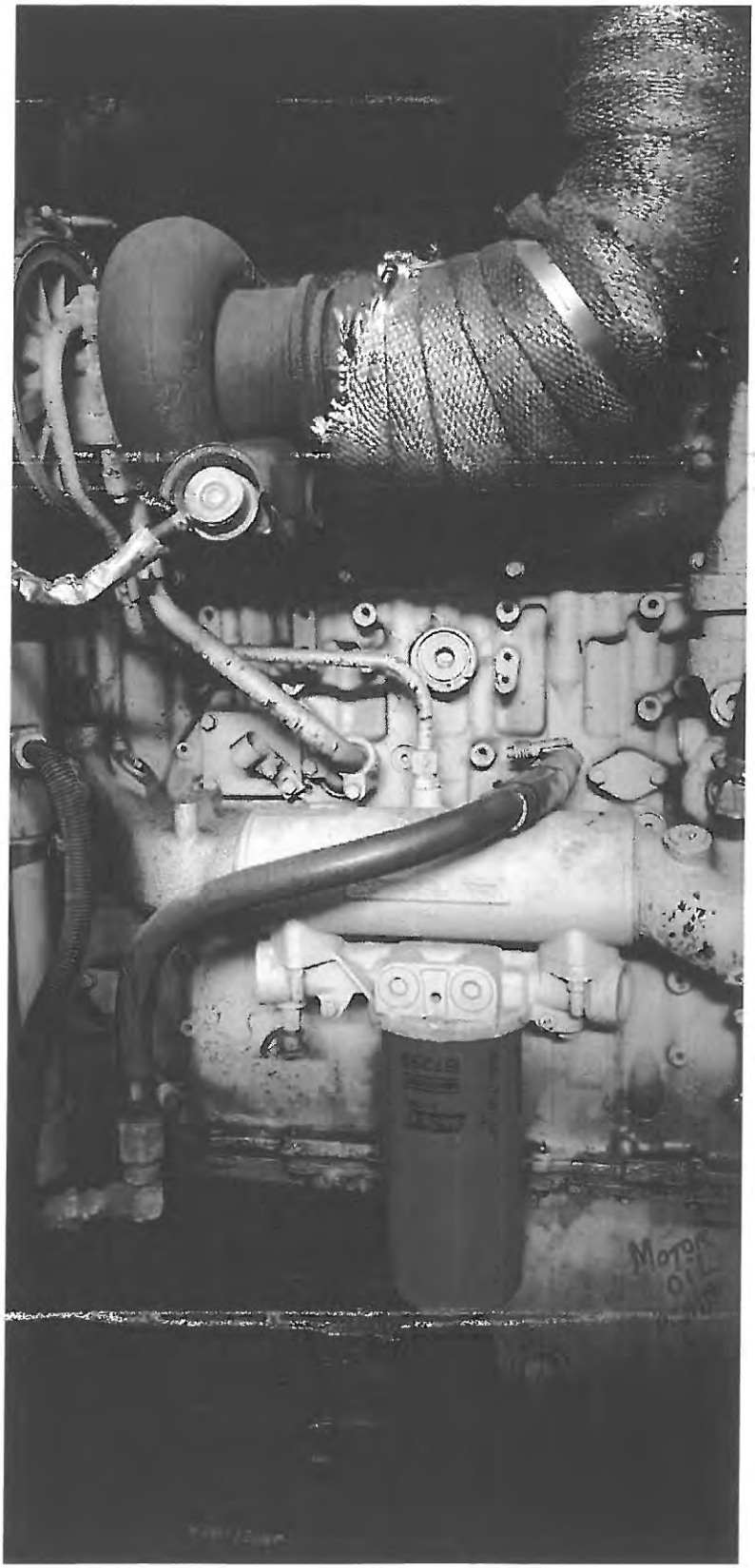


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Photo | 93



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Maintenance Logs



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SECTION VII

Maintenance Records

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1/6/2023
07:52 AM

Work Order : NN2-5665

Status : Open
Unit Code : T440-13
Unit Description : Favco Tower Crane
Unit Make : Favco
Unit Model : M440
Serial Number : 1475

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

- SERVICE AND PREP FOR RENTAL

Hours Upper 17,827
Date 1/6/23

Description	Employee(s)	Hours Worked	Parts
100 HOUR SERVICE			

Action List	Completed	Deficiency	N/A	Comments
100 HOUR SERVICE PER FAVCO MAINTENANCE MANUAL. REFER TO SECTION 5 OF THE INSTALLATION, OPERATIONS & MAINTENANCE MANUAL FOR PROPER PROCEDURE. SIGN OFF WHEN COMPLETED.	☑	☐	☐	
___S01: CHECK THE ENGINE OIL LEVEL	☑	☐	☐	
___S02: CHECK THE RADIATOR WATER LEVEL	☑	☐	☐	
___S03: CHECK THE PUMP DRIVE OIL LEVEL	☑	☐	☐	
___S04: CHECK THE HOIST BRAKE AND FLUID CONDITION	☑	☐	☐	
___S05: CHECK THE LUFF BRAKE AND FLUID CONDITION	☑	☐	☐	
___S06: INSPECT & GREASE THE SHEAVE BEARINGS OF MAST, BRIDLE, BOOM AND HOOK SHEAVES ASSEMBLIES	☑	☐	☐	
___S07: INSPECT & GREASE HOIST DRUM BEARINGS	☑	☐	☐	
___S08: INSPECT & GREASE LUFF DRUM BEARINGS	☑	☐	☐	
___S09: INSPECT & LUBRICATE HOIST DRUM DRIVE BEARINGS AND GEARBOX	☑	☐	☐	
___S10: INSPECT & LUBRICATE LUFF DRUM DRIVE BEARINGS AND GEAR BOX	☑	☐	☐	
___S11: INSPECT & LUBRICATE SLEW DRIVE BEARINGS AND GEAR BOX	☑	☐	☐	
___S12: INSPECT THE HYDRAULIC OIL TANK	☑	☐	☐	
___S13: DRAIN OFF 1 LITER OF HYDRAULIC OIL TO REMOVE ANY CONDENSED WATER. IF WATER IS PRESENT, DRAIN UNTIL REMOVED AND TOP OFF WITH CLEAN OIL	☑	☐	☐	

1/6/2023
07:52 AM

Work Order : NN2-5665

Status : Open
Unit Code : T440-13
Unit Description : Favco Tower Crane
Unit Make : Favco
Unit Model : M440
Serial Number : 1475

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Description	Employee(s)	Hours Worked	Parts
100 HOUR SERVICE			

Action List	Completed	Deficiency	N/A	Comments
___S14: CHECK ENGINE AIR CLEANER	☑	☐	☐	
___S15: CHECK HOIST ROPE LAY	☑	☐	☐	
___S16: CHECK THE ANNUNCIATOR TO ENSURE THE VISUAL AND AUDIBLE ALARMS ARE WORKING	☑	☐	☐	
___S17: CHECK THE HOIST UP LIMIT	☐	☐	☑	
___S18: CHECK THE HOIST DOWN LIMIT	☐	☐	☑	
___S19: CHECK THE LUFF IN LIMIT	☐	☐	☑	
___S20: CHECK THE LUFF OUT LIMIT	☐	☐	☑	
___S21: CHECK THE ENGINE/CRANE BATTERY (IF APPLICABLE)	☑	☐	☐	
___S22: CHECK POWERPACK HOLDING DOWN BOLTS/PINS	☐	☐	☐	
___S23: CHECK THE EMERGENCY STOP FUNCTION	☑	☐	☐	
___S24: CHECK THE SLEW LIMITS	☐	☐	☑	
___S25: TEST ALL FOUR CAVIATION SWITCHES	☐	☐	☑	
___S26: CHECK ENGAGEMENT FO LUFF RATCHET WHEN CRANE IS SHUTDOWN	☑	☐	☐	
___S27: CHECK THE HOIST ROPE FOR DEFECTS AND/OR FAILURE	☑	☐	☐	
___S28:CHECK THE LUFF ROPE FOR DEFECTS AND/OR FAILURE	☑	☐	☐	
___S29: GREASE SLEW RING BEARING	☑	☐	☐	
SIGN OFF: Leonardo Cambero.	☑	☐	☐	

250 HOUR SERVICE UPPER

Action List	Completed	Deficiency	N/A	Comments
250 HOUR SERVICE CHECKLIST PER FAVCO & CATERPILLER MANUAL. REFER TO SECTION 5 OF THE INSTALLATION, OPERATIONS & MAINTENANCE MANUAL FOR PROPER PROCEDURE. SIGN OFF WHEN COMPLETED.	☑	☐	☐	

1/6/2023
07:52 AM

Work Order : NN2-5665

Status : Open
Unit Code : T440-13
Unit Description : Favco Tower Crane
Unit Make : Favco
Unit Model : M440
Serial Number : 1475

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Description	Employee(s)	Hours Worked	Parts
250 HOUR SERVICE UPPER			

Action List	Completed	Deficiency	N/A	Comments
S01: CHANGE ENGINE OIL AND OIL FILTER (8 GALLONS OF 15W40)	☑	☐	☐	
S02: CHANGE PRIMARY FUEL FILTER	☑	☐	☐	
S03: CHANGE FUEL/WATER SEPERATOR	☑	☐	☐	
S04: CLEAN/REPLACE PRIMARY AND SECONDARY AIR FILTER	☑	☐	☐	
S05: INSPECT & GREASE HOIST DRUM BEARINGS	☑	☐	☐	
S06: INSPECT & GREASE LUFF DRUM BEARINGS	☑	☐	☐	
S07: INSPECT & GREASE HOIST DRUM DRIVE BEARINGS	☑	☐	☐	
S08: INSPECT & GREASE LUFF DRUM DRIVE BEARINGS	☑	☐	☐	
S09: INSPECT AND LUBRICATE SLEW DRIVE BEARINGS	☑	☐	☐	
S10: INSPECT LIMIT SWITCHES	☑	☐	☐	
S11: INSPECT THE HYDRAULIC OIL TANK	☑	☐	☐	
S12: CHECK RADIATOR WATER LEVEL	☑	☐	☐	
S13: CHECK PUMP DRIVE OIL LEVEL	☑	☐	☐	
S14: CHECK HYDRAULIC OIL LEVEL	☑	☐	☐	

SIGN OFF Leonardo Cambero.

Suggested Parts

8.00 Gallons	15W40	MOTOR OIL
1.00 Each	B7299	OIL FILTER (BALDWIN)
1.00 Each	BF7587	FUEL FILTER (BALDWIN)
1.00 Each	326-1643	FUEL FILTER
1.00 Each	RS3514	AIR FILTER (OUTER)
1.00 Each	RS3515	AIR FILTER (INNER)
1.00 Each	BF1382-SP	FUEL FILTER

BRAKE PAK SERVICE

Action List	Completed	Deficiency	N/A	Comments
SO1: DRAIN BRAKE PACKS WHILE OIL IS HOT AS PER FAVCO PROCEDURES	☑	☐	☐	

1/6/2023
07:52 AM

Work Order : NN2-5665

Status : Open
Unit Code : T440-13
Unit Description : Favco Tower Crane
Unit Make : Favco
Unit Model : M440
Serial Number : 1475

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Description	Employee(s)	Hours Worked	Parts

BRAKE PAK SERVICE

Action List	Completed	Deficiency	N/A	Comments
SO2: REMOVE LEVEL PLUG BEFORE FILLING BRAKE	☑	☐	☐	
S03: REPLACE SEALS ON ALL PLUGS	☑	☐	☐	
S04: INSTALL ALL PLUGS AND TIGHTEN TO MANUFACTURES SPECS	☑	☐	☐	
S05: ADD ATF FLUID TYPE DEXRON II TO PROPER LEVELS	☑	☐	☐	
S06: DRAIN PUMP GEAR BOX WHILE HOT AS PER FAVCO PROCEDURS	☑	☐	☐	
S07: CHECK FOR ANY VISIBLE LEAKS	☑	☐	☐	
S08: REFILL GEAR BOX TO PROPER LEVEL USING SAE 80 GEAR OL 600 XP 150	☑	☐	☐	
SIGN OFF: Leonardo Contreras	☑	☐	☐	

COOLING SYSTEM SERVICE

FAN BELTS REPLACED

Suggested Parts

1.00 Each	6N-6651	WATER PUMP BELT
1.00 Each	4N-8216	ALTERNATOR BELT

HYDRAULIC SYSTEM SERVICE

Action List	Completed	Deficiency	N/A	Comments
HYDRAULIC SYSTEM SERVICE CHECKLIST PER FAVCO MANUAL. REFER TO SECTION 5 OF THE INSTALLATION, OPERATIONS & MAINTENANCE MANUAL FOR PROPER PROCEDURE. SIGN OFF WHEN COMPLETED.	☑	☐	☐	
SO1: REPLACE HYDRAULIC FILTERS	☑	☐	☐	
SO2: OBTAIN HYDRAULIC FLUID SAMPLE	☑	☐	☐	
SO3: DRAIN HYDRAULIC FLUID	☑	☐	☐	
S04: CHECK ALL HOSES AND CONNECTORS FOR LEAKS	☑	☐	☐	
S05: CHECK ALL HOSES FOR CUTS AND ABRASIONS	☑	☐	☐	

1/6/2023
07:52 AM

Work Order :NN2-5665

Status :Open
Unit Code :T440-13
Unit Description :Favco Tower Crane
Unit Make :Favco
Unit Model :M440
Serial Number :1475

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Description	Employee(s)	Hours Worked	Parts
HYDRAULIC SYSTEM SERVICE			

Action List	Completed	Deficiency	N/A	Comments
S06: REFILL HYDRAULIC TANK TO PROPER LEVEL	☑	☐	☐	
S07: CHECK HYDRAULIC PUMP PRESSURES	☑	☐	☐	
S08: CHECK HYDRUALIC TANK LEVEL SENSOR	☑	☐	☐	
S09: CHECK ALL HYDRAULIC CONTROL HANDLES AND LINKAGES	☑	☐	☐	
SIGN OFF Leonardo Combero.	☑	☐	☐	

PUMP DRIVE SERVICE

REPAINT EQUIPMENT

SIX MONTH SERVICE

Action List	Completed	Deficiency	N/A	Comments
S01: INSPECT AND GREASE HOIST DRUM BEARINGS	☑	☐	☐	
S02: INSPECT AND GREASE LUFF DRUM BEARINGS	☑	☐	☐	
S03: INPECT AND LUBRICATE HOIST DRUM DRIVE BEARINGS	☑	☐	☐	
S04: INSPECT AND LUBRICATE LUFF DRUM DRIVE BEARINGS	☑	☐	☐	
S05: INSPECT AND LUBRICATE SLEW DRIVE BEARINGS AND GEARBOX	☑	☐	☐	
S06: INPSECT LIMIT SWITCH DRIVES	☑	☐	☐	
S07: INSPECT HYDRAULIC OIL TANK	☑	☐	☐	
S08: INSPECT SLEW DRIVE SPLINED PINIONS	☑	☐	☐	
S09: INSPCECT LUFF DRIVE SPLINED PINIONS	☑	☐	☐	
S10: INSPECT HOIST DRIVE SPLINED PINIONS	☑	☐	☐	
S11: INSPECT CRANE STRUCTURAL MEMEBERS AND WELDS	☐	☐	☑	

1/6/2023
07:52 AM

Work Order : NN2-5665

Status : Open
Unit Code : T440-13
Unit Description : Favco Tower Crane
Unit Make : Favco
Unit Model : M440
Serial Number : 1475

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Description	Employee(s)	Hours Worked	Parts
SIX MONTH SERVICE			

Action List	Completed	Deficiency	N/A	Comments
SIGN OFF Leonardo Cambero.	☑	☐	☐	

Comments The Whole maintenance service was completed by manufacturer specification procedure. —

Analytical Testing SERVICES, INC.
We Test It! 814-432-7214

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An Independent Laboratory
814-432-7214
Fax: 814-432-9424
www.WeTestIT.com

Correspondence: PO Box 61 Franklin, PA 16323 • Shipping: 190 Howard St. Suite 404 Franklin, PA 16323

January 16, 2024

Frank Hegan
Crane Tech Solutions
2030 Ponderosa St
Portsmouth, VA 23701

Dear Frank:

The following is the analyses for the sample submitted.

ATS Lab ID							**115916**
Crane Tech ID:							**ID #103 9/27/2023 Hydraulic Oil Samples Front of Engine Pack**
Test Method	**Description**						**Results**
ASTM D445	Kinematic Viscosity @ 40°C						43.05 cSt ‡
ASTM D5185	Elemental Analysis by iCP-AES						ppm
	Si	5	Al	0	Cr	0	
	Cu	2	Mn	0	Fe	2	
	Ni	2	Pb	1	Sn	0	
	Na	3	B	3	Ca	90	
	Mg	11	P	350	Zn	421	
	Mo	4	Ti	0	Ba	0	
	K	1	Cd	0	V	0	
ASTM D659	Autoignition Temperature (AIT)						360°C

‡ - The Kinematic Viscosity is within specifications for and ISO VG46 product.

Thank you for your business, and we look forward to working with you in the future.

Very truly yours,

Richard M. Eakin,
President

Reference: Final Report and Invoice #12497 emailed to Frank Hegan at fhegan@ct-sol.com on Jan-16-2024.

These services are rendered without any warranty or liability, since they are based on sample and information supplied by others.
Samples are retained thirty (30) days.

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Correspondence: PO Box 61 Franklin, PA 16323 • Shipping: 190 Howard St. Suite 404 Franklin, PA 16323

January 16, 2024

Frank Hegan
Crane Tech Solutions
2030 Ponderosa St
Portsmouth, VA 23701

Dear Frank:

The following is the analyses for the sample submitted.

ATS Lab ID							**115917**
Crane Tech ID:							**#391**
Test Method	**Description**						**Results**
ASTM D445	Kinematic Viscosity @ 40°C						42.82 cSt ‡
ASTM D5185	Elemental Analysis by iCP-AES						ppm
	Si	2	Al	0	Cr	0	
	Cu	2	Mn	0	Fe	1	
	Ni	2	Pb	0	Sn	0	
	Na	3	B	4	Ca	85	
	Mg	10	P	345	Zn	420	
	Mo	4	Ti	0	Ba	0	
	K	1	Cd	0	V	0	
ASTM D659	Autoignition Temperature (AIT)						369°C
ASTM D92	Flash Point, COC						244°C

‡ - The Kinematic Viscosity is within specifications for and ISO VG46 product.

There was free water in the sample container.

Thank you for your business, and we look forward to working with you in the future.

Very truly yours,

Richard M. Eakin,
President

Reference: Final Report and Invoice #12497 emailed to Frank Hegan at fhegan@ct-sol.com on Jan-16-2024.

These services are rendered without any warranty or liability, since they are based on sample and information supplied by others.
Samples are retained thirty (30) days.

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www.WeTestIT.com

Correspondence: PO Box 61 Franklin, PA 16323 • Shipping: 190 Howard St. Suite 404 Franklin, PA 16323

January 16, 2024

Frank Hegan
Crane Tech Solutions
2030 Ponderosa St
Portsmouth, VA 23701

Dear Frank:

The following is the analyses for the sample submitted.

ATS Lab ID							**115918**
Crane Tech ID:							**#302**
Test Method	**Description**						**Results**
ASTM D445	Kinematic Viscosity @ 40°C						43.08 cSt ‡
ASTM D5185	Elemental Analysis by iCP-AES						ppm
	Si	3	Al	0	Cr	0	
	Cu	2	Mn	0	Fe	1	
	Ni	1	Pb	0	Sn	0	
	Na	3	B	4	Ca	81	
	Mg	10	P	330	Zn	398	
	Mo	4	Ti	0	Ba	0	
	K	1	Cd	0	V	0	
ASTM D659	Autoignition Temperature (AIT}						360°C
ASTM D92	Flash Pont, COC						240°C

‡ - The Kinematic Viscosity is within specifications for and ISO VG46 product.

Thank you for your business, and we look forward to working with you in the future.

Very truly yours,

Richard M. Eakin,
President

Reference: Final Report and Invoice #12497 emailed to Frank Hegan at fhegan@ct-sol.com on Jan-16-2024.

These services are rendered without any warranty or liability, since they are based on sample and information supplied by others.
Samples are retained thirty (30) days.

Analytical Testing SERVICES, INC.
We Test It! 814-432-7214

Analytical Testing Services, Inc.
An Independent Laboratory
814-432-7214
Fax: 814-432-9424
www.WeTestIT.com

Correspondence: PO Box 61 Franklin, PA 16323 • Shipping: 190 Howard St. Suite 404 Franklin, PA 16323

January 16, 2024

Frank Hegan
Crane Tech Solutions
2030 Ponderosa St
Portsmouth, VA 23701

Dear Frank:

The following is the analyses for the sample submitted.

ATS Lab ID							**115919**
Crane Tech ID:							**#491**
Test Method	**Description**						**Results**
ASTM D445	Kinematic Viscosity @ 40°C						43.16 cSt ‡
ASTM D5185	Elemental Analysis by iCP-AES						ppm
	Si	3	Al	0	Cr	0	
	Cu	4	Mn	0	Fe	5	
	Ni	2	Pb	0	Sn	0	
	Na	2	B	5	Ca	134	
	Mg	23	P	356	Zn	426	
	Mo	5	Ti	0	Ba	0	
	K	1	Cd	0	V	0	
ASTM D659	Autoignition Temperature (AIT)						363°C
ASTM D92	Flash Point, COC						242°C

‡ - The Kinematic Viscosity is within specifications for and ISO VG46 product.

There was free water in the sample container.

Thank you for your business, and we look forward to working with you in the future.

Very truly yours,

Richard M. Eakin,
President

Reference: Final Report and Invoice #12497 emailed to Frank Hegan at fhegan@ct-sol.com on Jan-16-2024.

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January 16, 2024

Frank Hegan
Crane Tech Solutions
2030 Ponderosa St
Portsmouth, VA 23701

Dear Frank:

The following is the analyses for the sample submitted.

ATS Lab ID							**115920**
Crane Tech ID:							**#492**
Test Method	**Description**						**Results**
ASTM D445	Kinematic Viscosity @ 40°C						43.41 cSt ‡
ASTM D5185	Elemental Analysis by iCP-AES						ppm
	Si	1	Al	0	Cr	0	
	Cu	4	Mn	0	Fe	5	
	Ni	2	Pb	0	Sn	0	
	Na	2	B	5	Ca	140	
	Mg	23	P	374	Zn	459	
	Mo	5	Ti	0	Ba	0	
	K	1	Cd	0	V	0	
ASTM D659	Autoignition Temperature (AIT)						360°C
ASTM D92	Flash Point, COC						240°C

‡ - The Kinematic Viscosity is within specifications for and ISO VG46 product.

There was free water in the sample container.

Thank you for your business, and we look forward to working with you in the future.

Very truly yours,

Richard M. Eakin,
President

Reference: Final Report and Invoice #12497 emailed to Frank Hegan at fhegan@ct-sol.com on Jan-16-2024.

These services are rendered without any warranty or liability, since they are based on sample and information supplied by others.
Samples are retained thirty (30) days.

Erecting Tower Cranes: Required Protocol for Third-Party Certifications

Erecting a tower crane is **only** permitted after the equipment's applicant – the Engineer of Record (EOR) – submits **all required documentation** and the Department's Cranes and Derricks Unit reviews the submission and grants Crane Notice (CN) approval. To be granted a Crane Notice (CN), the EOR **must** submit third-party certifications, which include certification letters, reports and documentation.

The following protocol outlines the requirements for the EOR, third-party inspectors (inspector) and crane owners (owner) and may be updated to meet statutory requirements and industry practices.

THIRD-PARTY CERTIFICATION

Third-party certification **must** be provided and include certification letters from the EOR, inspector and owner. These letters **must** contain references to the equipment and project, such as the: CN approval number, Crane Device (CD) number, Crane Serial Number (SN), crane model number, project location of the crane, and all other relevant documentation outlined in this protocol. The third-party certification **must** state:

1. a thorough review of the crane installation, operation and maintenance manuals has been undertaken for a comprehensive understanding of the components, functions, servicing, and inspection requirements
2. the repair, testing and inspection records, and any other relevant crane documents were reviewed
3. a complete inspection and non-destructive testing of the crane and all its structural, mechanical, electrical and control components were performed and documented; and
4. that the electrical power source was connected by a Department verified licensed Master Electrician (for tower cranes operated primarily by electrical power source). If the crane is to be powered by Generator set, EOR/Owner shall provide crane power requirements and generator output specifics and certify by letter, that the unit is acceptable to power the machine. Submit NYC Licensed electrical permit, (Gen set and street power).

EOR PROVIDED DOCUMENTS

The *Applicant EOR Certification Letter* **must** state that the EOR has reviewed the inspector certification package, including all relevant documents of the inspection, and has found it to be complete and does not object to the crane's erection. The letter must reference and be submitted along with the following items:

- Draft of CN application showing crane details for site.
- Foundation approval if applicable. For foundations that utilize OEM stools/anchors. Any grillage/dunnage/ or basket type foundations require Engineering review and approval.

DOCUMENTS PROVIDED BY INSPECTOR

- *Third-Party Inspector Certification Letter* – submitted through the EOR with references to CD number and the equipment SN **must** state that:

- The crane installation, operation, and maintenance manuals (properly identified with the equipment SN) have been reviewed.
- Maintenance/repair records, inspection reports and logs have been reviewed (particularly logs and records showing crane meter hour and load cycle counter collating manufacturer's interval maintenance requirements with the actual performance hour readings and stating the condition of brakes, pads, gears and lubrication for all winches and slewing) and that a review was undertaken of the slew bearing's last inspection and maintenance report stating the latest date of inspection.
- Original equipment has not been altered, any visual structural damage and/or repairs and modifications performed have been identified and disclosed, and any repair or replacement components match or exceed the original manufacturers' standards and safety factors.
- All of the unassembled crane components are identified with unique numbers (2-3 inch stencils) and component description captured in the summary and checklists, and are in acceptable condition to permit erection. All individual counterweights are marked permanently noting their appropriate weights. Additionally, all main and structural components must be marked in pounds (lbs). components such as but not limited to Boom inserts, Jib inserts, Jib/fly extensions, tower mast, Counter jib, machine decks, winch packs, a-frame, turntable, adapters, slew mounts, climbing frame components, bridle, cab, Tower tie components, collars, struts, etc.

  EXCEPTION: components weighting 2000lbs or less need not be marked for weight.
- All components to be marked with 2-3 inch stencil, painted on in multiple locations if required, and in an area that can be viewed after erected.

- *Crane Component Checklist and Status* – **must** be provided and list:
  - Hardware, including but not limited to: structural bolts; nuts; washers; pins (boom/jib); mast, sheave, etc.; holders and keepers; ladders; railings; platforms; and paint and/or corrosion coating
  - Electronic monitoring (indicating device model numbers and manufacturer) controlling load, moment, angle, radius, anemometer, visual and audible warning – Load Moment Indicator (LMI)
  - Original Equipment Manufacturer (OEM) starter legs/anchor stools, undercarriages, templates, and mast sections
  - Boom/jib sections and jib extension sections
  - Transition section, turntable, slew ring, bearings and gears
  - Winch assembly, brakes and covers, fittings, valves, hoses and gears
  - Machine deck, A-frame, bridle, solid bar pendants, connection lugs and bushings
  - Wire rope pendants, wire ropes and sheaves
  - Trolley, hooks, headache/overhaul ball, load blocks and anti-two- block device
  - Operator Cab (including but not limited to the cab housing, wiring, dead-man control, control panels and windshields)
  - Electrical, direct/hard wire communication system, aviation strobe, lightning arrestor/grounding systems (stating the condition of wiring, contacts and components)

- Hydraulic system (stating condition of hoses, fittings and valves, and condition of pumps and motors)
- Top Climbers Climbing Frames (stating the condition of cylinders, valves, hoses, fittings, clips, shoes and gauges)
- OEM tie-ins, collar components and counterweights
- All major components shall have an identifying unique number stamped or otherwise tagged on the component itself and the associated corresponding number shall be noted alongside the named component in the checklist and/or the testing documents. Identification numbers on starter legs shall be visible after embedment. For electrically powered cranes, all electrical equipment must be labeled.

  NOTE: Inspection reports older than 60 days prior to the submission date will not be accepted. This is for any aspect of inspection.

DOCUMENTS PROVIDED BY THE OWNER

- The *Owner's Certification Letter,* with reference to the CD number, equipment SN, and Equipment Model Number **must** state:
  - current installation, operation and maintenance manuals were made available to Third-party Inspector for review
  - installation, operation and maintenance manuals are up to date, reference the correct serial number of the crane, contain service bulletins and a maintenance checklist appended to it, and are furnished within the crane
  - no structural repairs and/or modifications have been performed on the crane or any of its components
  - records listing all accidents, major repair history, and maintenance history were made available to third-party for review
  - all fastening hardware is OEM supplied, noting also if bolts and nuts are original or replacement components
  - hydraulic oil and filter of all hydraulic systems have been drained, flushed, replaced with new hydraulic fluid and filters according to the manufacturer's recommendation for this specific project, and that the system and hydraulic oil will be tested based on the manufacturer's recommendation.
  - all required operational safety devices (indicators, limiters, visual and audio warnings) on the crane and associated components, including software, are current to manufacturer's specifications, that all devices will be calibrated by the manufacturer or its representative or certified mechanic immediately after erection and prior to scheduling the load testing, and whether these safety devices are OEM or other
  - the crane or its components were not submerged in water or exposed to flooding conditions
  - no current crane components are 25 years old and that any future components utilized in any phase will not be over 25 years old
  - no current or future crane components are from prototypes revoked by the Department.

- *Five Years of Crane History*

  Provide records listing previous worksite locations and storage yards with appropriate dates.

- *List of Inspections Required*

  Provide detailed checklist of frequent and periodic maintenance, service and inspection requirements to be completed by the crane operator, maintenance engineer or designated person appointed by crane owner.

- *Non-OEM Components*

  The following documents are required for all proposed use of non-OEM manufactured hardware and/or components:

  1. vendor certifications and statements attesting that manufactured components meet OEM standards and are in compliance with or exceed all manufacturer safety factors
  2. EOR's acceptance certificate.

SPECIAL REQUIREMENTS

- **Potain GME Model Cranes**. Owner shall provide a Certificate of Inspection that the owner has inspected all of K-Mast components according to Manitowoc Crane Care Service Bulletin G09-T2 and found them to be free of defects.
- **Potain External Climber 800TA (Models: MR-415, 405, 295 & 90B)**. Owner shall provide a letter documenting performance date of a cracked-leg special inspection and repair procedure as outlined by Manitowoc.
- **Potain MR Models Technical Service Bulletin 23-345-A Dated 6.1.2023**. MR405, MR405B, MR415, MR418, MR418A, MR605, MR605B, MR608, MR615, MR618 counterweight and jib foot articulations maintenance. Owner shall provide certification that this required OEM bulletin has complied with and verified by 3rd party inspector special report.
- **Manitowoc Wind Sail Plate Stiffening Support**. Owner shall provide a Certificate of Inspection that the owner has inspected the wind sail support components in accordance with Manitowoc Crane Care Service Bulletin T11-062 and found them to be free of defects.
- **Terex Model CTL630**. Owner shall provide a letter documenting the performance date of a Special check as indicated in Terex notification dated August 11, 2013, for wear and cracks at the Counterweight Support Leverage Arms Bushings connections.
- **Wolffkran HT23 Mast sections**. Wolffkran letter dated July 13, 2017. Owner to confirm by special inspection all Type HT23 mast sections to be erected were inspected for weld imperfections on the spigot to mast end connections areas. (Mast Top and Bottom end connections)
- **Favco Models 220, 440 & 760**. Owner to provide a letter documenting the performance date of a Special Inspection of all hoisting winch and slew drive spline and pinion gear motors on the crane. Before crane erection all motor spline and pinion gears must be removed, inspected for wear and damage, checked for proper alignment and fit, and re-lubricated in accordance with manufacturer's recommendations.

- **Favco 760 Slew Mount welds Stiffener modification**. Owner to confirm that the Favco service bulletins: dated June 30, 2017, for in and out of service condition has been performed. Full paint removal is required for weld area per July 29, 2017, Favco service notice. This would include but not limited to DOB notification and approval of repair along with EOR and Favco Certification letters.
- **Favco Model 760 (M760 D/E, M760 ST**) **A-frame lug welds and Split deck lug welds**. Owner to confirm Favco Engineering Bulletin FFCA-EB-036, Revision C, *Deck Structural Enhancements*, dated April 26, 2018, has been performed. This would include but not limited to DOB Notification and approval of repair along with EOR and Favco certification letters.
- **Favco Model 440 (M440 D/E) Slew mount welds**, **A-frame lug welds, and Split deck lug welds.** Owner to confirm Favco Engineering Bulletin FFCA-EB-034, Revision C, *Deck and Slew Mount Structural Enhancements*, dated April 26, 2018, has been performed. This would include but not limited to DOB Notification and approval of repair along with EOR and Favco certification letters.
- **Favco: All Diesel Crane Models fire protection Service Bulletin FFCA-EB_030- RevA**

All long-term recommendations in the above Favco Bulletin are **required** enhancements for use in NYC. This includes but not limited to Fire rated Hydraulic hose's, steel suction lines with approved check valves. Fire detection and automatic fire suppression system, Battey box relocation and electrical connection protection. Luffing rope fire wall, etc. Owner to provide A separate 3rd party report to verify all bulletin items have been addressed and submitted with the full 3rd party report.

NEW YORK CRANE

37-30 Review Ave
Long Island City, NY 11101
(718) 254-9500

STANDARD LONG TERM EQUIPMENT RENTAL AGREEMENT (CT, DE, IL, NY)

This Lease Agreement is made and entered into on the 1st day of February 2023.

BETWEEN: New York Crane & Equipment,
37-30 Review Ave., Long Island City, NY 11101
(Hereinafter called "the Lessor")

AND: Cross Country Construction
3 West Main Street. Elmsford, NY 10523
(Hereinafter called "the Lessee")

Attention: Tom Costigan Phone: (914) 909-6700

WITNESS that consideration of the mutual covenants and agreements hereinafter contained, the parties hereto agree as follows:

1. The Lessor hereby leases to the Lessee the equipment hereinafter described under the heading "Details Of Equipment" (hereinafter called the "Equipment") commencing on the 4th day of February 2023 (hereinafter called the "Commencement Date") on the terms and conditions (including the General Conditions and the Special Conditions attached hereto) set forth in this Agreement for use by the Lessee at or near
550 10th Ave, New York, NY 10018
The Lessee shall not move the Equipment from the above noted location without prior written consent of the Lessor.

2. The parties agree as follows: Lessee hereby leases from Lessor, at the rates hereinafter stated, the following personal property together with the accessories used in connection therewith ("equipment") at the agreed valuations and at the rental rates stated on the equipment list which is attached hereto and which the parties expressly agree to incorporate herein by this reference.

Details of Equipment

Description	Lessor's Identification # or Manufacturer's Serial #	Replacement Value Of New Equipment	Minimum Rental Period	Rental Rate Per Weekly / Monthly (A)
Favco M440-D Tower Crane with 180' boom.	**Unit# T440-13** **Serial# 1475**	**$4,922,000.00**	**Six (6) Months**	**$63,000.00/160/hr. month. (Bare Rental) Plus, tax.**

Freight of crane parts needed for erection:

Saturday Delivery & Pick Up of Freight: $45,000.00 Plus Tolls and Permits, each way.
Sunday Delivery & Pick Up of Freight: $50,000.00 Plus Tolls and Permits, each way.

See attachments "Exhibit A" Equipment List and "Exhibit B", Responsibilities

TERMS AND CONDITIONS OF CONTRACT (CT, DE, IL NY)

1. **INDEMNIFICATION – To the fullest extent permitted by law, Lessee agrees to indemnify and save Lessor, its employees and agents harmless from claims for death or injury to persons, including Lessor's employees, of loss, damage or injury to property, including the Equipment, arising in any manner out of Lessee's operation. Lessee's duty to indemnify hereunder shall include costs or expenses arising out of claims specified herein, including all court and/or arbitration costs, filing fees, attorneys' fees and costs of settlement. Lessee shall not be required to indemnify Lessor for Lessor's own negligence, but it is hereby agreed that Lessor's liability for damage caused by Lessor's negligence shall be limited to the amount of Lessor's liability insurance. The indemnification obligation under the above paragraph shall not be limited in any way by any limitation on the amount or type of damage, compensation, or benefits payable by or for the Lessee under worker's compensation acts, disability benefit acts, or other employee benefit acts. The Lessee's obligations hereunder shall further not be limited by the amount of its liability insurance, and the providing of such insurance for Lessor shall not operate to waive any of the above obligations.**

This provision is separate and distinct from any other provision or paragraph in this contract, including any provision or paragraph concerning indemnification and providing of insurance.

If this paragraph is declared invalid, then all other paragraphs of this contract shall stand.

2. **INSURANCE** – The Lessee agrees to provide the following insurance coverages and to furnish to Lessor certificates of such insurance within ten (10) days from the date of Lessee's execution of this agreement and before taking delivery of the Equipment. These certificates should certify that the Lessee is protected on the work with:

A. Worker's compensation and employer's liability insurance, with limits at least the statutory minimum or $1,000,000, whichever is greater;

B. Primary non-contributory commercial general liability insurance on an occurrence basis, including bodily injury and property damage coverage with minimum limits of $1,000,000 per occurrence and $2,000,000, in the aggregate;

C. Excess/umbrella non-contributory insurance in the amount of at least $5,000,000; Lessee's policy must be endorsed so that it is primary to all of Lessor's insurance policies.

D. Inland marine/all-risk physical damage insurance to cover the full insurance value of the Equipment, including any boom or jib, for its loss or damage from any and all causes, including but not limited to, overloading, misuse, fire, theft, flood, explosion, overturn, accident, and acts of God occurring during the rental term AND Rental Insurance for a period of twelve (12) months. The valuation of the Equipment is listed under the heading of "Details of Equipment", and the parties agree that this is the actual value of the Equipment for the purposes of fixing the Equipment's insurable value;

E. All policies are to be written by insurance companies acceptable to the Lessor;

F. The Lessor is to be included as an additional insured on all liability insurance policies, including umbrella/excess (ISO Form CG 20 10 10 01, ISO CG 20 37 10 01, CG 20 28 07 04, and CG 20 34 03 97 must be used); Lessee shall name Lessor as loss payee on all insurance policies. Also, the Lessor is to be named as an additional insured on all liability insurance certificates. Lessee shall provide all such liability insurance certificates to Lessor;

G. All policies shall be endorsed to require the insurer to give thirty (30) days advanced notice to Lessor prior to cancellation.

In the event of loss, proceeds of property damage insurance on the Equipment shall be made payable to Lessor. Lessee's agreements to indemnify and hold harmless from any liability, damage and loss are in addition to, and not an alternative to, these insurance provisions and the providing of any of the above coverages shall not operate to waive any of the above indemnity provisions.

To the extent that the Lessee may perform under this lease without obtaining the above coverages, such an occurrence shall not operate, in any way, as a waiver of the Lessor's right to maintain any breach of contract action against Lessee.

3. **OPERATION OF EQUIPMENT** –Lessee agrees to employ only competent, experienced and reliable personnel to operate maintain and assemble/disassemble the Equipment. If Lessor exercises the above mentioned option and makes available to Lessee a pool of personnel from which the Lessee selects personnel to operate or assist in the operation of the leased Equipment Lessee agrees to indemnify Lessor against and save it harmless from all liability for wages, taxes, insurance contributions, other such payments, benefits under any worker's compensation or similar law and employer's liability charges or other similar expense respecting Lessee's employment of such personnel. Lessee agrees that the Equipment and all personnel operating such Equipment, including Lessor's employees, are under Lessee's exclusive jurisdiction, supervision and control.

Lessee agrees to provide or otherwise select competent and experienced personnel to direct the operation of the Equipment, in accordance with OSHA 29 CFR 1926.1428 signal person qualifications and Lessee further agrees that the standard of care and

responsibilities will be in accordance with all American National Standards Institute (ANSI) specifications and that ASME B30.5-2014 (and as amended) shall be used when operating the Equipment, specifically Chapter 5-3 Operation, as well as the OSHA 29 CFR Subpart CC Cranes and Derricks in Construction sections 1926.1400 – 1926.1442.

Lessee further agrees to use said Equipment in accordance with the manufacturer's instructions and agrees not to exceed the manufacturer's rated load capacities for such or similar Equipment. Lessee expressly agrees that counter-weight in excess of the manufacturer's specification shall not be used.

4. RIGHT TO CONTROL – It is expressly agreed by and between the parties hereto that the Equipment and all persons operating the Equipment are under the exclusive jurisdiction, supervision and control of Lessee under this lease. It shall be the duty of Lessee to give specific instructions and directions to all persons operating, maintaining, and assembling/disassembling the leased Equipment. Lessee specifically agrees that the Lessor has absolutely no control over any person operating or assisting in operating the leased Equipment. Lessor may, at its option, provide a pool of personnel from which the Lessee may select or reject personnel for its own use in the operation of, or assisting in the operation of, the leased Equipment.

Lessee agrees that if Lessee allows any person from this pool of personnel, or any other person, to operate or assist in operation of the leased Equipment, that these persons have been selected and approved by the Lessee and are under the Lessee's exclusive direction and control and are the Lessee's agents, servants and employees, and the Lessee waives the right to make any claim to the contrary. If the Lessee selects a person to operate or assist in the operation of the leased Equipment from the pool of personnel which the Lessor may provide at its option, the lease payments made by the Lessee shall include that person's wages, even though that person's wages may be disbursed by the Lessor. This lease is upon the agreement of the parties that the Lessor has no right to replace or substitute personnel except at the direction of and with the approval of Lessee and that the Lessee shall have the right to control, including the right of termination, and shall be deemed to have exercised that right as to all details or operation of the leased Equipment and personnel the Lessee selects to operate the Equipment.

5. WAIVER OF SUBROGATION/LIEN -- Lessee hereby agrees to waive any and all right of subrogation and any and all lien rights which may accrue to it or its insurers. This shall include, but not be limited to, rights of subrogation and lien rights arising from workers compensation/employer's liability policies or other employee benefit programs or acts, commercial general liability policies, or any other loss incurred by the Lessee, or any other party, as a result of bodily injury or property damage. The Lessee understands that this waiver shall bind its insurers of all levels, and agrees to put these insurers on notice of this waiver and to have any necessary endorsements added to the insurance policies applicable to this lease. The Lessee further agrees that to the extent any insurer fails to recognize and honor this waiver and attempts to subrogate against the Lessor or enforce any lien rights against the Lessor, the Lessee shall be liable to the Lessor for all such sums as the Lessor may be required to pay or otherwise suffer loss of as a result of such subrogation or enforcement of lien rights.

6. GROUND CONDITIONS -- The Lessee hereby agrees that it will assume all responsibility for the ground or soil conditions in the area where the crane is to be stored, parked or operated. The Lessee shall perform or have performed all necessary inspections or testing to determine the nature of the ground or soil and its ability to support the crane while in operation or otherwise. If the ground or soil condition is such that it cannot support the crane, the Lessee shall take all necessary measures to ensure that these conditions are remedied prior to the crane being placed on that ground or soil. These measures include, but are not limited to, the provision of proper shoring or cribbing or other measures.

7. POWER LINES --Lessee assumes all responsibility to protect the Equipment and persons in or around the Equipment from the danger of power lines. Lessee shall not expose the Equipment or any persons in or around such Equipment to the danger of energized power lines. All power lines in the work area shall be identified prior to the work beginning. All power lines are to be de-energized prior to the Equipment being operated in or around such power lines. Lessee shall contact the local electric utility or other such authorized entity to arrange to have the power lines de-energized prior to beginning work. Even if power lines are de-energized, Lessee shall keep the Equipment clear of such power lines at the distance required by OSHA, ANSI and any other safety regulations or standards. If it is not possible to de-energize power lines, then the Lessee shall be responsible for the insulating of any power lines, the grounding of all Equipment and will be required to use rigging or other Equipment designed to prevent electrocution. Further, the Lessee shall keep the Equipment clear of such energized power lines at the distance required by OSHA, ANSI any other safety regulations or standards.

8. RIGGING—Lessee is required to provide any and all rigging to be used with the Equipment. If chokers, slings, straps, chains, hooks, spreaders, fittings, rope or wire, etcetera; are loaned to the Lessee by the Lessor for the Lessee's convenience, and solely at the Lessee's responsibility. Lessee assumes responsibility for any defects in any rigging, whether the property of Lessee or otherwise. Lessee assumes the responsibility for damage to any load on hook due to a failure of the rigging. **Lessee assumes the responsibility for the method of rigging and agrees that all persons involved in the rigging process are qualified according to OSHA's definition 1926.1401 and are under Lessee's direct supervision and control.**

9. ACCIDENT INVESTIGATION – As part of Lessee's obligations hereunder, Lessee shall bear the cost of any investigation initiated by the Lessor, Lessor's insurance carriers or Lessor's third party adjusters (designated below as Lessor "representatives") into

any accident of any kind, when such accident occurs during the term of this lease, and involving directly or indirectly the leased Equipment, whether or not such accident involves personal injury or death or damage to the leased Equipment or other property or any or all of the above. The decision to initiate any such investigation and the scope of any such investigation shall be at the sole discretion of the Lessor or the Lessor's representatives. The cost of any such investigation to be paid by the Lessee, shall include but not be limited to, attorneys' fees for site inspections, contract and document review and interview with witnesses of any kind, including costs of travel, fees of private investigators for site inspections, any fees or costs associated with obtaining and reproducing related contracts and documents and interviews of witnesses of any kind, including adjustors' fees, costs for photography, experts' fees, including costs of site inspections and destructive and/or non-destructive testing, as needed, and costs of dismantling, storing and maintaining property, Equipment or other items as evidence. These costs shall be invoiced to the Lessee along with rental fees and other costs incurred under this agreement and shall be payable according to the terms of this agreement.

10. NO RELIANCE ON LOAD MEASURING DEVICE -- If any crane has been fitted with a load measuring device, the Lessee hereby acknowledges and agrees that the Lessor has made no warranties or representations whatsoever with respect to the ability of the said load measuring device to accurately or consistently measure the weight of loads being lifted by such crane. The Lessee further acknowledges and agrees that it is the responsibility of the Lessee to independently determine the weight of every load to be lifted by any crane comprising all or any portion of the Equipment, so as to ensure that any such load measuring device shall be used as an operator-aide only. As well, the Lessee acknowledges and agrees that if he relies in any way whatsoever on any load measuring device that he does so completely at his own risk.

11. THE RENTAL PERIOD – The Rental Period shall commence on the date set forth above and shall include the date upon which the Equipment is picked up by the Lessee or the Lessee's agent (including any public carrier). Notwithstanding anything to the contrary contained herein, the Rental Period and the term of this Lease shall end upon and include the earlier of the following dates:

a. The date of the actual delivery of the Equipment by the Lessee to the Lessor at such location as may be designated in writing by the Lessor; or
b. The date immediately preceding the one-year anniversary of the commencement date of the Rental Period (the "Anniversary Date").

If, for any reason, the Lessee retains possession of the Equipment beyond the Anniversary Date, such continued possession on the part of the Lessee shall be deemed to be without the consent of the Lessor, and the Lessee shall pay to the Lessor, by way of liquidated damages, an amount equal to the Rental payable in respect of the Equipment pursuant to paragraph 12 "Calculation of Rental Charges" hereof for the period during which the Lessee retains possession of the Equipment beyond the Anniversary Date and, notwithstanding that the Lessor may, in its discretion, provide cartage for the return of the Equipment, the Lessee shall be deemed to be in possession of the Equipment without the Lessor's consent until the Equipment has been returned to its point or origin or such other location as may be designated in writing by the Lessor.

12. CALCULATION OF RENTAL CHARGES -- The Lessee shall pay Rental for the entire Rental Period on each article listed under Details of Equipment at the rate herein stipulated and on the following basis:

a. The Rental Rate expressed in the "Details of Equipment" is the rental for a month period, running from the day of commencement up to but not including the same day in the fourth week following.
b. The Rental Rate stipulated under Details of Equipment shall apply only when the Equipment is operated for no more than 160 hours in a month. In the event that the Equipment is operated in excess of 160 hours in a month, the Lessee agrees to pay for any such excess operation in accordance with the following formula:

Hours of operation in excess of 160 hours per month ÷ 160 hours x Rental rate

The Lessee further covenants and agrees to open for inspection by the Lessor, any and all payroll records and hour meters for the purpose of verifying the actual hours worked.
c. After expiration of the minimum rental period, the rental payment for any succeeding period shall be the proportionate part of the monthly rate according to the number of calendar days in such period based on a twenty-eight (28) day month.
d. Rentals shall not be subject to any set-off or deduction for any reason whatsoever and, without limiting the generality of the foregoing, by reason of non-working time howsoever caused during the Rental Period or any extension thereof, nor shall the Lessee be relieved from his responsibility to pay rent for the entire Rental Period by reason of the fact that the Equipment is returned prior to the expiration of the minimum rental period.
e. Rental at the Rental Rate shall be paid by the Lessee to the Lessor until the Equipment is returned to the Lessor in good operating condition, reasonable wear and tear expected. If repairs are found to be required by the Lessor, the Lessee shall continue to pay Rental at the Rental Rate until the Equipment is returned to good operating condition ad determined by the Lessor.
f. The Lessor shall pay any and all applicable taxes related in any way whatsoever to rent payable by the Lessee to the Lessor under this lease, including sales tax and Special Mobile Machinery (SMM) tax of 2% of rental rate (if applicable).

13. **PAYMENT** – The rentals due under this Lease shall be paid monthly in advance at the office of the Lessor. All overdue payments shall bear interest at the rate of 2% per month (26.8% per annum) without prejudice to the Lessor's right as hereinafter stipulated to terminate this Lease for non-payment Rental.

All rentals are billed in advance and are due in thirty (30) days. Overdue rental payments shall bear interest at 2% per month, without prejudice to Lessor's right as hereinafter stipulated to terminate lease for non-payment. Lessor may, upon reasonable notice, require Lessee to pay rentals in advance.

14. **TRANSPORTATION** – Lessee agrees to pay all transportation costs, including but not limited to, loading and unloading costs, and agrees to be responsible for any damage or loss to the Equipment while it is in transit. Lessee shall furnish timely instructions for shipment, and absent such instructions, Lessor may ship to railhead or such other shipping point which Lessor reasonably believes to be the most convenient and/or closest to the place of use specified herein. Lessor shall furnish shipping instructions for the return of the Equipment upon Lessee's written request. The Lessor shall furnish insurance as required by paragraph 2 while Equipment is transported to and from Lessor to Lessee.

15. **REPAIRS AND OPERATION COSTS** -- Lessee agrees to inspect the Equipment upon taking delivery. Lessee's failure to notify Lessor in writing of any deficiencies in the Equipment within 24 hours after taking delivery, or such other period of time as may be mutually agreed upon in writing, is Lessee's acknowledgment that the Equipment was, when delivered, in good, safe and serviceable condition and fit for its intended use. Lessee shall maintain the Equipment in good, safe operating condition and shall bear all costs of whatever nature incurred in doing so. Without first obtaining Lessor's written consent, Lessee shall not incur any liability or expend any money for Lessor's account. The title to all parts, materials and supplies furnished to the Equipment become the property of the holder of the title to the Equipment.

All accessories or attachments not listed herein or necessarily included as part of the Equipment shall be furnished by Lessee at its own expense.

16. **DAMAGE TO EQUIPMENT** – All risks of loss or damage to the Equipment, accidental or otherwise shall be borne by Lessee. The appraisal of any such loss or damage shall be based upon the replacement value of new Equipment as stated under the heading "Details of Equipment". In making such adjustment it is understood that no rentals, paid or due, shall apply to the payment of such loss. The rental period shall continue while all repairs to the Equipment are completed. Lessee shall and does hereby indemnify and hold Lessor harmless from any liability of any kind arising out of possession, maintenance, use, operation, assemble/disassemble, and/or failure of the leased Equipment, whether defective or not. If the Equipment is damaged or made inoperable in any way other than as a result of normal operating wear, the Lessee shall notify Lessor in writing within 48 hours of its occurrence, specifying the extent and nature of the damage. Repairs to structural or load carrying portions of the Equipment, including but not limited to boom sections, are not to be undertaken without first obtaining Lessor's written consent.

17. **TITLE** – Lessor retains title to the Equipment. Lessee agrees to keep the Equipment free from all liens or other encumbrances. Lessee agrees to notify Lessor immediately if any lien or any attachment or other claim is filed against the Equipment. Lessee agrees to protect Lessor's interest in the Equipment at all times during the term.

18. **INTERPRETATION/DURATION OF CONTRACT** -- This agreement shall be interpreted and enforced according to the laws of the State of New York. This agreement shall be interpreted fairly and reasonably and neither more strongly for nor against either party. This contract shall be in effect for the duration of one year unless expressly terminated in writing by Lessor. All notices required may be served personally or sent by certified mail, return receipt requested, with postage prepaid, to the address of the other party herein unless a different address is designated hereafter in writing. Should any provision of this lease be invalidated in whole or in part by any competent authority, such provision shall continue in effect only to the extent permitted; however, the remaining provisions shall remain in full force and effect.

19. **NO WARRANTIES** -- The Equipment is leased as is; Lessor makes no representations or warranty of any kind that the Equipment is or shall be fit or suitable for any specific purpose or purposes of Lessee. This document is a complete and exclusive statement of all the terms of this lease and includes all the representations of the parties. Lessor makes no other express or implied warranties respecting the Equipment nor shall this contract be varied, supplemented, qualified, or interpreted by any prior course of dealing between the parties or by any usage of trade. It is understood by the parties that Lessor is not the manufacturer of the Equipment nor the manufacturer's agent for any purpose. Lessee warrants that it is duly authorized do business in the jurisdiction where the Equipment is to be used and that the person signing this agreement has the authority to bind Lessee.

20. **FORM OF AGREEMENT/ATTORNEYS FEES AND COSTS** – This agreement, when duly executed by the parties, is the complete agreement of the parties. Lessee represents that it has not relied upon any previous representations by anyone as an inducement to enter into this lease. Lessor may withhold delivery of the Equipment until this agreement has been properly executed by all parties; however, acceptance of delivery of the Equipment and its use by Lessee shall constitute its acceptance of this general condition.

Any attempt by Lessee to assign, sublet or otherwise transfer this lease or any interest herein in the absence of Lessor's written consent, shall be void. Lessee shall not, in the absence of Lessor's prior written consent, remove the Equipment from its place of

designated use, nor shall Lessee relinquish possession, custody or control of the Equipment to anyone other than those designated by Lessor in writing. If Lessor assigns this lease, such assignment shall be free of all claims or offsets in favor of Lessee. Upon assignment, the term "Lessor" shall include and refer to Lessor's assignee.

If Lessor institutes any proceeding to enforce this lease or any provision thereof, it shall be entitled to recover all court costs, including but not limited to, reasonable attorney's fees regardless of whether or not such action is prosecuted to final judgment.

Paragraph headings are not a part of this lease and shall have no effect upon its construction or interpretation.

21. TIME OF ESSENCE – WAIVER -- Time is of the essence of this lease and all of its provisions. Lessor's failure to require strict performance by Lessee of any of the lease provisions, or Lessor's acceptance of late or partial performance hereunder, shall not constitute a waiver of any prior defaults of Lessee, nor of Lessor's rights thereafter to demand strict compliance therewith, or with any other provision hereof. The parties agree that Lessor's rights under this lease are cumulative and shall be in addition to all other remedies in its favor existing at law or in equity. Successors and assigns -- this lease shall be binding upon and shall inure to the benefit of the parties and their respective heirs, successors, administrators, executors, trustees and assigns.

22. RETURN OF EQUIPMENT – Lessee agrees to return the Equipment to Lessor at the point of origin unencumbered and in the same condition as when received by Lessee, excepting reasonable wear and tear resulting from normal proper use. The cost of any repair necessary to restore the Equipment to said condition shall be paid by Lessee. Any time beyond the minimum term required to make such repairs shall extend the term to include such reasonable additional repair time as is necessary under the circumstances. Lessor may require Lessee to ship the Equipment to a point other than the point of origin; however, Lessee shall not be required to pay any additional costs incurred thereby unless such is mutually agreed upon.

23. USE OF EQUIPMENT – In the absence of Lessor's written permission to do otherwise, Lessee shall use the Equipment only in the conduct of its business and at the places of anticipated use as specified above. At no time shall the Equipment be subjected to improper, careless or needlessly rough use or to any usage in violation of any statute, ordinance, rule regulation or order of any governmental or other entity having jurisdiction over the place of use. Lessee agrees: (a) to use the Equipment in accordance with the manufacturer's instructions and within the rated load capacity for such or similar Equipment; (b) that counterweight in excess of the manufacturer's specifications shall not be used; (c) that the Equipment shall be protected from all hazard.

Lessee agrees not to alter or modify the Equipment nor to remove or otherwise alter any numbering, lettering or insignia placed upon the Equipment without first obtaining Lessor's written consent. Lessee shall maintain accurate lubrication records, repair records for the Equipment and records of actual hours and dates of operation in the form prescribed by Lessor, which the parties expressly agree shall be incorporated herein by this reference. Lessee shall keep Lessor informed of the location and condition of the Equipment at all times and Lessor shall be given access to the Equipment at all reasonable times for the purpose of inspection.

24. TAXES -- Lessor agrees to pay all property taxes or other similar charges incurred by reason of the Equipment being located at Lessor's yard or other permanent situs under Lessor's control if established prior to execution of this lease ("permanent situs"). Lessee agrees to pay as additional rental hereunder, or shall reimburse Lessor if Lessor is required to pay any other taxes, penalties and fines or other charges of any governmental entity other than that having jurisdiction over the permanent situs, or which may be assessed or levied against the Equipment during the lease term by reason of execution of this agreement, the transaction represented hereby, or arising from the ownership, operation or possession of the Equipment.

Unless otherwise provided herein, if there are several Lessors of the Equipment during any one taxation period in a jurisdiction other than that of the permanent situs, Lessee need only pay its pro rata share. Such share shall be computed, among other things, with reference to the minimum term, all extensions of the term and with reference to the period for which the charge is made and the length of time the Equipment is in the jurisdiction. Lessor may, at its sole option, bear the pro rata cost of any such payments. The parties agree to make all necessary adjustments at the termination of this lease.

25. DEFAULT – REPOSSESSION -- Lessor may enter any premises where the Equipment is located without notice and may repossess all or any part of it if (a) Lessee fails to make prompt payments when due; and/or (b) if Lessee breaches any other provision of this lease; and/or (c) if Lessee becomes insolvent, or makes an assignment for the benefit of creditors, or becomes subject to any proceeding in the nature of bankruptcy; and/or (d) if Lessor shall deem it necessary to protect its rights in the Equipment against loss or damage; and/or (e) upon termination of this lease for any reason. The rights specified by this paragraph are in addition to all other rights of Lessor. If Lessor repossesses the Equipment, Lessee expressly waives all further rights to possession and all claims for damages howsoever arising from repossession.

26. AMENDMENTS – Neither party shall be bound by any agreement, warranty or representation, express or implied, unless contained herein or a duly executed amendment thereto. No representative, agent or employee of Lessor has the authority to amend, modify or waive any of these terms and conditions. No modification or amendment hereof shall be binding on Lessor unless it is in writing and signed by Lessor.

27. STORAGE OF EQUIPMENT – Lessor shall not be liable for any loss or injury to Lessee's property stored in Lessor's yard, and it is further understood and agreed to that Lessee's property/Equipment stored is not insured by Lessor against loss or injury, however

caused. Lessee is responsible for maintaining insurance coverage on a first party basis to cover the goods/Equipment/machinery stored with Lessor.

28. AUTHORIZED SIGNATURE - In the event this agreement has been executed by an individual on behalf of a corporation or other business entity, the person whose signature is affixed hereto and the company for which the individual has signed this agreement represent to Lessor that the individual signing has full authority to execute this agreement on behalf of said corporation or other business entity.

(CORPORATE SEAL)

LESSOR: New York Crane EQ

BY: [signature]

TITLE: Fuel Mgr

ADDRESS: 37-30 Review Ave

LIC NY 11101

(CORPORATE SEAL)

LESSEE: Cross Country Construction

BY: [signature]

TITLE: Operations

ADDRESS: 5 W. Main St., Suite 103

Elmsford, NY 10523

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EXHIBIT "A"
EQUIPMENT LIST

EQUIPMENT	SERIAL NUMBER	VALUATION	RENTAL RATE
Favco M440-D Tower Crane with 180' boom.	1475	$2,500,000.00	$63,00.00/160/hr. month. (Bare Rental) Plus, tax.
36 Towers @ $50,000.00/ea.		$1,800,000.00	
1 Climbing Frame @ $300,000.00		$300,000.00	
5 Tower Collars @ $50,000.00/ea.		$250,000.00	
36 sets of Tower bolts, nuts and washers.		$72,000.00	
Additional trucking, if needed, at time plus material.			
Loading and unloading fee @ $250.00 each, per trailer.			
Technician to assist in assembly of crane - at rate of $205.00/hr. on regular time and $395.00/hr. on overtime portal to portal.			
Service truck fee at $175.00/per day, plus tolls.			
		Total Value: $4,922,000.00	$63,000.00/160/hr. month. (Bare Rental) Plus, tax.

PLUS, APPLICABLE TAXES: Rate of NYS Tax is 8.875%

** *The rate for mechanic supplied by the New York Crane and Equipment Corporation will be billed at $205.00 per hour regular time, $395.00 per hour for over time and double time for Sundays. plus $1.50 per mile portal to portal from Brooklyn, NY or Newark, NJ plus tolls. Plus $175.00 per day, for service truck fee.*

** *On site Local 282 trucking at $195.00 per hour regular time and $265.00 overtime. Sunday rate $360.00 per hour portal to portal. Plus tolls and permits.*

** *SUBJECT TO PAY UNION INCREASES.*

"NEW YORK"
EXHIBIT "B"

You are responsible for the following:

1. All On-Site Permits for crane usage, (such as D.O.B., D.O.T.)

2. Third Party Certification of crane, to be determined by you and paid by you, directly.

3. Any assist crane needed for erection or dismantling, to be acquired from N.Y. Crane. (Rental and trucking of assist crane will be billed separately).

4. New York Crane technician to assist in on-site computer calibration for Department of Buildings Load Test, to be billed additional to rental rate of crane. ($205/hr. on regular & $395/hr. on overtime)

5. All maintenance and lubrication on crane after delivery, such as Department of Buildings requirements and the manufacturers 250-hour service, is to be performed by New York Crane and billed to customer.

6. All wire ropes are to be supplied by New York Crane and if damaged by customer, to be billed to customer.

7. Collar ties, are to be back charged to Lessee, if damaged.

8. Starter Legs--$32,000.00- to Purchase + Tolls + Permits + Trucking to job site. (Oversized load requires permit.).

9. Crane mats/Steel plates if needed.

10. D.P.F. Filters are not included in any rental.

11. Any overtime on trucking delivery over eight (8) hours.

12. Cleaning of concrete off machine.

We will accept no back charges whatsoever.

** In order to secure cranes, a signed contract is required, no verbal commitments are considered binding.

** All quotes are valid for 45 days from day sent and are based upon availability.

EXHIBIT "C"

2019 New York City Rental
Under D.O.B. Code & Rules

EFFECTIVE IMMEDIATELY 1/1/19

- No work will start without a signed rental contract.
- Rental charges will start when the third-party inspection starts.
- All third-party inspections are for customers accounts.
- We will bill any labor required for inspection.
- Any defect found by an inspector of your choice will be repaired at our expense. Under no circumstance will we pay any additional inspection fees.
- Once a crane is inspected in our yard and approved, all future repairs are for your account.
- Any and all NYC D.O.B. requests, changes or modifications are for your account.
- All cranes will be shipped with standard factory cable lengths, any change in lengths will be for your account.
- We are not responsible for any swivels or attachments below the becket.
- Any towers bolted together or unbolted are for your account at T&M.
- Any trailers loaded for you, and the delivery is canceled, you will be charged a fee of $50.00 per day, per trailer, until delivered.

VOL III EXHIBIT 8

From: Michael Khoo <mkhoo@favcousa.com>
Sent: Friday, July 1, 2016 8:44 AM
To: Jimmy Lomma (jflomma@jflommainc.com) <jflomma@jflommainc.com>; Joe M <jmitrione@pinnacle2.com>; Kelly, John (John.Kelly@related.com) <John.Kelly@related.com>; Eneix, James <eneixj@zhi.com>; 'Grande, Ralph J' <rjgrande@bechtel.com>; 'robert.koch@skanska.com' <robert.koch@skanska.com>; Tom Auringer <tom@uscraneriggingllc.com>
Subject: Engineering bulletin

Dear Favco crane owners,

This is an update of the Engineering Bulletin first issued to you back in April 29, 2016 in regards to the fire on a Favco crane in Sydney in 2012. The bulletin is self-explanatory.

Should you have any questions regarding this bulletin, please contact the undersigned.

Regards,

Michael Khoo
Favelle Favco Cranes (USA) Inc
26360 FM 106 Harlingen
TX 78550 USA
Office: 956-428-7488
Cell: 956-495-8488

Hydraulic Oil Testing Protocol
New York City Crane Incident
Favco 440
Date of Accident – July 26, 2023

There were limited places CTS could draw hydraulic oil samples due to the extent of the fire. The oil was fuel for the fire, and therefore most of the oil burned in the fire. CTS obtain five oil samples on September 25, 2023, from three (3) locations. CTS retrieved two (2) samples from the climbing system at the turntable, two (2) samples from the slewing motor located in the turntable, and one from a hose on the outside of the power assembly as far from the fire as possible.

All oil samples are to be sent to Analytical Testing Services, Inc., or other reputable laboratory to perform the tests noted below.

EVALUATION

A. The samples will be sent to an analytical lab via Federal Express (address below).
B. Standard test for flash and fire points, ASTM D92 will attempt to determine the flash point of the sample provided.
C. Standard test for Auto Ignition, ASTM E659 will attempt to confirm the hot surface will ignite the hydraulic oil.
D. The laboratory will test for the viscosity of the oil using the ASTM D445 - 11a Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity).
E. To assess water content, the ASTM E1064-05 - Standard Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration will be used.
F. The laboratory will use the ASTM D5185 - 09 Standard Test Method for Determination of Additive Elements, Wear Metals, and Contaminants in Used Lubricating Oils and Determination of Selected Elements in Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) testing standard.
G. Assuming there is enough remaining fluid, the lab will perform the particle contamination test using the ISO 4406:1999 - Hydraulic fluid power -- Fluids -- Method for coding the level of contamination by solid particles standard.
H. The above tests will consume most if not all the samples so none will be returned to DOB.
I. The lab will video various aspects of the tests.
J. The above steps will result in a detailed report issued by the laboratory.

Analytical Testing Services, Inc.
190 Howard Street, Suite 404
Franklin, PA 16323-0061

814 432 7214

PYTHON®
HIGH PERFORMANCE WIRE ROPE

WDI WIRE ROPE

WESTFÄLISCHE DRAHTINDUSTRIE GMBH

INSPECTION CERTIFICATE (according to EN 10204 - 3.1): 22677133 / 1.0

Manufacturer declaration
We, Westfälische Drahtindustrie GmbH, hereby declare that the following machinery fulfills all of the relevant requirements of EC Machinery Directive 2006/42/EC. This declaration becomes invalid if the product is changed without the agreement of Westfälische Drahtindustrie or if the instructions for "use and maintenance" as stated in EN 12385-3 and/or if the instructions for "care, maintenance, installation, examination and discard" as per ISO 4309 is disregarded.

CE

Date: 23-Mar-2017

Customer:	Manufacturer:
A.S.C. Industries Ltd.	Westfälische Drahtindustrie GmbH
1406 W. 175th Street	Seilerstraße 1 b
USA IL 60429 East Hazel Crest	D - 08056 Zwickau
Customer no: 1314853	Order confirmation: 17713
Customer P/O: 109679 / Attn.PO107323	Bill of delivery: 22677133
	Production batch: 406623

ROPE DETAILS

Article:	123031
Brand name:	High Performance Rope PYTHON Solid 8 C
Construction:	8xK31WS-IWRC(K)
Nominal diameter:	32,00 mm (0,0%/+2,5%)
Surface finish:	bright
Tensile grade:	2160 N/mm²
Lay type and direction:	Right lang lay (zZ)
Minimum breaking strength Fmin:	943,00 kN
Lubrication:	D4, Nyrosten T55
Weight:	477,00 kg/100 m
Applicable standard:	Manufactured acc. to DIN EN 12385-1/2/4

Example of working load limit when coefficient of utilisation is 5: 188,60 kN

NOTES

Ends welded

TEST RESULTS

Actual diameter:	32,40 mm
Actual breaking load Fm:	1.034,00 kN

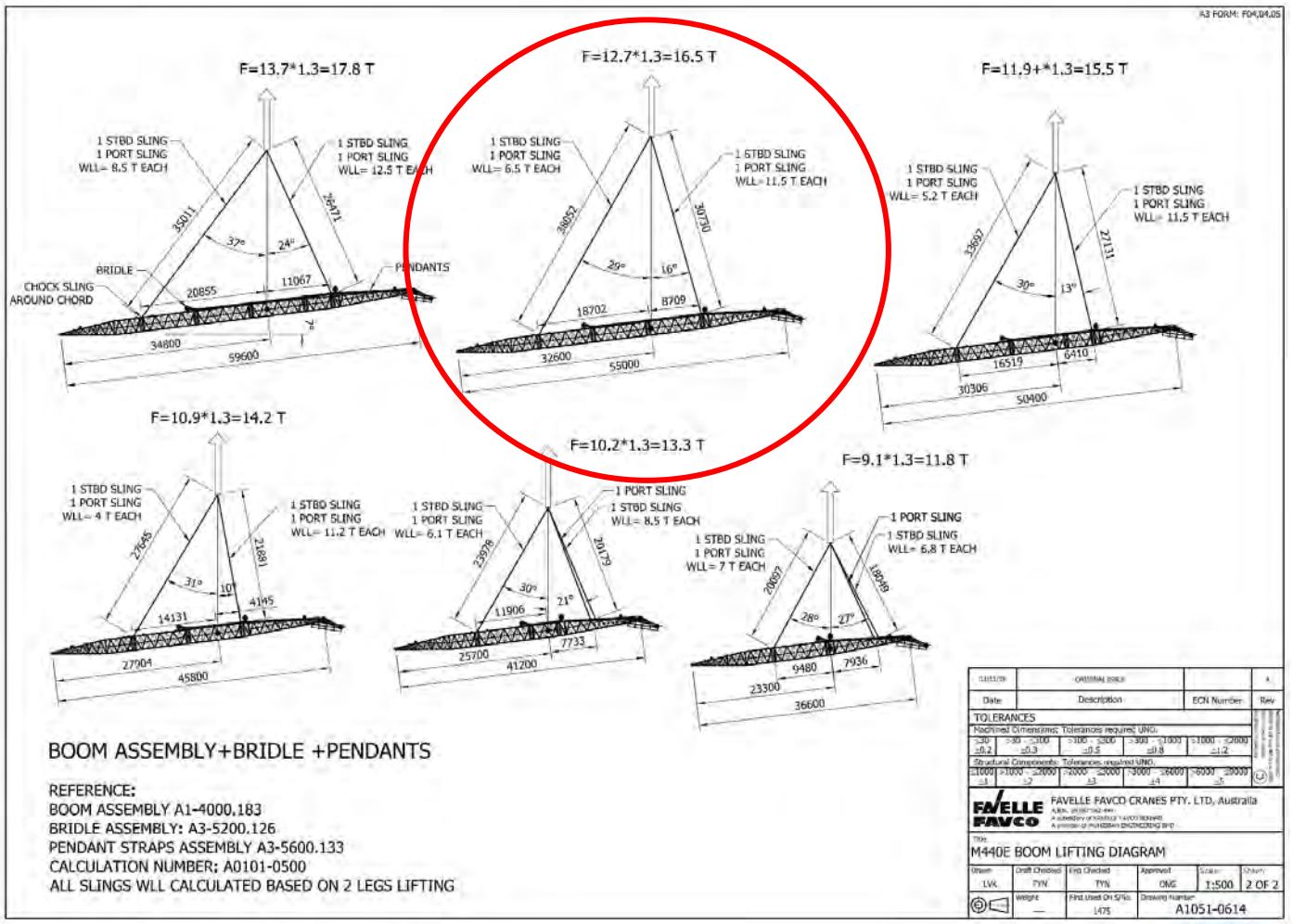
REEL DETAILS

Reel	Length (m)	Net weight (kg)	Gross weight (kg)
S-00406623-001	2.030,00	9683	9920

I certify that the product described herein complies with the terms of the order.

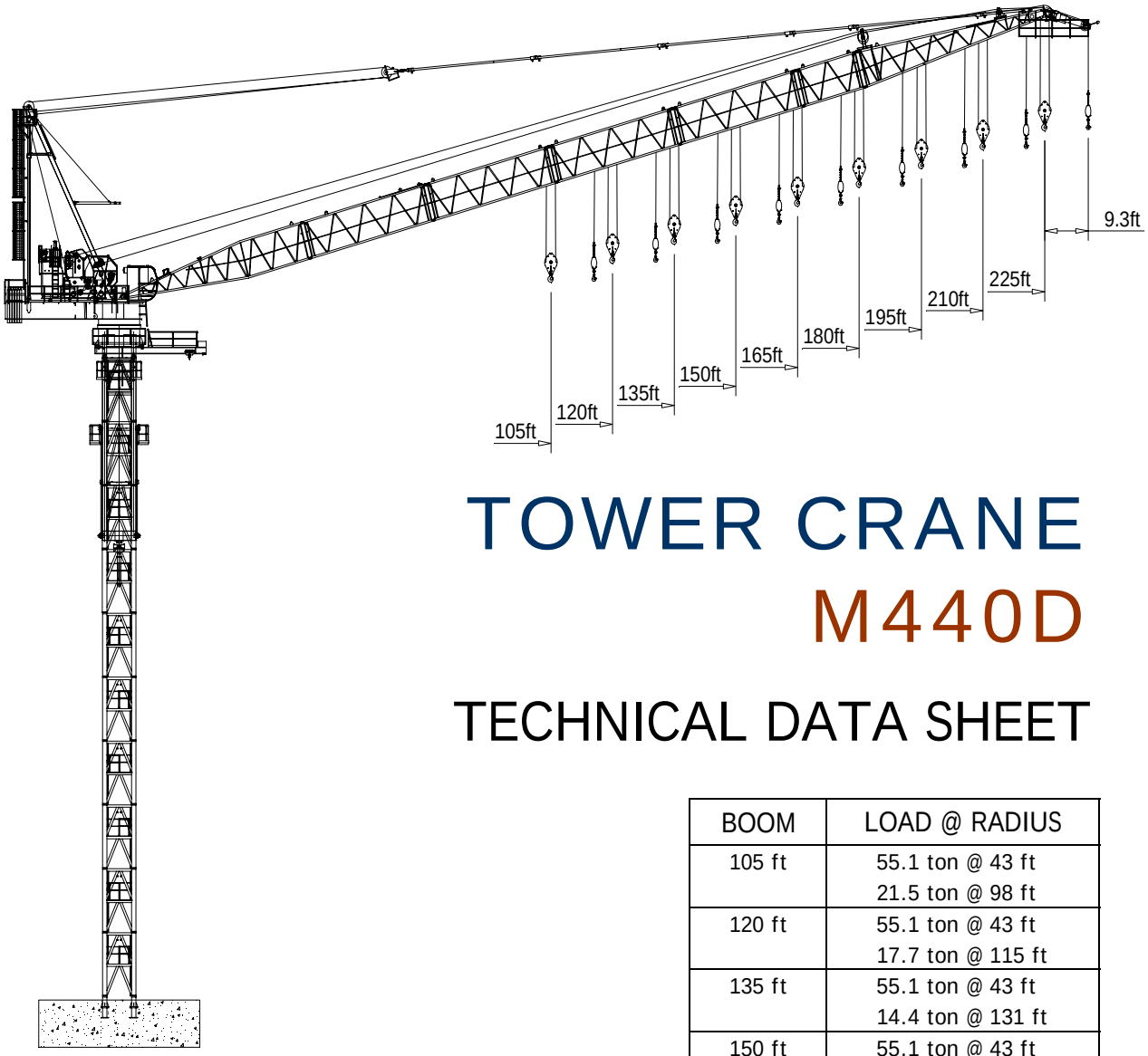
Matthias Schmidt
Quality Control

VOL. III EXHIBIT 11



FAV000736

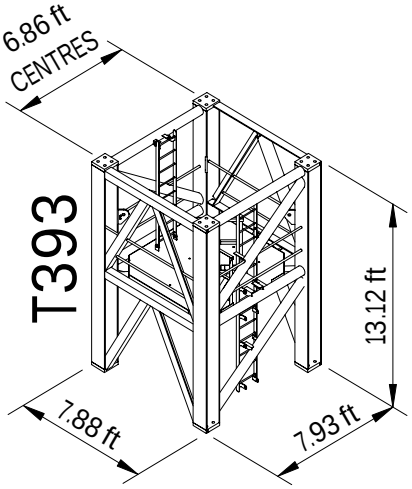
VOL. III EXHIBIT 12



TOWER CRANE
M440D

TECHNICAL DATA SHEET

BOOM	LOAD @ RADIUS
105 ft	55.1 ton @ 43 ft 21.5 ton @ 98 ft
120 ft	55.1 ton @ 43 ft 17.7 ton @ 115 ft
135 ft	55.1 ton @ 43 ft 14.4 ton @ 131 ft
150 ft	55.1 ton @ 43 ft 12.9 ton @ 139 ft
165 ft	55.1 ton @ 39 ft 10.5 ton @ 156 ft
180 ft	48.5 ton @ 46 ft 8.8 ton @ 172 ft
195 ft	35.3 ton @ 33 ft 7.3 ton @ 180 ft
210 ft	35.3 ton @ 28 ft 5.3 ton @ 197 ft
225 ft	27.6 ton @ 38.7 ft 3.0 ton @ 213 ft



FAVELLE FAVCO

www.favellefavco.com

M440D MAIN HOIST RADIUS AND CAPACITY

1-FALL										
Boom Length (feet)		225	210	195	180	165	150	135	120	105
Min Radius (feet)		20	17	16	14	14	13	12	11	10
SWL at Min Radius (ton)		27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
	20	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
	30	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
	40	27.2	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
	50	24.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
	60	22.6	26.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
	70	20.8	24.5	27.2	27.6	27.6	27.6	27.6	27.6	27.6
	80	19.3	22.5	24.5	26.1	26.3	26.9	27.2	27.4	27.6
	90	17.8	20.4	21.7	22.6	22.8	23.3	23.7	24.0	24.2
	100	16.3	18.3	18.9	19.6	19.8	20.3	20.6	21.0	-
	110	14.7	16.1	16.7	17.2	17.5	18.1	18.3	18.8	-
	120	13.1	14.2	14.8	15.2	15.6	16.1	16.3	-	-
	130	11.5	12.6	13.2	13.5	13.9	14.3	14.7	-	-
	140	10.1	11.2	11.8	12.1	12.5	-	-	-	-
	150	8.9	10.0	10.4	10.8	11.2	-	-	-	-
	160	8.0	8.9	9.3	9.8	-	-	-	-	-
	170	7.1	7.9	8.3	9.0	-	-	-	-	-
	180	6.1	7.0	-	-	-	-	-	-	-
	190	5.3	6.0	-	-	-	-	-	-	-
	200	4.4	-	-	-	-	-	-	-	-
	210	3.3	-	-	-	-	-	-	-	-
Max Radius (feet)		213	197	180	172	156	139	131	115	98
SWL at Max Radius (ton)		3.0	5.3	7.3	8.8	10.5	12.9	14.4	17.7	21.5

2-FALL										
Boom Length (feet)		225	210	195	180	165	150	135	120	105
Min Radius (feet)		20	17	16	14	14	13	12	11	10
SWL at Min Radius (ton)		27.6	35.3	35.3	48.5	55.1	55.1	55.1	55.1	55.1
	20	27.6	35.3	35.3	48.5	55.1	55.1	55.1	55.1	55.1
	30	27.6	34.7	35.3	48.5	55.1	55.1	55.1	55.1	55.1
	40	27.2	31.6	34.2	48.5	54.5	55.1	55.1	55.1	55.1
	50	24.6	28.8	32.6	44.6	45.7	46.0	46.5	47.1	47.3
	60	22.6	26.6	29.9	37.1	37.7	38.1	38.4	38.7	39.1
	70	20.8	24.5	27.2	30.8	31.2	31.6	31.8	31.9	32.4
	80	19.3	22.5	24.5	26.1	26.3	26.9	27.2	27.4	27.6
	90	17.8	20.4	21.7	22.6	22.8	23.3	23.7	24.0	24.2
	100	16.3	18.3	18.9	19.6	19.8	20.3	20.6	21.0	-
	110	14.7	16.1	16.7	17.2	17.5	18.1	18.3	18.8	-
	120	13.1	14.2	14.8	15.2	15.6	16.1	16.3	-	-
	130	11.5	12.6	13.2	13.5	13.9	14.3	14.7	-	-
	140	10.1	11.2	11.8	12.1	12.5	-	-	-	-
	150	8.9	10.0	10.4	10.8	11.2	-	-	-	-
	160	8.0	8.9	9.3	9.8	-	-	-	-	-
	170	7.1	7.9	8.3	9.0	-	-	-	-	-
	180	6.1	7.0	-	-	-	-	-	-	-
	190	5.3	6.0	-	-	-	-	-	-	-
	200	4.4	-	-	-	-	-	-	-	-
	210	3.3	-	-	-	-	-	-	-	-
Max Radius (feet)		213	197	180	172	156	139	131	115	98
SWL at Max Radius (ton)		3.0	5.3	7.3	8.8	10.5	12.9	14.4	17.7	21.5

Note: All charts are for information only and should not be used for lifting purposes. Favelle Favco reserves the right to make specification changes without prior notice.

Approx. Ambient Day Time Temperature		Below 0°C	0°- +20°C	+10°-+35°C
Hydraulic Oil : ISO Class		VG 32	VG 46	VG 68
Diesel Engine Oil : SAE Grade			10W - 20	20W -20
	Viscosity	**Oil Temperature**		
Oil must be heated to reach minimum temp. of	1000cst	-10°C	-5°C	0°C
Preferred minimum starting temperature	600cst	-5°C	0°C	+5°C
Minimum full pressure working temperature	100cst	+20°C	+27°C	+33°C
Optimum working temperature	30cst	+40°C	+50°C	+60°C
Maximum working temperature	20cst	+50°C	+60°C	+70°C
Short time peak temperature (critical)	15cst	+60°C	+70°C	+80°C

Table 4-1 Minimum Warming Up Temperature

4 MAINTENANCE

4.1. Preventative Maintenance - General 4-2
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4.8. Service and Repair of Fluid and Electrical Components 4-37
4.9. Maintenance Log 4-42

4.1 Preventative Maintenance - General

This section of the manual covers routine maintenance recommendations for the crane.

The owner must establish a regular maintenance schedule, suited to the specific application and local conditions, using this manual as a guide in conjunction with component manufacturer's manuals.

It is recommended that the owner of this crane clearly defines the responsibilities of the crane operators (drivers) and the maintenance personnel.

As experience is gained by the owner, and operating schedules established, the following recommended procedures and checks should be modified to suit the operating pattern.

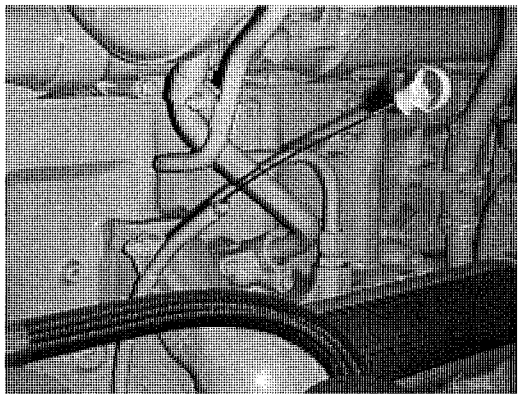
For this reason, specific quantities and times are not specified for normal maintenance procedures, eg. greasing, fuelling, inspections, etc. These requirements should be determined by observation, and practical application of established maintenance procedures.

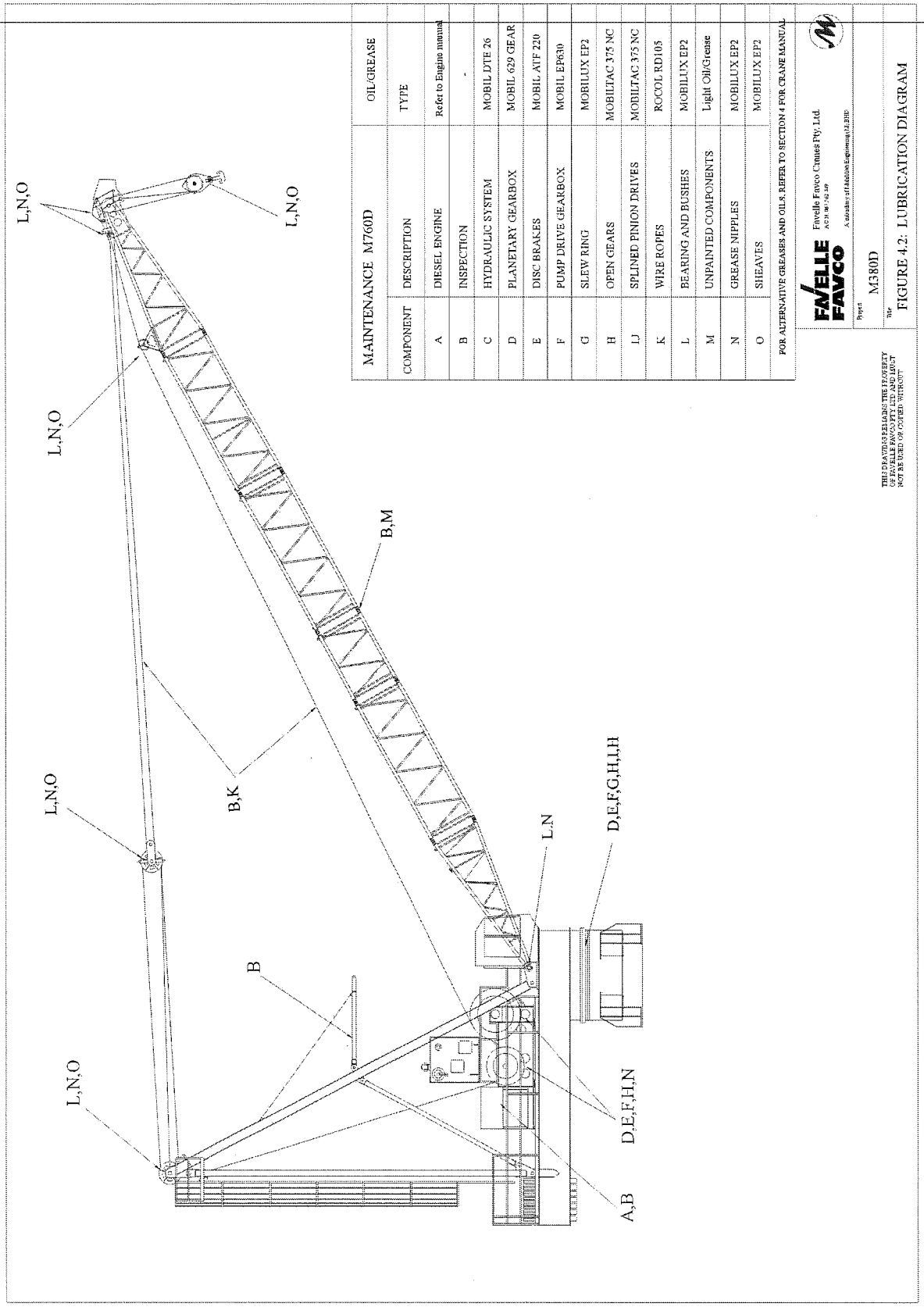
A maintenance log book should be used to establish the required schedule. This log book should contain the SLEW RING CLEARANCES record.

In later sub-sections, we recommend periodical checks, lubrication schedule and system maintenance. These are based on an annual usage of 2000 hours.

4.2 Maintenance - Detailed

ATTENTION ***Read the following sub-sections in conjunction with Lubrication Diagram***

Letter	Description
A	**Diesel Engine** Maintenance instructions for diesel engine must be taken from separate "Engine Manuals" or refer to pages at the end of this section.  Engine Oil Dip Stick  Engine Oil Filter Check for: - Oil filter - Fuel filter - Coolant level - Drive belt tensions - Electrical leads and hoses - Oil leakages - Battery condition
B	A thorough examination of the crane should be carried out after the initial 100 hours of operation. **ATTENTION** ***Bolts, screws and hydraulic fittings should be checked and re-tightened if necessary.*** For recommended bolt tightening torques, refer to figure 2-2 Crane Fastener Torque.



MAINTENANCE M760D		OIL/GREASE
COMPONENT	DESCRIPTION	TYPE
A	DIESEL ENGINE	Refer to Engine manual
B	INSPECTION	-
C	HYDRAULIC SYSTEM	MOBIL DTE 26
D	PLANETARY GEARBOX	MOBIL 629 GEAR
E	DISC BRAKES	MOBIL ATF 220
F	PUMP DRIVE GEARBOX	MOBIL EP630
G	SLEW RING	MOBILUX EP2
H	OPEN GEARS	MOBILTAC 375 NC
IJ	SPLINED PINION DRIVES	MOBILTAC 375 NC
K	WIRE ROPES	ROCOL RD105
L	BEARING AND BUSHES	MOBILUX EP2
M	UNPAINTED COMPONENTS	Light Oil/Grease
N	GREASE NIPPLES	MOBILUX EP2
O	SHEAVES	MOBILUX EP2

FOR ALTERNATIVE GREASES AND OILS, REFER TO SECTION 4 FOR CRANE MANUAL

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Project: M380D

Title: FIGURE 4.2: LUBRICATION DIAGRAM

Figure 4-1 Lubrication Diagram

C

Hydraulic system

Maintenance of the hydraulic system mainly involves changing the oil and oil filter elements.

Typical system maintenance checks are :

a) Check for the filter bypass warning light on the annunciator panel when starting the engine.
b) Check tank oil level regularly, with crane absolutely level.
c) Top up with correct oil as specified.

NOTE ***Do not overfill hydraulic oil tank, as the oil might overflow through breather during operation.***

d) Use clean oil receptacles.
e) Check filler breather on tank for clogging.
f) Check the system instrumentation ie. ensure pressure gauges, etc., are functioning satisfactorily.
g) After each 100 hours operation or during general service of crane, drain off 1 litre of oil from tank to remove any condensed water. If water is present, drain until removed and top up with clean oil.
h) Frequency of hydraulic oil change depends on the cleanliness of the oil. Compare tank oil with a sample of new oil and if in doubt ask an oil company for assistance in evaluating suitability of oil for further use.
i) Check for external leaks. Repair immediately.
j) Check that pipework is sound. Where rubber hose is used, ensure that no chafing has occurred.
k) Check that all system pressures are normal for the application.
l) When a maintenance shutdown occurs it is advisable to examine the oil tank for sludge and foreign matter, and completely clean if necessary. This is imperative if a component failure has occurred.

Refer to Section 4.2 for Recommended Oils and Greases

D

Planetary gearboxes (motion drives)

The first oil change must be carried out after the initial 50-100 hours of operation, with subsequent changes every 2500 hours or 12 months, which ever occurs first.

These intervals may be modified, depending on actual operating conditions.

During oil change, we recommend that the inside of the gearbox is flushed out with flushing fluid recommended by the lubricant manufacturer. Check that there are no metallic parts with unsual dimension in the magnetic plug of the gear unit and in any multi-disk brake.

Oil should be changed when hot to prevent build up of sludge deposit.

Oil levels should be checked once per month.

ATTENTION ***When checking oil levels in gear units equipped with a multi-disk brake or hydraulic motor, if the levels have risen, this means that oil is penetrating either from the brake seals or from the motor rotary seal.***

If more than 10% of total oil capacity has to be added, check for oil leaks.

Oil level on horizontal mounted boxes is on the centreline. Figure 4-2 illustrates the winch drive gearbox maintenance.

Vertical mounted boxes (slew drives) are filled to the top through the Expansion tank.

1. Remove Expansion tank plug
2. Fill until oil reaches the min. mark.
3. With the gear running under steady steady-state thermal condition and the oil at its expansion add oil to the maximum, but not exceeding maximum.
4. Run the gear until all air pockets are eliminated.

Due to the lesser usage, change oil in slew drives every year.

Figure 4-3 illustrates the slew gearbox maintenance.

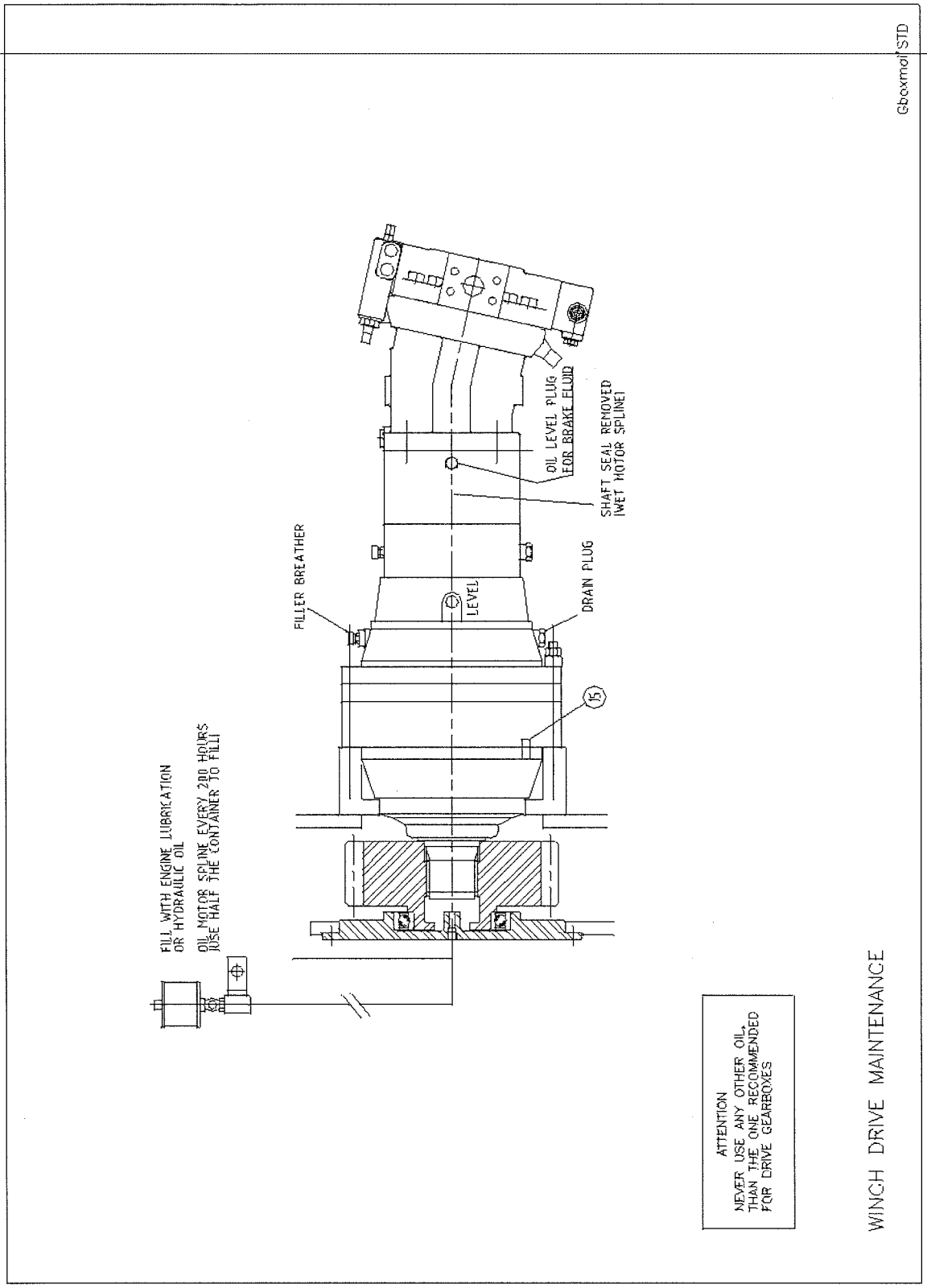


Figure 4-2 Hoist and Luff Drive Maintenance

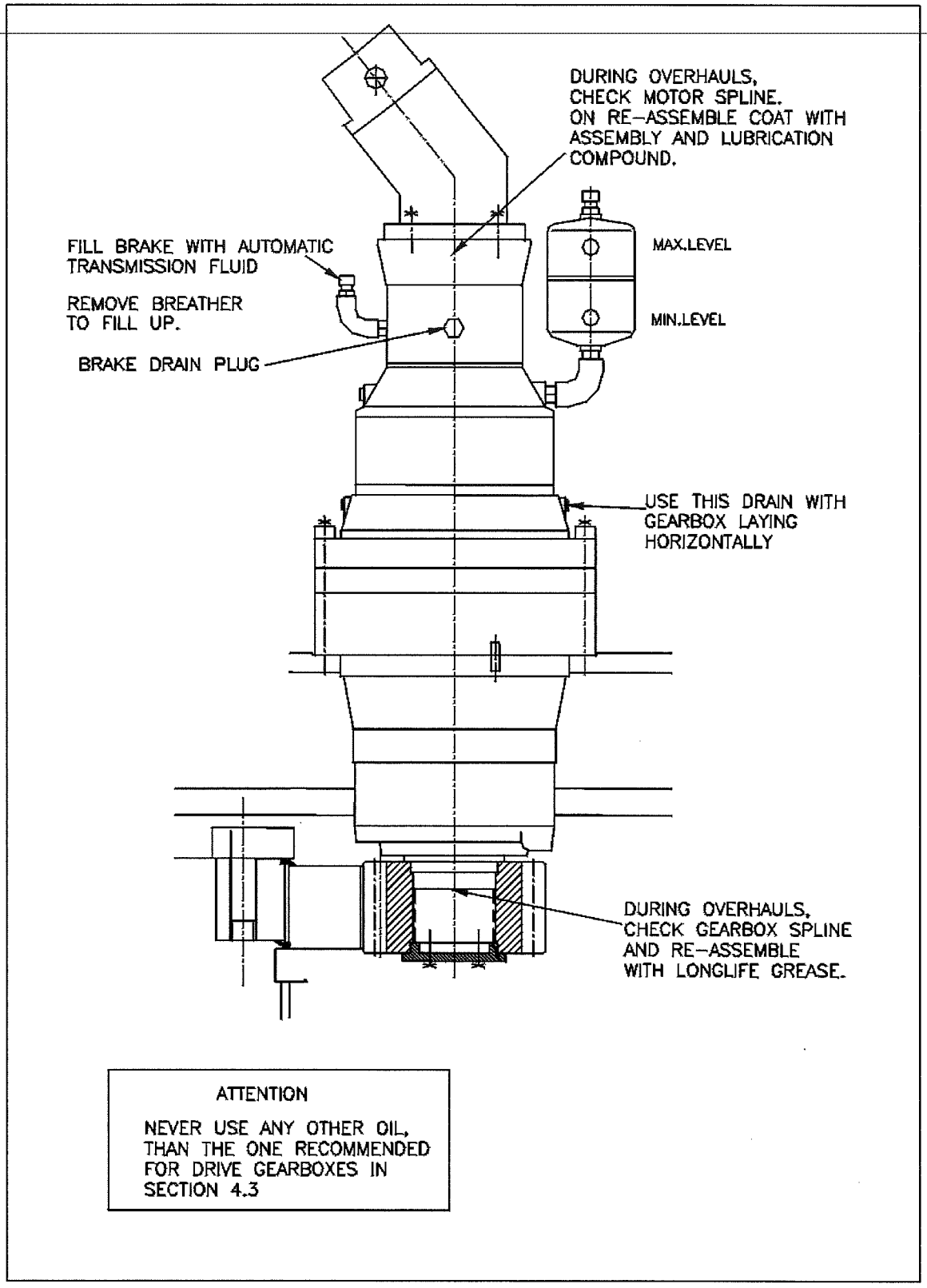


Figure 4-3 Typical Slew Drive Maintenance

E Disc brakes (part of planetary gearboxes)

Refer to Figure 4-4 for details of disc brake maintenance.

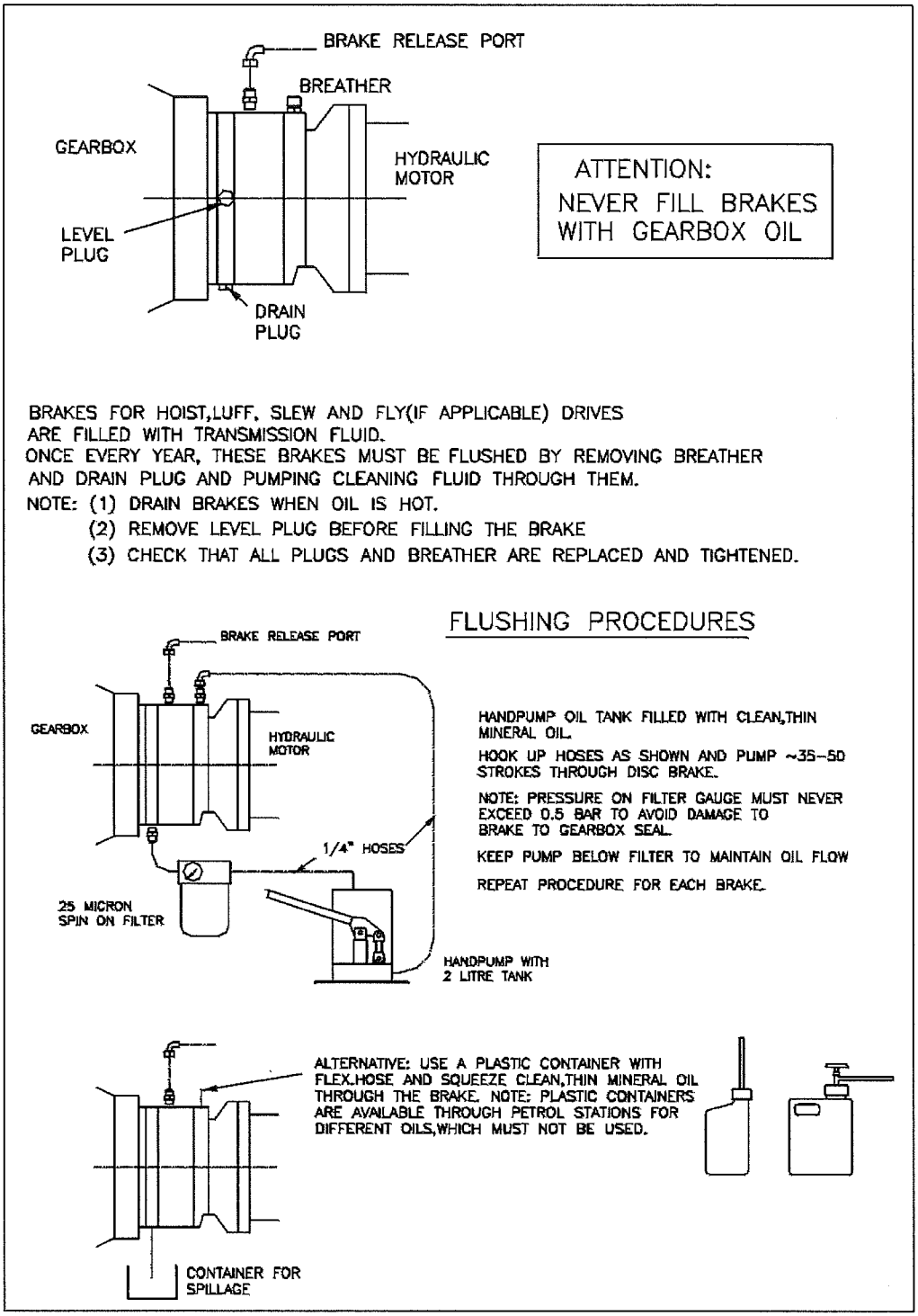


Figure 4-4 Brake Maintenance

F

Pump drive gearbox (if applicable)

The first oil change must be carried out after initial 50 hours of operation, with subsequent changes every 500 - 1000 hours or every 6 months, which ever occurs first.

These intervals may be modified, depending on actual operating conditions.

During oil change, we recommend that the inside of the gearbox is flushed out with flushing fluid recommended by the lubricant manufacturer.

Oil should be changed when hot to prevent build up of sludge deposit.

Oil levels should be checked once per month.

If more than 10% of total oil capacity has to be added, check for oil leaks.

If oil level rises, pump shaft seal or engine seals may be faulty and must be replaced.

Oil level is indicated by the maximum notch on the measuring stick (part of breather) or oil tank.

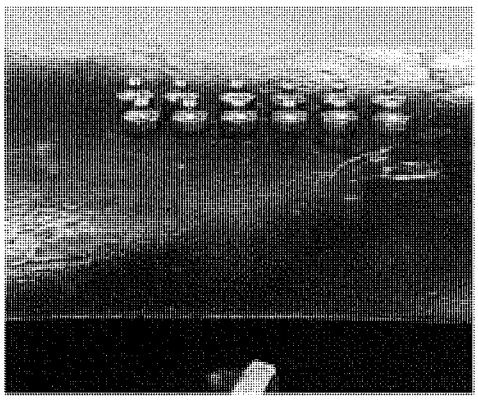
G

Slew ring

Lubricating intervals depend on the operating conditions. This is generally every 100 operating hours for ball bearings, or every 50 operating hours for roller bearings.

The grease filling is there to reduce friction, seal the bearing and provide protection against corrosion. Therefore, the bearing must always be greased liberally so that a collar of fresh grease forms around the whole circumference of the bearing gaps and seals. The bearing should be rotated during relubrication.

During periods of down time (3 months), the crane should be slewed to form a collar of fresh grease around the slew ring circumference. This is to ensure fresh grease forms at the seals and the bearing gaps around the slew ring. Grease till it leaks



Slew ring grease nipples located on front top machinery deck flange.

H

Open gears

Grease open gears with the recommended compounds avoiding bare metal to metal contact. For best result, apply with brush sparingly to avoid dripping or splattering. Lubrication should be checked weekly.

I

Maintenance / inspection of splined pinion drives

Cranes fitted with splined pinion drives on the luff, main hoist and fly hoist winches must be inspected prior to erection of the crane. This must be repeated every 5,000 working hours, or every two years, whichever occurs first. Failure to do so can result in the premature failure of the winches on the crane. The following is a procedure for inspection of the pinion spline.

I.1 Standard gearbox / pinion arrangement

1. Remove the pinion from each gearbox output shaft.
2. Wash down and clean the male and female splines and inspect for wear.
3. Hand fit the pinion to the shaft and rock the pinion backwards

	and forwards as per normal rotation. Any movement greater than 1 mm at the outer edge of the teeth of the pinion indicates the pinion and/or the gearbox output shaft must be replaced. Any visual signs of significant corrosion or wear also indicates that the pinion and/or gearbox shaft must be replaced. 4. If the pinion and the gearbox shaft wear is within limits, refit the pinion, and ensure oiler is connected and charged with oil 5. Repeat the procedure for each pinion. **ATTENTION** ***Slew drives which incorporate splines should also be inspected at the above frequency.***
J	**Lubrication of splines on pinion drives** See Figure 4-2 Hoist and Luff Drive Maintenance.
K	**Wire ropes** Use compound when necessary to prevent corrosion. Check weekly. Refer also to the sub-section Ropes - General for further information.
L	**Bearings and bushes** Grease every 100 working hours or monthly, which ever occurs first. For individual grease points refer to "Lubrication Diagram".
M	**Unpainted components** Unpainted parts of the crane, such as shafts and pins, should be inspected on a regular basis and preserved with a spray-on coating.

N

Fuel filter/ water separators (if fitted)

The contamination level of the fuel governs how often it is to drain water or to replace the filter element. Drain the collection bowl before contaminants reach the bottom of the turbine or when the water detector (optional) indicates it is time to 'drain water'. Inspect or drain the collection bowl of water daily and replace the element every 500 hours, every other oil change or if a power loss is noticed, whichever comes first.

If a vacuum gauge has been installed on the outlet side of the filter, change the element between 6" (152.4 mm) to 10" (254 mm) of mercury (restriction). Note that the actual measurement varies in different fuel systems. Always carry an extra filter element as one tank-full of excessively contaminated fuel can a filter.

To drain water:

Open the self-venting drain to evacuate contaminants. If necessary, remove the lid and prime the unit by filling with clean fuel. Replace the lid and tighten the T-handle snugly by hand ONLY.

To replace the filter element:

Only use genuine filter elements.
A convenient moulded handle on the top of the element simplifies removal. Remove the lid and then remove the element by slowly pulling upward on the moulded handle with a turning motion. Replace the lid gasket with the one supplied with the new element. Apply a coating of clean fuel to the seal prior to reassembly. Fill the bowl with clean fuel, then replace the lid and tighten the T-handle snugly by hand ONLY. Start the engine and check for leaks. Correct any leaks with the engine off.

The spare parts drawing for the fuel / water separator is shown in Figure 4-5 Filter.

O

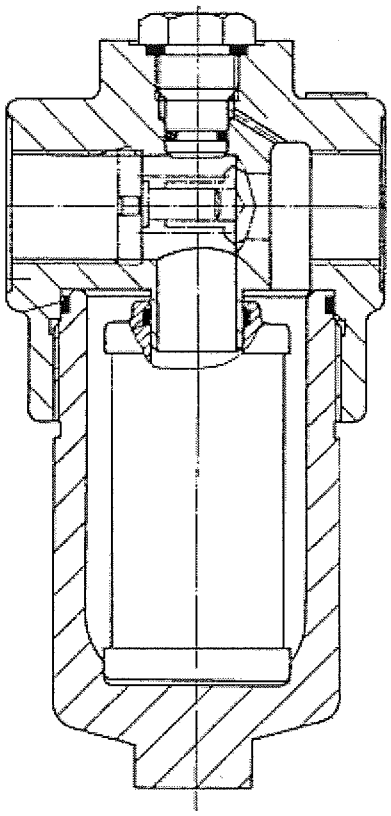
Replacing filter element

O1. Element removal and cleaning

1. Ensure that the oil supply lines to the filter are closed and the line decompressed to atmosphere.
2. Drain the filter of oil by removing the bowl, which is threaded into the housing. Unscrew by applying the correct spanner to the base hexagon.
3. Lower the bowl vertically to clear the element assembly, which will remain in the housing.
4. Dislodge the element from the housing. Remove carefully.
5. Paper elements cannot be cleaned, and must be replaced. Cranes fitted with washable elements should be cleaned appropriately before replacing the element.

O2. Fitting the clean element

1. Before replacing the element, thoroughly clean the interior of the bowl and the accessible areas of the housing. Replace element, wire only, 'O' ring seal and lubricate.
2. Push the element spigot into the housing until it holds in place.
3. Replace bowl rim seal and lubricate housing and bowl before refitting bowl.
4. Screw the bowl rim seal and lubricate the housing and tighten with the correct spanner.



Hydraulic Oil Filter showing replaceable filter element

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Figure 4-5 Filter

P	**Sheaves (Mast, Bridle, Boom and Hook)** 1. Grease sheave bearings. 2. Check for bearing wear and nilos covers every 250hrs. 3. Check sheave rotation and wobble 4. Check sheave root and root flanges for normal wear.

4.3 Recommended Oils and Greases

4.3.1 Hydraulic System Oil

For optimum performance and service life of hydraulic axial piston pumps and motors, and fixed displacement pumps and motors, the viscosity is to be 30 centistokes (30cst) at 60°C.

Favelle Favco Cranes Pty. Ltd. recommends using hydraulic oil with an ISO viscosity class "VG68" or a diesel engine oil with SAE grade of 20W-20.

Both types of fluid with a viscosity index of minimum 95 are suitable for tropical conditions or for areas with high ambient temperatures.

For areas where the ambient temperature falls below zero or day time ambient temperature is between 0°C to maximum of +20°C, a thinner oil as ISO - VG 46 or 32 must be used. Refer also to table on next page.

NOTE ***Oil should be exchanged and stored in clean drums for future use before ambient temperatures fall below 0°C and the allowable viscosity of the oil in the system rises above 1000 cst.***

ATTENTION ***For cranes in low temperature (0°C to -10°C) condition only: Position to fit low wattage heaters into hydraulic oil tank must be made, but the warm oil will only benefit the pumps when started, while the control, brake and safety system oil remains in freezing environment and will operate sluggishly and could lead to a dangerous condition.***

In any case, oil must be warmed up to a minimum temperature as shown on following table before full pressure operation can commence.

They are :

* Mobil	-	DTE	26
Shell	-	Tellus	68
Esso	-	Nuto H	68
Ampol	-	Tecoma	68
Castrol	-	Hystin AWH	68

* Shows factory recommended and first fill.

Approx. Ambient Day Time Temperature		Below 0°C	0°- +20°C	+10°-+35°C
Hydraulic Oil : ISO Class		VG 32	VG 46	VG 68
Diesel Engine Oil : SAE Grade			10W - 20	20W -20
	Viscosity	**Oil Temperature**		
Oil must be heated to reach minimum temp. of	1000cst	-10°C	-5°C	0°C
Preferred minimum starting temperature	600cst	-5°C	0°C	+5°C
Minimum full pressure working temperature	100cst	+20°C	+27°C	+33°C
Optimum working temperature	30cst	+40°C	+50°C	+60°C
Maximum working temperature	20cst	+50°C	+60°C	+70°C
Short time peak temperature (critical)	15cst	+60°C	+70°C	+80°C

Table 4-1 Minimum Warming Up Temperature

~~Pump Drive Gearbox (if applicable)~~

Gearbox manufacturer's recommendation:
SAE 90 with EP additives.

Alternative oils are:

Ampol	:	Gearlube SP220
Esso	:	Spartan EP220
* Mobil	:	Mobilgear 630
Shell	:	Omala Oil 220

4.3.2 Planetary Gearboxes (motion drives)

Gearbox manufacturer's recommendation :
ISO viscosity. Class : VG150 (V.I. 95 min.)

Alternative oils are

Ampol	:	Gearlube SP150
Castrol	:	Alpha SP150
Esso	:	Spartan EP150
* Mobil	:	Mobilgear 629
Shell	:	Omala Oil 150

4.3.3 Disc Brakes (part of planetary transmission gearboxes)

Manufacturer's recommendations: Hydraulic Oils, ISO class: VG32.

Mineral oils with enhanced heat and aging resistance and viscosity ISO VG 32, with a viscosity index greater than or equal to 95

Alternative Oil: Auto transmission fluid, SAE Grade: 10W

* Mobil	:	ATF 220
Esso	:	ATF Dexron II

4.3.4 Grease Points (nipples provided)

Grease must contain an effective corrosion prevention additive and must be consistent after extreme periods of service. Recommended Lithium based EP 2 grease to be used in slew bearing. If the slewring bearing grease contains **MOLYBDENUM DISULPHIDE** then the molybdenum content must not be greater than 3%.

Use of example

Castrol	:	EPL2
Esso	:	Beacon EP2
* Mobil	:	Mobilux EP2

4.3.5 Open Gear Teeth

This compound is highly water resistant and of an adhesive nature.

Use for example

* Castrol	:	Molub-Alloy 936
Esso	:	Surett Fluid 4K'
Mobil	:	Mobiltac 375NC
Shell	:	Cardium Fluid C

4.3.6 Sheaves

The sheaves are fitted with grease nipples or greased through sheave pin.

Castrol	:	EPL2
Esso	:	Beacon EP2
* Mobil	:	Mobilux EP2

The root of the sheave can be lubricated with rope lubricant.

4.3.7 Ropes

The type of lubricant and frequency of application varies with rope construction, the operating conditions and its functional application. The lubricant must provide protection, against wear, corrosion and minimise internal friction between wires and strands while the rope is in service.

The rope must be cleaned of moisture, residual lubricant and contaminants before clean lubrication is applied.

Recommended rope lubricants:

* Rocol	:	RD105

4.3.8 Engine Lubrication Oil

For recommendation refer to separate 'Engine Operators Handbook'.

4.3.9 Engine Radiator

Engine cooling system should have radiator preservatives added. Use antifreeze conditioner if required.

4.3.10 Engine Diesel Fuel

If ambient temperature falls below +5°C, a winter fuel or equivalent should be used to prevent fuel waxing which can the filter. Otherwise a fuel heating attachment is to be considered.

4.4 Ropes - General

Also see Rope Specification chart and Reeving diagram in Section 6.

4.4.1 Recommended Storage and Handling of Ropes

When unreeling or uncoiling rope, attention should be given to avoid the introduction of kinks or twists into the rope. This type of damage is permanent and places weak spots in the rope. Mount the reel on a vertical or horizontal axle and rotate the reel as the rope is pulled off.

When pulling rope out of a coil, the coil should be rolled on the ground to allow it to uncoil. It should be treated the same as if it were being uncoiled from a spool.
Other points to note in the storage and handling of ropes include:

- The stored rope shall be covered in a well ventilated area and away from excessive heat. If covered storage is not available, the rope and reel shall be covered with hemp material. This prevents humidity built up which would result in corrosion of the rope.
- For long periods of storage, apply a lubricant coating to the outside layer of the rope on the reel, and cover the rope and reel with hemp material.
- Care shall be taken during shipping and handling of the reel and rope to prevent damage to the rope. The loose end of the rope on the reel shall be secured properly to the reel. Do not drive a nail through the centre of the wire rope.

4.4.2 Fitting a New Rope

When anchoring a new rope on the drum, make sure that the entire cross section of the rope is held solid, otherwise the inner strands may draw from the attachment, leaving only the outer strands anchored. This can result in core protrusion.

The end of the rope should be brazed or tightly served to ensure no movement between the inner and outer layers of strand can occur.

When winding the new rope on from a reel, always wind from the top of the reel to the top of the drum or from the bottom of the reel to the bottom of the drum. Failure to do this will put a reverse bend in the rope and shorten its life. Check with reeving diagram to ensure correct winding. Figure 4-6 illustrates this concept.

The first layer on the drum must be wound on tight and true. Open or wavy winding will cause serious damage to multiple layers.

Adjacent turns should be tapped against each other with a wooden mallet, when drum is not grooved.

The whole rope should be wound on the drum tightly and correctly. A poor start will mean poor winding and short life. Never allow ropes to become slack. This can cause incorrect coiling on the drum which may allow the rope to jump off the drum or sheaves. If the rope has become slack, check the coiling on the drum before continuing.

WARNING ***Limits must be reset when new ropes are fitted.***

4.4.3 Correct Reeving

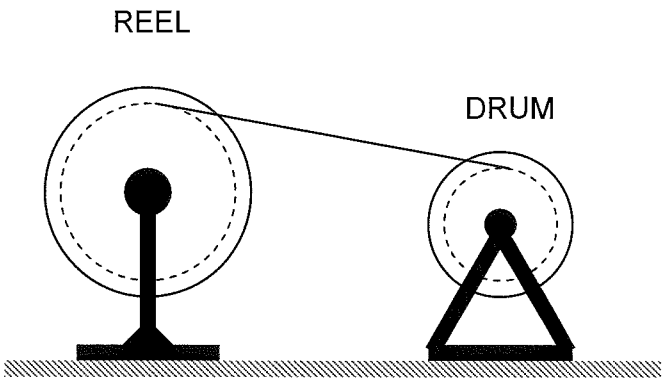
Reeving of hoist or luff ropes must always conform to the reeving diagram.

After installing, run the rope through its operating cycle several times with a light load and at reduced speed.
This is to ensure that the new rope

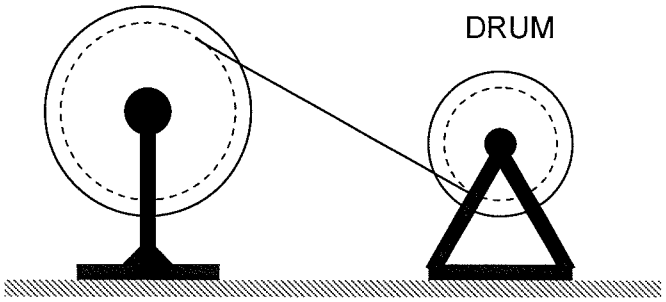
- Adjusts itself gradually to working conditions,
- Strands to become seated,
- Some stretch to occur and
- Diameter to reduce slightly as the strands and core are compacted.

By following the procedure above to condition the rope. A longer working life of the rope can be achieved.

WARNING ***Always observe the first spooling onto the drum of a new rope.***



CORRECT METHOD



INCORRECT METHOD

Favelle Favco Cranes Pty Ltd.

Figure 4-6 Correct Method for Reeving Ropes

4.4.4 Rope Inspection

All running ropes in continuous service should be visually inspected once every working day. A thorough inspection of all ropes in use should be made at least once a month. Any rope damage should be noted and the cause be determined and fixed before loading the rope.

No precise rules can be given to determine the exact time for replacements of ropes, since many variable factors are involved. Safety in this respect depends largely upon the use of good judgment by an appointed or authorised person. Conditions such as the following should be sufficient reason for questioning rope safety and for consideration of replacement.

A Broken wires

For non rotation-resistant ropes used in the main hoist fly hoist and/or the luff

In running ropes, six (6) randomly distributed broken wires within one (1)lay length or three (3) broken wires in one strand within one (1) lay length.

For rotation-resistant ropes used in the main hoist

In running ropes, four (4) randomly distributed broken wires within one (1) lay length or two (2) broken wires in one strand within one (1) lay length.

For standing ropes such as boom pendants:

In running ropes, three (3) broken wires within one (1) lay length or two (2) broken wires at the end connection.

B Wire rope wear

Wear of more than one-third of the original diameter of the outside wires of the strand are worn.

C Wire rope deterioration

Kinking, crushing, bird-caging, or any other damage resulting in the distortion of the rope construction.

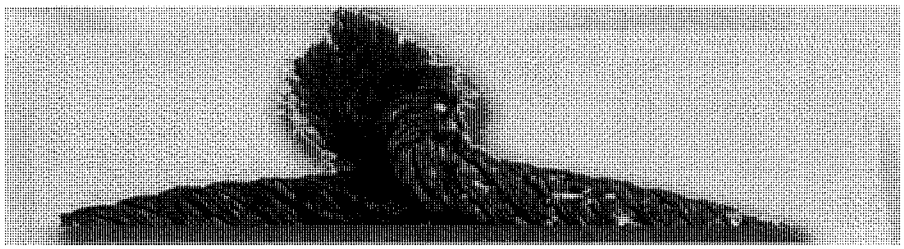
D Heat damage to wire rope

There is evidence of any heat damage from any source. Heat can be generated by passing a rope over a frozen or non-turning sheave, contact with structural members of the crane, improperly grounded welding leads or lightning strikes.

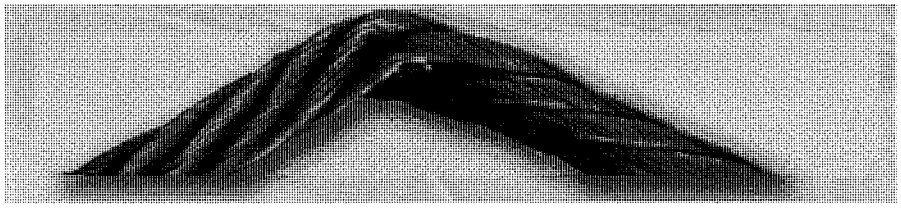
E Valley break to wire rope

If one (1) valley break is observed, this may indicate internal rope damage requiring close inspection of this section of the rope. See Figure 4-9. When

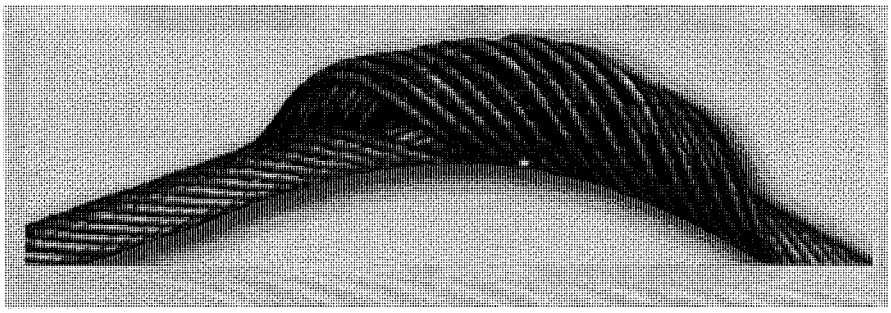
two (2) or more valley breaks are found in one (1) lay length the rope should be discarded.



Kinks

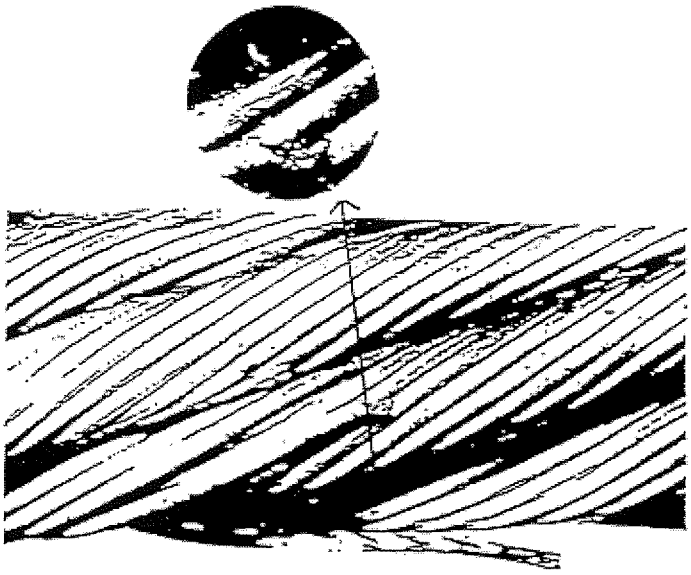


Crush



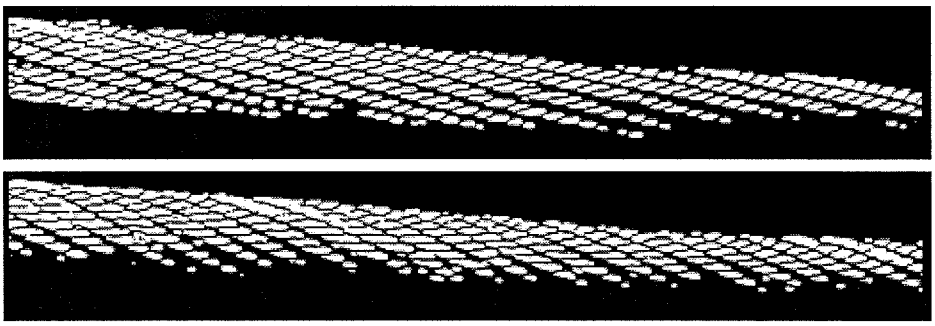
Birdcage

Figure 4-7 Types of Rope Damage



Favelle Favco Cranes Pty Ltd.
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Figure 4-8 Valley Break



Favelle Favco Cranes Pty Ltd.
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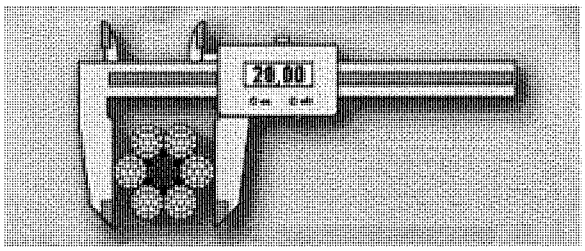
Figure 4-9 Core Failure in Rotation Resistant Wire Ropes

Wire rope diameter

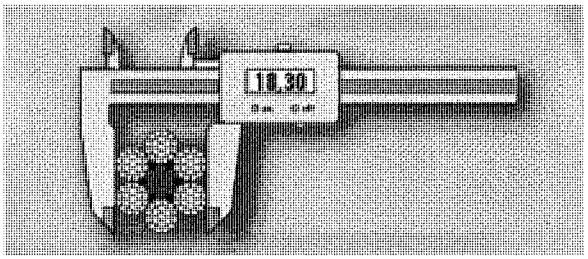
Reductions from rope diameter in a non-working area (an area away from the sheaves) compared to the lowest diameter of rope measured in three (3) working areas (areas where the rope regularly goes over a sheave) of more than the following is observed:

- 1.19mm (3/64 inch) for diameters up to and including 19.05mm (3/4 inch).
- 1.59mm (1.16 inch) for diameters of 22.22mm (7/8 inch) through 28.58 mm (1 1/8 inch).
- 2.36mm (3/32 inch) for diameters of 31.75mm (1 1/4 inch) through 38.1 mm (1 1/2 inch).

See below for proper method of measuring rope diameters.



Correct Method



Incorrect Method

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Figure 4-10 Proper method of measuring rope diameters

F **Wire rope length**

There is an observation of the increase in the length of an individual rope lay. This increase in lay length and accompanying reduction in diameter can be caused by failure of the core. This usually occurs more readily in ropes of rotation-resistant construction. See Figure 4-9 for core failures in rotation-resistant wire rope.

G **Wire rope corrosion**

Extensive external and/or internal permanent corrosion is cause for rope replacement.

In the case of rotation resistant ropes which consist of a number of strand layers, internal corrosion may not be readily detectable. During inspection, outer strands must be separated to assess internal rope condition.

Wires in the rope which are corrosively pitted have greatly reduce flexibility and will break much earlier as a result of rope bending over sheaves.

4.4.5 Rope Lubrication

A wire rope is made up of hundreds of wires which move relative to each other when the rope runs over sheaves. When a rope is manufactured it is completely filled with lubricant; firstly, to minimise frictional wear; and secondly, to keep out moisture and resulting corrosion.

It is vital that this lubrication be preserved to get the maximum life from the rope. An external coating of lubricant must be applied to the rope regularly to prevent the escape of the internal lubricant and also reduce friction on the sheaves.

Lubricating the rope is as important as greasing any other part of the crane. Any of the following methods can be used to lubricate the rope:

- Pouring of lubricant onto rope as it passes over a sheave. Wipe off excess.
- Swab the rope when not in motion with lubricant soaked rags.
- Brush or spray with lubricant.
- Pressure lubrication.

Points to Remember

- Never overload.
- Do not shock load Take up any slack carefully and apply the power smoothly and steadily.
- Protect ropes from sharp edges.
- Avoid dragging ropes from under loads.
- Avoid rolling loads with ropes.
- Avoid dropping ropes from heights.

WARNING ***Never use rope that has been cut, kinked or crushed.***

Prevent loops in slack lines from being pulled tight and kinking. A weak spot will always remain no matter how well the kink seems to have straightened out. If a loop forms do not pull it out, unfold it. Avoid reverse bends.

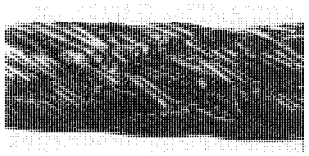
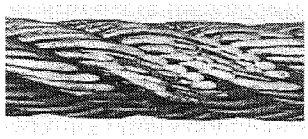
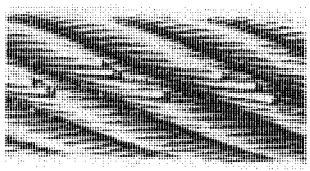
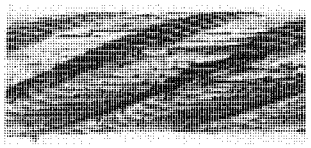
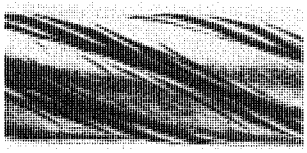
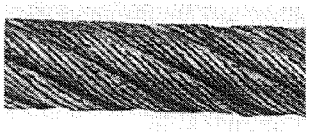
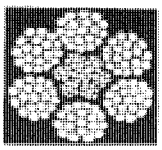
Never wind more that the proper amount of rope on to any drum.

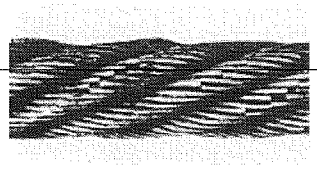
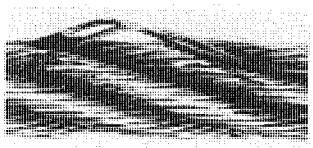
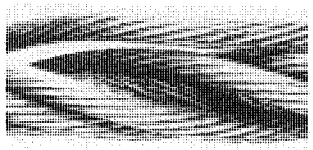
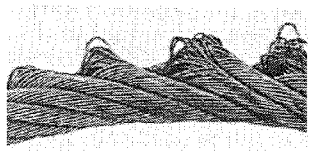
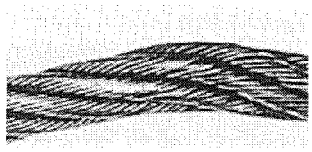
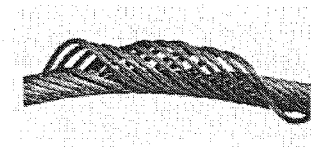
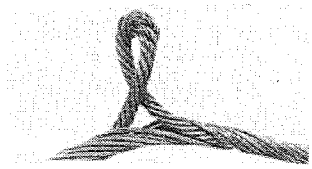
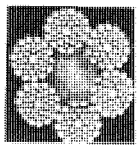
Ensure that the rope ends are properly seized.

Ensure that the ropes do not bind in the sheaves.

Watch for local wear. Premature wear at one spot is common. Uneven wear can be minimised by moving the rope so that different sections are at critical wear points. The wear can be distributed by cutting a few meters of rope from the drum and re-anchoring it.

Maintain the equipment over which the rope runs. Worn grooves, poor alignment of sheaves and worn bearings can result in shock loads and excessive vibration.

Rope Damage	Description
	Mechanical damage due to rope movement over sharp edge whilst under load
	Localised wear due to abrasion on supporting structure
	Narrow path of wear resulting in fatigue fractures, caused by working in a grossly oversized groove, or over small support rollers
	Two parallel paths of broken wires indicative of bending through an undersize groove in the sheave
	Severe wear associated with high tread pressure
	Severe wear in Langs Lay, caused by abrasion
	Severe corrosion
	Internal corrosion whilst external surface shows little evidence of deterioration

	Typical wire fractures as a result of bend fatigue
	Wire fractures at the strand, or core interface, as distinct from crown fractures
	Break up of IWRC resulting from high stress
	Looped wire as a result of torsional imbalance and/or shock loading
	Typical example of localised wear and deformation
	Multi strand rope bird caged to torsional imbalance
	Protrusion of rope centre resulting from build up of turn
	Substantial wear and severe internal corrosion

4.5 Checking Of Slew Ring & Tower Bolts

4.5.1 Tightness

1. After 100 hours first use of the crane. 100% of the bolts should be retightened to specified torque.

2. Every 3-month there after 25% of the tower bolts should be hand checked for tightness. If any are found loose, all should be retightened. When hand checking with no load on crane, and boom at shorts radius, ensure that check is carried out with Counterweight over the bolt/corner. 10% of slew bolts should be checked for adequate torque and if any found loose all should be brought up to tension.

3. If bolts are found loose check that the correct hardened washes are in place as this is a common cause of looseness, and check the seatings are flat.

4.5.2 Fatigue Cracking

Before every installation 10% of the bolts should be checked with Non Destructive Testing Methods (Magnetic Particle Inspection) for cracking. The main area of concern is at or near the head and at or near the transition between the tread and shank. If any bolts are found cracked all bolts should be removed and tested. The defectives ones should be replaced.

ATTENTION ***All inspection, testing and analysis of specimens are to be carried out by/under a certified authority or under instructions of the manufacturer.***

4.6 Sheave Inspection

A Sheave Location

Boom Sheaves

Refer to Boom Assembly drawing A1.4000.183

- Deflector sheaves on boom
- Boom head sheaves main hoist
- Boom head luff sheaves

Mast

Mast sheaves are located on the mast head. Refer to Mast Assembly drawing A1.3000.140

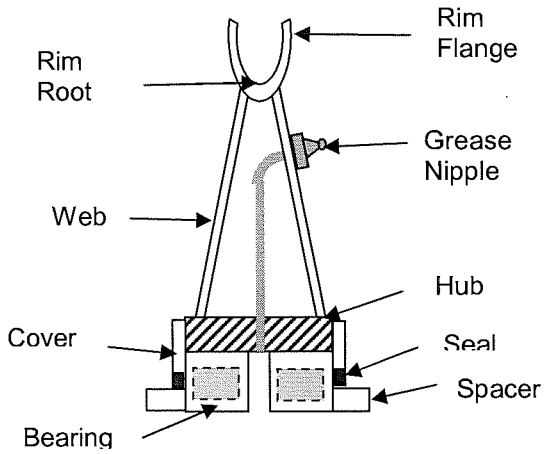
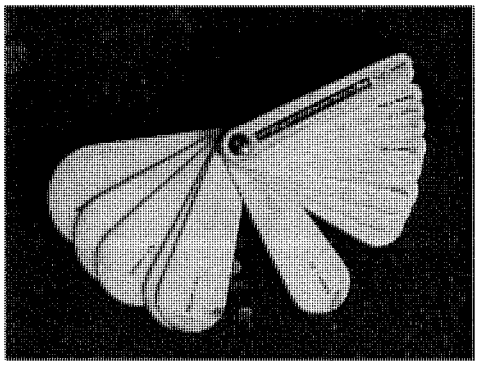


Figure 4-11 Parts of a sheave

B Root

The root area is the inner concave area of the sheave rim, where the rope sits on. Check for excessive wear, corrosion and deformations which could damage the rope.



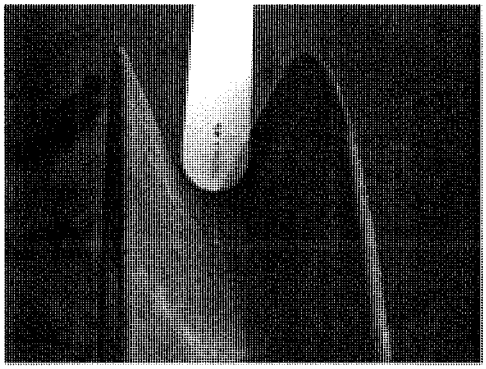


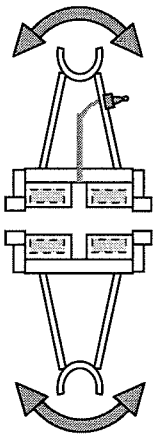
Figure 4-12 Sheave root gauge checking for wear.

C Flange Wear

The flanges are the sidewalls of the rim. Check for excessive wear and deformations which can damage the rope.

D Lateral Wobble

Rock the sides of the sheave and check for excessive play. Check bearings, seals, spacers and pins for wear.



E Cracks in Web, hubs or flange

Check the welded joints for signs of cracks or corrosion. Check the web for straightness and alignment to the centre.

F Sample Inspection Table

Sheave Location, No.	Root Wear	Flange Wear	Lateral Wobble	Cracks in Web, Hubs of Flange	Comments

4.7 Service and Repair of Structural and Mechanical Components

4.7.1 Arc Welding

Due to the materials used and the forces imposed on the structural components of this crane, repair or modifications, and in particular arc welding, should only be carried out in accordance with Favelle Favco Cranes Pty. Ltd. recommended procedures. These are available on written request.

WARNING

In the event that repairs or modifications to the steelwork above the slew ring require electric arc welding, the welding ground cable MUST BE GROUNDED ABOVE THE SLEWING RING.

Failure to observe this precaution could result in damage to the slew ring.

4.7.2 Shaft and Pins

All shafts and pins are fabricated from high tensile steel and must never be replaced with any material other than as specified by Favelle Favco Cranes Pty. Ltd.

4.7.3 Fasteners

Care should be exercised when replacing bolts or cap screws to ensure that the correct thread and bolt grade is selected and the correct tightening torque is applied.

In general, metric thread fasteners are fitted, but other threads such as UNC and UNF may be used on pumps and various other proprietary components.

Where grade and torque of a bolt is critical, the requirements are shown on the relevant drawing.

The following is offered as a guide:

ISO Grade 8.8 bolts are used throughout the crane, for cover plates, brackets, handrails etc., and other non primary structural components. Bolts less than 12mm are of stainless steel type (SS316).

Grade 8.8 or 10.9 bolts are used mainly on winches, slew drives, slew ring, power pack, slip ring assembly (if applicable), winch frame, bridle and mast.

Recommended tightening torques, refer to Figure 2-2 Crane Fastener Torques at the end of Section 2.

4.7.4 Reinstatement of Coatings

Washing down to remove all grease and other foreign matter is essential before any coating repairs are carried out.

If the top coats are mechanically damaged and require repair, feather back rough edges and re-apply paint to the recommended thickness.

Refer to Customer's specification for paint to be used.

If damage has affected the primer, reprime and re-coat after spot blasting or mechanical scrubbing to clean metal.

4.8 Service and Repair of Fluid and Electrical Components

4.8.1 Hydraulic

Concentration should be given to preventive maintenance of hydraulic components rather than complete overhaul, which requires highly specialised repair equipment and skills. The wear rate of pumps and motors is negligible as long as ample boost pressure is provided and the oil is kept free from impurities and operated in a manner that the temperature in the hydraulic circuit does not exceed 70°C.

Although this crane manual contains exploded and sectional views which would assist in stripping and rebuilding of hydraulic components, it is recommended that under normal circumstances such work should be carried out by Favelle Favco Cranes Pty. Ltd. or the component distributor. It is however recognised that circumstances may arise where it is necessary for the user to strip and rebuild hydraulic units.

Claims under guarantee however, cannot normally be entertained especially when pumps or motors have been stripped by untrained personnel.

It is therefore recommended that arrangements be made for the stocking of exchange units with additional minor parts eg. Seals, O-Ring, etc.

Faulty units should be returned to the manufacturer directly through the nearest Favelle Favco Cranes Pty. Ltd. agent for reconditioning.

CAUTION

1. ***Before removing any unit from the installation, clean areas adjacent to ports and drains. Remove pipes or hoses and cover these and component ports to prevent the ingress of dirt.***

2. ***Dismantle and rebuild any hydraulic components only under the cleanest conditions.***

4.8.2 Pressure override on variable displacement motor

Control Description: Motors fitted with option allow remote control of the motor displacement until system pressure reaches the pressure setting of the pressure override (POR) valve. When this occurs, displacement adjusts automatically towards maximum, until the product of displacement and set (system) pressure satisfies the output torque demand put on the motor.

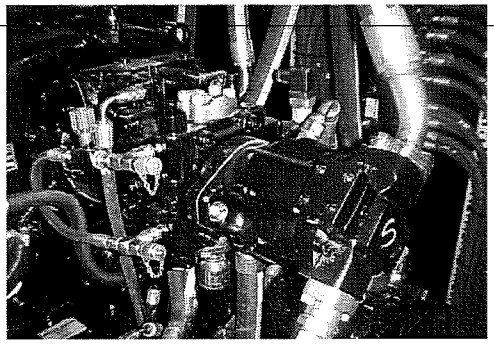
System pressure greater than the set pressure of the POR valve will keep the motor at maximum displacement, even if the HD, EP, or EZ control signal is set to send the motor to minimum displacement.

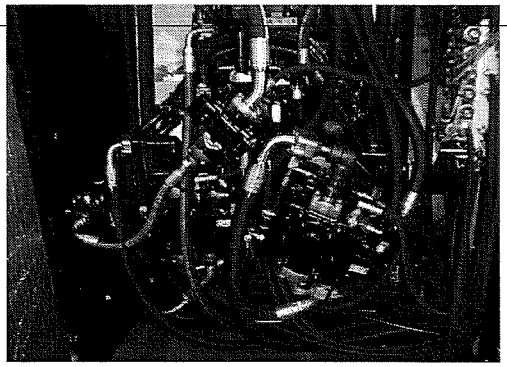
The integral POR valve has the capability of a high low pressure setting. This allows the system pressure at which the override functions to be preset at two different pressure levels.

High range is selected by supplying a pressure signal from "G" port to the "G2" port of the POR valve. Adjustment screw "A" is used to set the high POR setting.

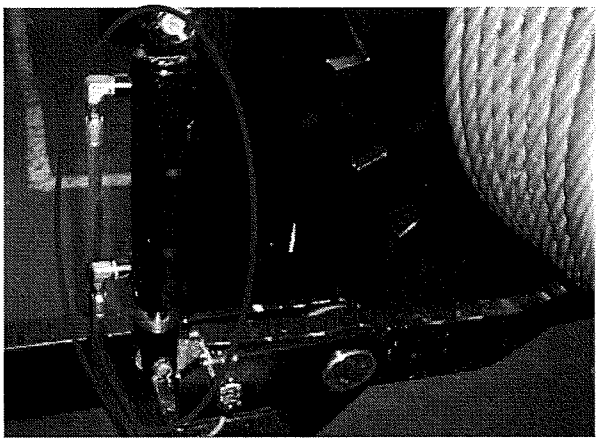
Low range is selected by blocking the pressure supply from the "G" port and connecting the "G2" port of the POR to tank. Adjustment screw "B" is used for the low POR setting.

If a single POR setting is required for an application, adjustment screw "B" should be turned in (clockwise) until firm resistance is encountered, ports "G2" and "G" are plugged. Adjustment screw "A" is then used to set the override pressure.
or pressure setting, refer to the hydraulic circuit relevant to this crane.

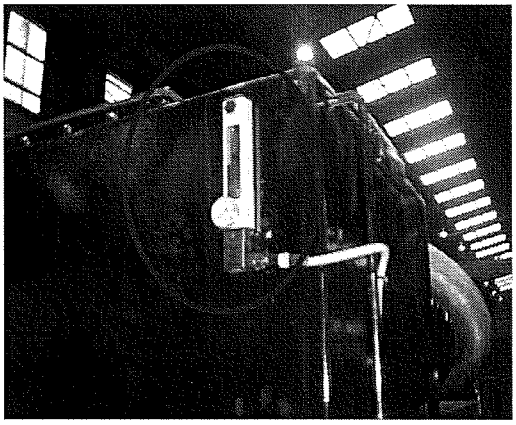




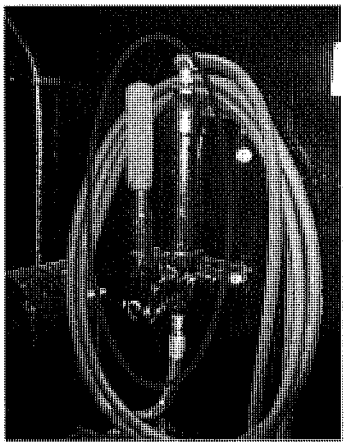
Pump Gearbox with Hydraulic Pump



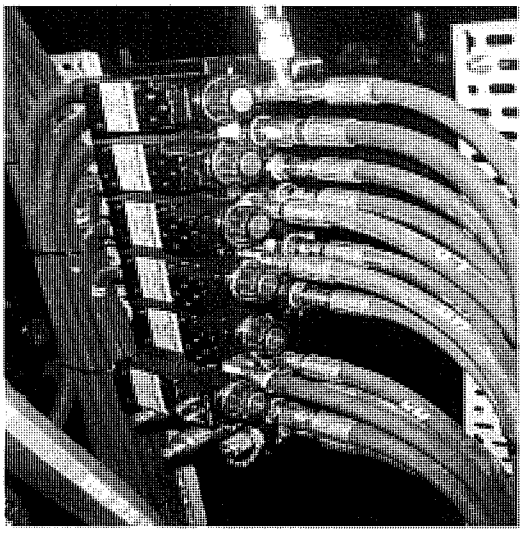
Luff Ratchet Cylinder



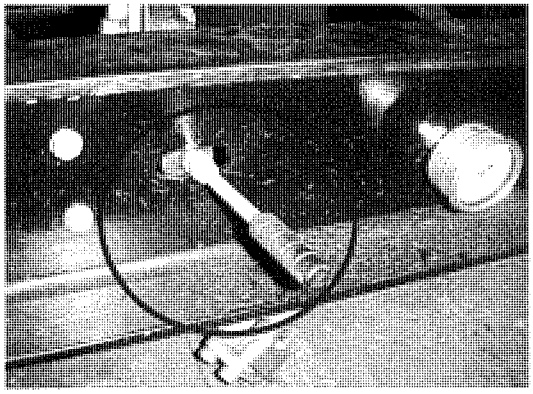
Hydraulic Tank and Tank Level Gauge with Temperature gauge



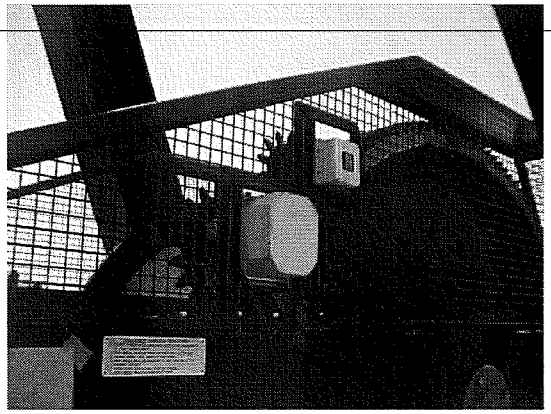
Emergency Brake Release Hand Pump



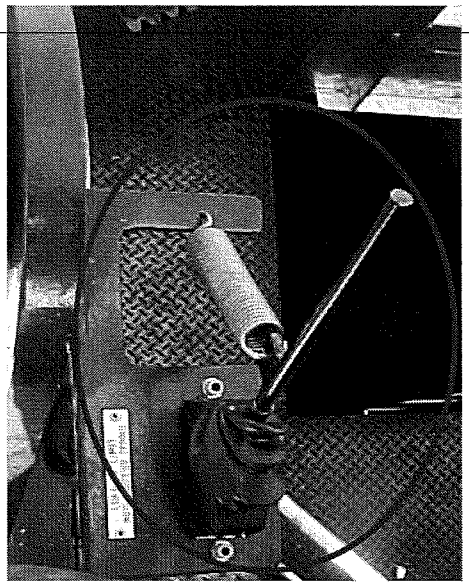
Hydraulic Manifold



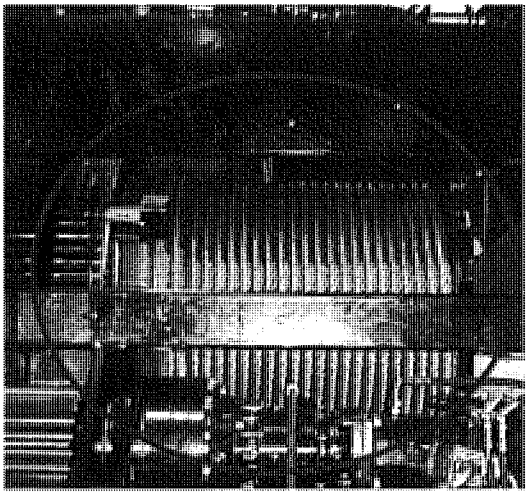
Crane Climbing Lever



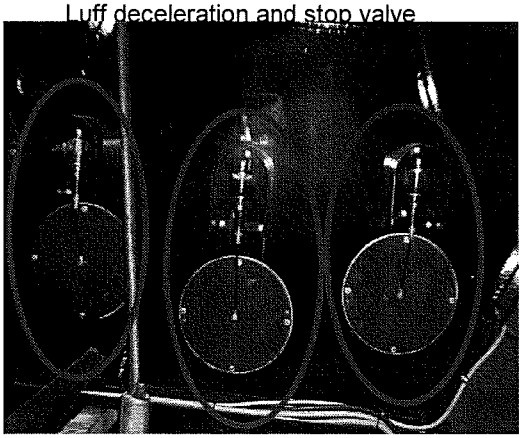
Gear limit switch and rope counter encoder



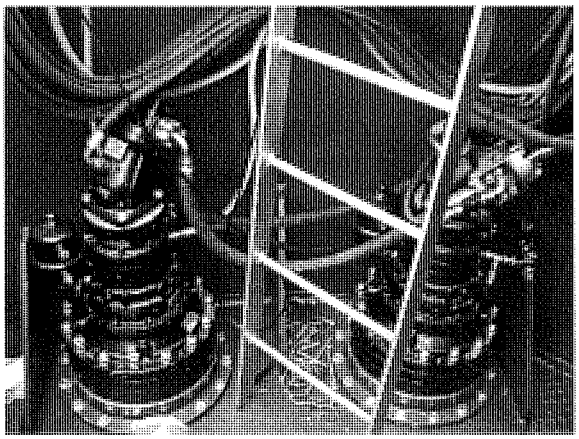
Luff deceleration and stop valve



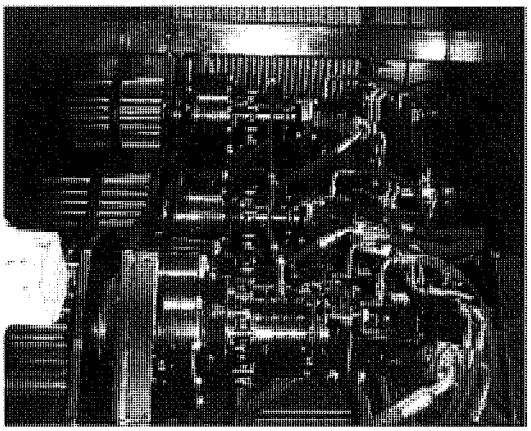
Luff drum



Hoist Spline Lubrication Oil Bottles



Slew Drive



Hoist drum drives

4.8.3 Electric

Electrical components within this crane are serviceable by a competent electrician, the exception being any electronic items.

As previously mentioned, it is recommended to have exchange units for the most important parts stocked for fast replacement.

WARNING ***All sources of electricity supply to the boom must be shut off before any piece of electrical apparatus is serviced.***

4.9 Maintenance Log

(This is a general maintenance sheet and items not applicable are to be deleted).

Refer also to sections

3.4 : Check lists
4.2 : Maintenance – detailed Lubrication Diagram

DAILY MAINTENANCE/CHECKS

ITEM	(WHERE APPLICABLE) MARK S OR MARK U.S CRITERIA: SATISFACTORY/UNSATISFACTORY							OPERATORS NAME & CERT NO& SIGNATURE
	Mon	Tue	Wed	Thur	Fri	Sat	Sun	
TIME								
OVERALL INSPECTION								
CHECK ENGINE OIL LEVEL								
CHECK RADIATOR WATER LEVEL								
CHECK DIESEL FUEL LEVEL								
CHECK PUMP DRIVE OIL LEVEL								
CHECK HYDRAULIC OIL LEVEL								
CHECK ENGINE AIR CLEANER								
CHECK HOIST ROPE LAY								
CHECK THE CONTROL PANEL TO ENSURE THE VISUAL AND AUDIBLE ALARMS ARE WORKING								
CHECK THE HOIST UP LIMIT								
CHECK THE HOIST DOWN LIMIT								
CHECK THE LUFF IN LIMIT								

CHECK THE LUFF OUT LIMIT								
CHECK THE ENGINE/ CRANE BATTERY (IF APPLICABLE)								
CHECK POWERPACK HOLDING DOWN BOLTS/PINS								
CHECK THE EMERGENCY STOP FUNCTION								
CHECK THE SLEW LIMITS								
Remarks								

MAINTENANCE LOG	WEEKLY OR EVERY 40 WORKING HOURS							
DATE								
TIME								
OVERALL INSPECTION INCLUDING VISUALLY CHECKING FOR OIL LEAKAGE AROUND THE POWERPACK AND THE WINCH.								
CHECK ENAGEMENT OF LUFF RATCHET WHEN CRANE SHUTDOWN								
CHECK THE HOIST ROPE FOR DEFECTS AND/OR FAILURE								
CHECK THE LUFF ROPE FOR DEFECTS AND /OR FAILURE								
GREASE SLEW RING BEARING								
INSPECT & GREASE THE HOIST DRUM GEAR								
INSPECT & GREASE THE LUFF DRUM GEAR								
INSPECT & GREASE THE SLEW RING GEAR								
GREASE THE BOOM HEEL BUSHES								
Remarks								

MAINTENANCE LOG	MONTHLY OR EVERY 100 WORKING HOURS							
DATE								
TIME								
CHECK THE ENGINE OIL LEVEL								
CHECK THE RADIATOR WATER LEVEL								
CHECK THE PUMP DRIVE OIL LEVEL								
CHECK THE HOIST BRAKE AND FLUID CONDITION								
CHECK THE LUFF BRAKE AND FLUID CONDITION								
CHECK THE HOIST BRAKE AND FLUID CONDITION								
INSPECT & GREASE THE SHEAVE BEARINGS OF MAST, BRIDLE, BOOM AND HOOK SHEAVES ASSEMBLIES								
INSPECT & GREASE HOIST DRUM BEARINGS								
INSPECT & GREASE LUFF DRUM BEARINGS								
INSPECT & LUBRICATE HOIST DRUM DRIVE BEARINGS AND GEARBOX								
INSPECT & LUBRICATE LUFF DRUM DRIVE BEARINGS AND GEARBOX								
INSPECT & LUBRICATE SLEW DRIVE BEARINGS AND GEARBOX								
INSPECT THE HYDRAULIC OIL TANK								
Remarks								

MAINTENANCE LOG	EVERY THREE MONTHS OR 250 WORKING HOURS							
DATE								
TIME								
INSPECT & GREASE HOIST DRUM BEARINGS								
INSPECT & GREASE LUFF DRUM BEARINGS								
INSPECT & LUBRICATE HOIST DRUM DRIVE BEARINGS								
INSPECT & LUBRICATE LUFF DRUM DRIVE BEARINGS								
INSPECT & LUBRICATE SLEW DRIVE BEARINGS								
INSPECT LIMIT SWITCH DRIVES								
INSPECT THE HYDRAULIC OIL TANK								
Remarks								

MAINTENANCE LOG	EVERY 5000 WORKING HOURS							
DATE								
INSPECT THE SLEW DRIVE SPLINED PINIONS								
INSPECT THE LUFF DRIVE SPLINED PINIONS								
INSPECT THE HOIST DRIVE SPLINED PINIONS								
INSPECT CRANE STRUCTURAL MEMBERS AND WELDS								
Remarks								

VOL III EXHIBIT 15

Inspection Forms Contained in the
Favco Operator's Manual

4.9 Maintenance Log

(This is a general maintenance sheet and items not applicable are to be deleted).

Refer also to sections

3.4 : Check lists
4.2 : Maintenance – detailed Lubrication Diagram

DAILY MAINTENANCE/CHECKS

ITEM	(WHERE APPLICABLE) MARK S OR MARK U.S CRITERIA: SATISFACTORY/UNSATISFACTORY							OPERATORS NAME & CERT NO& SIGNATURE
	Mon	Tue	Wed	Thur	Fri	Sat	Sun	
T I M E								
OVERALL INSPECTION								
CHECK ENGINE OIL LEVEL								
CHECK RADIATOR WATER LEVEL								
CHECK DIESEL FUEL LEVEL								
CHECK PUMP DRIVE OIL LEVEL								
CHECK HYDRAULIC OIL LEVEL								
CHECK ENGINE AIR CLEANER								
CHECK HOIST ROPE LAY								
CHECK THE CONTROL PANEL TO ENSURE THE VISUAL AND AUDIBLE ALARMS ARE WORKING								
CHECK THE HOIST UP LIMIT								
CHECK THE HOIST DOWN LIMIT								
CHECK THE LUFF IN LIMIT								

CHECK THE LUFF OUT LIMIT								
CHECK THE ENGINE/ CRANE BATTERY (IF APPLICABLE)								
CHECK POWERPACK HOLDING DOWN BOLTS/PINS								
CHECK THE EMERGENCY STOP FUNCTION								
CHECK THE SLEW LIMITS								
Remarks								

MAINTENANCE LOG	WEEKLY OR EVERY 40 WORKING HOURS							
DATE								
TIME								
OVERALL INSPECTION INCLUDING VISUALLY CHECKING FOR OIL LEAKAGE AROUND THE POWERPACK AND THE WINCH.								
CHECK ENAGEMENT OF LUFF RATCHET WHEN CRANE SHUTDOWN								
CHECK THE HOIST ROPE FOR DEFECTS AND/OR FAILURE								
CHECK THE LUFF ROPE FOR DEFECTS AND /OR FAILURE								
GREASE SLEW RING BEARING								
INSPECT & GREASE THE HOIST DRUM GEAR								
INSPECT & GREASE THE LUFF DRUM GEAR								
INSPECT & GREASE THE SLEW RING GEAR								
GREASE THE BOOM HEEL BUSHES								
Remarks								

MAINTENANCE LOG	MONTHLY OR EVERY 100 WORKING HOURS							
DATE								
TIME								
CHECK THE ENGINE OIL LEVEL								
CHECK THE RADIATOR WATER LEVEL								
CHECK THE PUMP DRIVE OIL LEVEL								
CHECK THE HOIST BRAKE AND FLUID CONDITION								
CHECK THE LUFF BRAKE AND FLUID CONDITION								
CHECK THE HOIST BRAKE AND FLUID CONDITION								
INSPECT & GREASE THE SHEAVE BEARINGS OF MAST, BRIDLE, BOOM AND HOOK SHEAVES ASSEMBLIES								
INSPECT & GREASE HOIST DRUM BEARINGS								
INSPECT & GREASE LUFF DRUM BEARINGS								
INSPECT & LUBRICATE HOIST DRUM DRIVE BEARINGS AND GEARBOX								
INSPECT & LUBRICATE LUFF DRUM DRIVE BEARINGS AND GEARBOX								
INSPECT & LUBRICATE SLEW DRIVE BEARINGS AND GEARBOX								
INSPECT THE HYDRAULIC OIL TANK								
Remarks								

MAINTENANCE LOG	EVERY THREE MONTHS OR 250 WORKING HOURS							
DATE								
TIME								
INSPECT & GREASE HOIST DRUM BEARINGS								
INSPECT & GREASE LUFF DRUM BEARINGS								
INSPECT & LUBRICATE HOIST DRUM DRIVE BEARINGS								
INSPECT & LUBRICATE LUFF DRUM DRIVE BEARINGS								
INSPECT & LUBRICATE SLEW DRIVE BEARINGS								
INSPECT LIMIT SWITCH DRIVES								
INSPECT THE HYDRAULIC OIL TANK								
Remarks								

Inspection Forms Complete by Cross Country Construction HMO Inspections

Maintenance Log Book Make:Favco Model:M440 Serial:#1475 CD #4052

Daily Maintenance Checklist

FAVELLE FAVCO

SERIAL # 1475 17847 HRS

Daily Maintenance Checklist

Page 1 of 2

Date 2-8-23			2/8	2/9	2/10		
Time MORNING VISUAL INSPECTION							
Check Item	**Mark 'V' for Satisfactory; Mark 'X' for Unsatisfactory; Mark '-' where not applicable**						
Day	**Mon**	**Tue**	**Wed**	**Thur**	**Fri**	**Sat**	**Sun**
Check crane fluid level:							
• Diesel fuel tank			✓	/	/		
• Hydraulic oil tank			✓	/	/		
• Window washer water			—	—	—	—	
Check crane rope condition on drum							
• Main hoist rope lay			✓	/	/		
• Aux hoist rope lay			—	—	—	—	
• Luff hoist rope lay			✓	/	/		
Check crane control function							
• Control joystick response			✓	/	/		
• Emergency stop button(s)			✓	/	/		
• Annunciator panel (visual and audible alarms)			✓	/	/		
• Window wiper			✓	/	/		
• Window washer			—	—	—	—	
• Warning horn			✓	/	/		
Check crane limit function							
• Hoist up limit			✓	/	/		
• Hoist down limit			✓	/	/		
• Luff in limit			✓	/	/		
• Luff out limit			✓	/	/		
• Slew limit			—	—	—	—	

FAVELLE FAVCO

Daily Maintenance Checklist
Page 2 of 2

Date 2-8-23			2/8	2/9	2/10		
Time							
Check Item	**Mark 'V' for Satisfactory; Mark 'X' for Unsatisfactory; Mark '-' where not applicable**						
Day	**Mon**	**Tue**	**Wed**	**Thur**	**Fri**	**Sat**	**Sun**
Overall inspection			✓	/	-		
Checked by:							
Name			DMc	[illegible]	[illegible]		
Certificate #							
Remarks							

Weekly Maintenance Checklist

FAVELLE FAVCO

Weekly (*or every 40 working hours*) Maintenance Checklist

Page 1 of 2

Week				
Date				
Time				
Check item	**Mark 'V' for Satisfactory; Mark 'X' for Unsatisfactory; Mark '-' where not applicable**			
Oil leakage around/in cabin, powerpack and winches				
Luff ratchet engagement				
Check crane fluid level:				
• Engine lubrication oil				
• Radiator tank water				
• Winch drive gearbox oil				
• Pump drive gearbox oil				
Rope condition				
• Main hoist(s)				
• Aux hoist				
• Luff hoist				
• Tugger hoist(s)				
Gearing grease				
• Slew ring bearing				
• Slew ring drive gear				
• Main hoist drum gear(s)				
• Aux hoist drum gear				
• Luff drum gear				
Ropes grease				
• Main hoist(s)				
• Aux hoist				
• Luff hoist				
• Tugger hoist				

FAVELLE FAVCO

Weekly (*or every 40 working hours*) Maintenance Checklist

Page 2 of 2

Week				
Date				
Time				
Check item	**Mark 'V' for Satisfactory; Mark 'X' for Unsatisfactory; Mark '-' where not applicable**			
Shafts & bearings grease				
• Boom heel bush(es)				
• Main hoist drum(s)				
• Aux hoist drum				
• Luff hoist drum				
• Mast head sheave(s)				
• Bridle sheave(s)				
• Deflector sheave(s)				
• Boom head sheave(s)				
• Fly jib head sheave(s)				
Checked by:				
Name				
Certificate #				
Remarks				

Monthly Maintenance Checklist

FAVELLE FAVCO

Serial # 1475

Monthly (*or every 100 working hours*) Maintenance Checklist

Page 1 of 2

Month	APRil			
Date	4-1-23			
Time	Morning			
Check item	**Mark 'V' for Satisfactory; Mark 'X' for Unsatisfactory; Mark '-' where not applicable**			
Brake holding capacity	✓			
Engine air cleaner	✓			
Engine battery	✓			
Powerpack mounting	✓			
Air receiver	✓			
Check the engine oil level	✓			
Check the radiator water level	✓			
Check the pump drive oil level	✓			
Check the hoist brake	✓			
Inspect & grease the sheave bearings of mast, bridle, boom and hook Sheaves assemblies	✓			
Inspect & grease hoist drum bearings	✓			
Inspect & grease luff drum bearings	✓			
Inspect & grease hoist drum drive bearings	✓			
Inspect & grease luff drum drive bearings	✓			
Inspect & grease slew drive bearings	✓			
Inspect the hydraulic oil tank	✓			

FAVELLE FAVCO

Monthly (*or every 100 working hours*) Maintenance Checklist

Page 2 of 2

Month	April			
Date	4-1-23			
Time	morning			
Checked by:				
Name	[illegible]			
Certificate #				
Remarks				

Inspection Forms Completed by New York Crane and Equipment

1/6/2023
07:52 AM

Work Order : NN2-5665

Status : Open
Unit Code : T440-13
Unit Description : Favco Tower Crane
Unit Make : Favco
Unit Model : M440
Serial Number : 1475

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

- SERVICE AND PREP FOR RENTAL

Hours Upper 17,827
Date 1/6/23

Description	Employee(s)	Hours Worked	Parts
100 HOUR SERVICE			

Action List	Completed	Deficiency	N/A	Comments
100 HOUR SERVICE PER FAVCO MAINTENANCE MANUAL. REFER TO SECTION 5 OF THE INSTALLATION, OPERATIONS & MAINTENANCE MANUAL FOR PROPER PROCEDURE. SIGN OFF WHEN COMPLETED.	☑	☐	☐	
___S01: CHECK THE ENGINE OIL LEVEL	☑	☐	☐	
___S02: CHECK THE RADIATOR WATER LEVEL	☑	☐	☐	
___S03: CHECK THE PUMP DRIVE OIL LEVEL	☑	☐	☐	
___S04: CHECK THE HOIST BRAKE AND FLUID CONDITION	☑	☐	☐	
___S05: CHECK THE LUFF BRAKE AND FLUID CONDITION	☑	☐	☐	
___S06: INSPECT & GREASE THE SHEAVE BEARINGS OF MAST, BRIDLE, BOOM AND HOOK SHEAVES ASSEMBLIES	☑	☐	☐	
___S07: INSPECT & GREASE HOIST DRUM BEARINGS	☑	☐	☐	
___S08: INSPECT & GREASE LUFF DRUM BEARINGS	☑	☐	☐	
___S09: INSPECT & LUBRICATE HOIST DRUM DRIVE BEARINGS AND GEARBOX	☑	☐	☐	
___S10: INSPECT & LUBRICATE LUFF DRUM DRIVE BEARINGS AND GEAR BOX	☑	☐	☐	
___S11: INSPECT & LUBRICATE SLEW DRIVE BEARINGS AND GEAR BOX	☑	☐	☐	
___S12: INSPECT THE HYDRAULIC OIL TANK	☑	☐	☐	
___S13: DRAIN OFF 1 LITER OF HYDRAULIC OIL TO REMOVE ANY CONDENSED WATER. IF WATER IS PRESENT, DRAIN UNTIL REMOVED AND TOP OFF WITH CLEAN OIL	☑	☐	☐	

1/6/2023
07:52 AM

Work Order : NN2-5665

Status : Open
Unit Code : T440-13
Unit Description : Favco Tower Crane
Unit Make : Favco
Unit Model : M440
Serial Number : 1475

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Description	Employee(s)	Hours Worked	Parts
100 HOUR SERVICE			

Action List	Completed	Deficiency	N/A	Comments
___S14: CHECK ENGINE AIR CLEANER	☑	☐	☐	
___S15: CHECK HOIST ROPE LAY	☑	☐	☐	
___S16: CHECK THE ANNUNCIATOR TO ENSURE THE VISUAL AND AUDIBLE ALARMS ARE WORKING	☑	☐	☐	
___S17: CHECK THE HOIST UP LIMIT	☐	☐	☑	
___S18: CHECK THE HOIST DOWN LIMIT	☐	☐	☑	
___S19: CHECK THE LUFF IN LIMIT	☐	☐	☑	
___S20: CHECK THE LUFF OUT LIMIT	☐	☐	☑	
___S21: CHECK THE ENGINE/CRANE BATTERY (IF APPLICABLE)	☑	☐	☐	
___S22: CHECK POWERPACK HOLDING DOWN BOLTS/PINS	☐	☐	☐	
___S23: CHECK THE EMERGENCY STOP FUNCTION	☑	☐	☐	
___S24: CHECK THE SLEW LIMITS	☐	☐	☑	
___S25: TEST ALL FOUR CAVIATION SWITCHES	☐	☐	☑	
___S26: CHECK ENGAGEMENT FO LUFF RATCHET WHEN CRANE IS SHUTDOWN	☑	☐	☐	
___S27: CHECK THE HOIST ROPE FOR DEFECTS AND/OR FAILURE	☑	☐	☐	
___S28:CHECK THE LUFF ROPE FOR DEFECTS AND/OR FAILURE	☑	☐	☐	
___S29: GREASE SLEW RING BEARING	☑	☐	☐	
SIGN OFF: Leonardo Cambero.	☑	☐	☐	

250 HOUR SERVICE UPPER

Action List	Completed	Deficiency	N/A	Comments
250 HOUR SERVICE CHECKLIST PER FAVCO & CATERPILLER MANUAL. REFER TO SECTION 5 OF THE INSTALLATION, OPERATIONS & MAINTENANCE MANUAL FOR PROPER PROCEDURE. SIGN OFF WHEN COMPLETED.	☑	☐	☐	

1/6/2023
07:52 AM

Work Order : NN2-5665

Page 3 of 6

Status : Open
Unit Code : T440-13
Unit Description : Favco Tower Crane
Unit Make : Favco
Unit Model : M440
Serial Number : 1475

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Description	Employee(s)	Hours Worked	Parts

250 HOUR SERVICE UPPER

Action List	Completed	Deficiency	N/A	Comments
S01: CHANGE ENGINE OIL AND OIL FILTER (8 GALLONS OF 15W40)	☑	☐	☐	
S02: CHANGE PRIMARY FUEL FILTER	☑	☐	☐	
S03: CHANGE FUEL/WATER SEPERATOR	☑	☐	☐	
S04: CLEAN/REPLACE PRIMARY AND SECONDARY AIR FILTER	☑	☐	☐	
S05: INSPECT & GREASE HOIST DRUM BEARINGS	☑	☐	☐	
S06: INSPECT & GREASE LUFF DRUM BEARINGS	☑	☐	☐	
S07: INSPECT & GREASE HOIST DRUM DRIVE BEARINGS	☑	☐	☐	
S08: INSPECT & GREASE LUFF DRUM DRIVE BEARINGS	☑	☐	☐	
S09: INSPECT AND LUBRICATE SLEW DRIVE BEARINGS	☑	☐	☐	
S10: INSPECT LIMIT SWITCHES	☑	☐	☐	
S11: INSPECT THE HYDRAULIC OIL TANK	☑	☐	☐	
S12: CHECK RADIATOR WATER LEVEL	☑	☐	☐	
S13: CHECK PUMP DRIVE OIL LEVEL	☑	☐	☐	
S14: CHECK HYDRAULIC OIL LEVEL	☑	☐	☐	

SIGN OFF Leonardo Cambero.

Suggested Parts

8.00 Gallons	15W40	MOTOR OIL
1.00 Each	B7299	OIL FILTER (BALDWIN)
1.00 Each	BF7587	FUEL FILTER (BALDWIN)
1.00 Each	326-1643	FUEL FILTER
1.00 Each	RS3514	AIR FILTER (OUTER)
1.00 Each	RS3515	AIR FILTER (INNER)
1.00 Each	BF1382-SP	FUEL FILTER

BRAKE PAK SERVICE

Action List	Completed	Deficiency	N/A	Comments
SO1: DRAIN BRAKE PACKS WHILE OIL IS HOT AS PER FAVCO PROCEDURES	☑	☐	☐	

1/6/2023
07:52 AM

Work Order : NN2-5665

Status : Open
Unit Code : T440-13
Unit Description : Favco Tower Crane
Unit Make : Favco
Unit Model : M440
Serial Number : 1475

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Description	Employee(s)	Hours Worked	Parts
BRAKE PAK SERVICE			

Action List	Completed	Deficiency	N/A	Comments
SO2: REMOVE LEVEL PLUG BEFORE FILLING BRAKE	☑	☐	☐	
S03: REPLACE SEALS ON ALL PLUGS	☑	☐	☐	
S04: INSTALL ALL PLUGS AND TIGHTEN TO MANUFACTURES SPECS	☑	☐	☐	
S05: ADD ATF FLUID TYPE DEXRON II TO PROPER LEVELS	☑	☐	☐	
S06: DRAIN PUMP GEAR BOX WHILE HOT AS PER FAVCO PROCEDURS	☑	☐	☐	
S07: CHECK FOR ANY VISIBLE LEAKS	☑	☐	☐	
S08: REFILL GEAR BOX TO PROPER LEVEL USING SAE GEAR OL 600 XP 150	☑	☐	☐	
SIGN OFF: Leonardo Contreras	☑	☐	☐	

COOLING SYSTEM SERVICE

FAN BELTS REPLACED

Suggested Parts

1.00 Each	6N-6651	WATER PUMP BELT
1.00 Each	4N-8216	ALTERNATOR BELT

HYDRAULIC SYSTEM SERVICE

Action List	Completed	Deficiency	N/A	Comments
HYDRAULIC SYSTEM SERVICE CHECKLIST PER FAVCO MANUAL. REFER TO SECTION 5 OF THE INSTALLATION, OPERATIONS & MAINTENANCE MANUAL FOR PROPER PROCEDURE. SIGN OFF WHEN COMPLETED.	☑	☐	☐	
SO1: REPLACE HYDRAULIC FILTERS	☑	☐	☐	
SO2: OBTAIN HYDRAULIC FLUID SAMPLE	☑	☐	☐	
SO3: DRAIN HYDRAULIC FLUID	☑	☐	☐	
S04: CHECK ALL HOSES AND CONNECTORS FOR LEAKS	☑	☐	☐	
S05: CHECK ALL HOSES FOR CUTS AND ABRASIONS	☑	☐	☐	

1/6/2023
07:52 AM

Work Order :NN2-5665

Status :Open
Unit Code :T440-13
Unit Description :Favco Tower Crane
Unit Make :Favco
Unit Model :M440
Serial Number :1475

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Description	Employee(s)	Hours Worked	Parts
HYDRAULIC SYSTEM SERVICE			

Action List	Completed	Deficiency	N/A	Comments
S06: REFILL HYDRAULIC TANK TO PROPER LEVEL	☑	☐	☐	
S07: CHECK HYDRAULIC PUMP PRESSURES	☑	☐	☐	
S08: CHECK HYDRUALIC TANK LEVEL SENSOR	☑	☐	☐	
S09: CHECK ALL HYDRAULIC CONTROL HANDLES AND LINKAGES	☑	☐	☐	

SIGN OFF Leonardo Combero.

PUMP DRIVE SERVICE

REPAINT EQUIPMENT

SIX MONTH SERVICE

Action List	Completed	Deficiency	N/A	Comments
S01: INSPECT AND GREASE HOIST DRUM BEARINGS	☑	☐	☐	
S02: INSPECT AND GREASE LUFF DRUM BEARINGS	☑	☐	☐	
S03: INPECT AND LUBRICATE HOIST DRUM DRIVE BEARINGS	☑	☐	☐	
S04: INSPECT AND LUBRICATE LUFF DRUM DRIVE BEARINGS	☑	☐	☐	
S05: INSPECT AND LUBRICATE SLEW DRIVE BEARINGS AND GEARBOX	☑	☐	☐	
S06: INPSECT LIMIT SWITCH DRIVES	☑	☐	☐	
S07: INSPECT HYDRAULIC OIL TANK	☑	☐	☐	
S08: INSPECT SLEW DRIVE SPLINED PINIONS	☑	☐	☐	
S09: INSPCECT LUFF DRIVE SPLINED PINIONS	☑	☐	☐	
S10: INSPECT HOIST DRIVE SPLINED PINIONS	☑	☐	☐	
S11: INSPECT CRANE STRUCTURAL MEMEBERS AND WELDS	☐	☐	☑	

1/6/2023
07:52 AM

Work Order : NN2-5665

Status : Open
Unit Code : T440-13
Unit Description : Favco Tower Crane
Unit Make : Favco
Unit Model : M440
Serial Number : 1475

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Description	Employee(s)	Hours Worked	Parts
SIX MONTH SERVICE			

Action List	Completed	Deficiency	N/A	Comments
SIGN OFF Leonardo Cambero.	☑	☐	☐	

Comments The Whole maintenance service was completed by manufacturer specification procedure. —

NEWARK, NJ

NEW YORK CRANE 5/10/23

QUANTITY	PART NUMBER	PARTS DESCRIPTION	PRICE

UNIT NUMBER: DATE: TIME: 8 HRS.

CUSTOMER NAME:

CUSTOMER ADDRESS:

MACHINE LOCATION: 550 - 10th Avenue NEW YORK, N.Y. 10018

DATE REPAIRS REQUESTED: REQUESTED BY: S.I

MAKE: FAUCO SERIAL NUMBER: 1475

MODEL: M440E ENGINE HOURS/MILEAGE:

REPAIRS REQUESTED:

☐ ACCIDENT ☐ MAINTENANCE ☐ DAMAGE ☐ REPAIRS

REPAIRS COMPLETED: Diagnostic (Tower Crane Low Speed while Cabling up on the MAIN Hoist with Concrete Bucket on it.)

1) Checked And Tested the Hydraulic Pressure Setting ON MAIN and AUXIARY Pumps - Press up 300 bar (NO Accurate) Press Down 300 bar (NO Accurate)

2) ReAdjusted (Reset) MAIN Hoist pump AT : 350 bar Press Up.

3) ReAdjuste (Reset) Auxiliary Hoist Pump AT : 350 bar Press up.

4) Checked (Tested) Press down is 50 bar (OK Accurate).

5) Performed A Visual Inspection ON The Tower Crane Components And Everything Looks ON The Safety FACTOR At the time.

Labor: hr	
hr	
Total Labor:	
Total Parts:	
Mileage:	
Misc. Charges:	
SubTotal:	
TOTAL:	$

Service Representative L.C. Willy

Customer Signature

Date

5/18/2023
11:25 AM

Work Order :NN2-5910

Status :Open
Unit Code :T440-13
Unit Description :Favco Tower Crane
Unit Make :Favco
Unit Model :M440
Serial Number :1475
Job No :NY-304070

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Customer
Cross Country Construction LLC
5 West Main Street
Suite 103
Elmsford, NY 10523
Phone:(914) 909-6700

JobSite 550 10TH AVE
550 10TH AVE

NEW YORK, NY

Report To: _____ WP: _____ CP: _____ E-Mail: _____
Ordered By: _____ WP: _____ CP: _____ E-Mail: _____

- PERFORM MONTHLY INSPECTION

Hours Upper 18,525.0
Date 5/15/2023

Description	Employee(s)	Hours Worked	Parts
100 HOUR SERVICE			

AT TIME OF INSPECTION, MECHANIC FOUND CRANE TO BE IN GOOD WORKING CONDITION

Action List	Completed	Deficiency	N/A	Comments
100 HOUR SERVICE PER FAVCO MAINTENANCE MANUAL. REFER TO SECTION 5 OF THE INSTALLATION, OPERATIONS & MAINTENANCE MANUAL FOR PROPER PROCEDURE. SIGN OFF WHEN COMPLETED.	☑	☐	☐	
___S01: CHECK THE ENGINE OIL LEVEL	☑	☐	☐	
___S02: CHECK THE RADIATOR WATER LEVEL.	☑	☐	☐	
___S03: CHECK THE PUMP DRIVE OIL LEVEL	☑	☐	☐	
___S04: CHECK THE HOIST BRAKE AND FLUID CONDITION	☑	☐	☐	
___S05: CHECK THE LUFF BRAKE AND FLUID CONDITION	☑	☐	☐	
___S06: INSPECT & GREASE THE SHEAVE BEARINGS OF MAST, BRIDLE, BOOM AND HOOK SHEAVES ASSEMBLIES	☑	☐	☐	
___S07: INSPECT & GREASE HOIST DRUM BEARINGS	☑	☐	☐	
___S08: INSPECT & GREASE LUFF DRUM BEARINGS	☑	☐	☐	
___S09: INSPECT & LUBRICATE HOIST DRUM DRIVE BEARINGS AND GEARBOX	☑	☐	☐	
___S10: INSPECT & LUBRICATE LUFF DRUM DRIVE BEARINGS AND GEAR BOX	☑	☐	☐	

5/18/2023
11:25 AM

Work Order :NN2-5910

Status :Open
Unit Code :T440-13
Unit Description :Favco Tower Crane
Unit Make :Favco
Unit Model :M440
Serial Number :1475
Job No :NY-304070

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Customer
Cross Country Construction LLC
5 West Main Street
Suite 103
Elmsford, NY 10523
Phone:(914) 909-6700

JobSite 550 10TH AVE
550 10TH AVE

NEW YORK, NY

Description	Employee(s)	Hours Worked	Parts
100 HOUR SERVICE			

AT TIME OF INSPECTION, MECHANIC FOUND CRANE TO BE IN GOOD WORKING CONDITION

Action List	Completed	Deficiency	N/A	Comments
___S11: INSPECT & LUBRICATE SLEW DRIVE BEARINGS AND GEAR BOX	☑	☐	☐	
___S12: INSPECT THE HYDRAULIC OIL TANK	☑	☐	☐	
___S13: DRAIN OFF 1 LITER OF HYDRAULIC OIL TO REMOVE ANY CONDENSED WATER. IF WATER IS PRESENT, DRAIN UNTIL REMOVED AND TOP OFF WITH CLEAN OIL	☑	☐	☐	
___S14: CHECK ENGINE AIR CLEANER	☑	☐	☐	
___S15: CHECK HOIST ROPE LAY	☑	☐	☐	
___S16: CHECK THE ANNUNCIATOR TO ENSURE THE VISUAL AND AUDIBLE ALARMS ARE WORKING	☑	☐	☐	
___S17: CHECK THE HOIST UP LIMIT	☑	☐	☐	
___S18: CHECK THE HOIST DOWN LIMIT	☑	☐	☐	
___S19: CHECK THE LUFF IN LIMIT	☑	☐	☐	
___S20: CHECK THE LUFF OUT LIMIT	☑	☐	☐	
___S21: CHECK THE ENGINE/CRANE BATTERY (IF APPLICABLE)	☑	☐	☐	
___S22: CHECK POWERPACK HOLDING DOWN BOLTS/PINS	☑	☐	☐	
___S23: CHECK THE EMERGENCY STOP FUNCTION	☑	☐	☐	
___S24: CHECK THE SLEW LIMITS	☑	☐	☐	
___S25: TEST ALL FOUR CAVIATION SWITCHES	☐	☐	☒	
___S26: CHECK ENGAGEMENT FO LUFF LATCHET WHEN CRANE IS SHUTDOWN	☑	☐	☐	
___S27: CHECK THE HOIST ROPE FOR DEFECTS AND/OR FAILURE	☑	☐	☐	
___S28:CHECK THE LUFF ROPE FOR DEFECTS AND/OR FAILURE	☑	☐	☐	

5/18/2023
11:25 AM

Work Order : NN2-5910

Status Open
Unit Code T44[illegible]
Unit Description Favco Tower [illegible]
Unit Make Favco
Unit Model M440
Serial Number 1475
Job No NY-304[illegible]
JobSite 550 10TH AVE
550 10TH AVE

NEW YORK, NY

New York Crane and Equipment
286 Central Avenue
South Kearny, NJ 07032
(718) 254-9500

Customer
Cross Country Construction LLC
5 West Main Street
Suite 103
Elmsford, NY 10523
Phone:(914) 909-6700

Description	Employee(s)	Hours Worked	Date

100 HOUR SERVICE

AT TIME OF INSPECTION, MECHANIC FOUND CRANE TO BE IN GOOD WORKING CONDITION

Action List	Completed	Deficiency	N/A	Comments
S29 GREASE SLEW RING BEARING	☑	☐	☐	
SIGN OFF: Leonardo Cantero. L.C. Willy	☑	☐	☐	

Comments

This inspection was done on the Favco crane, [illegible]
[illegible] the end operator has left the area secured [illegible]

Exhibit 16 – Sampling of Photographs Taken

September 8, 2023
September 25, 2023
September 26, 2023
September 27,2023
October 24, 2023

September 8, 2023















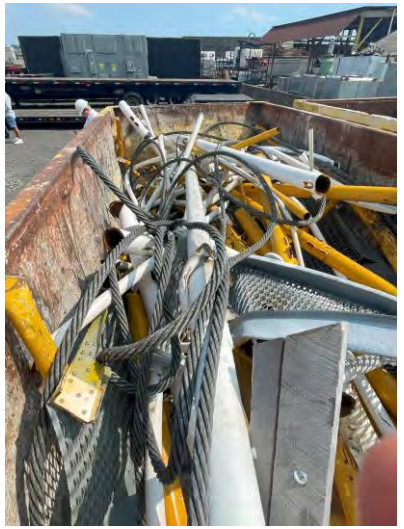














September 25 and 26 2023



Broken boom hoist rope



Length of boom hoist from drum
To frayed end. Added 1' because
Could not get to end and not straight



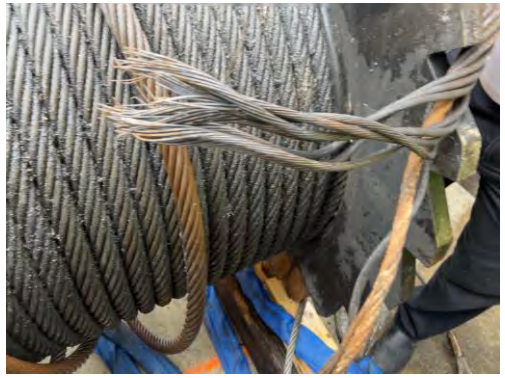
End of failed hydraulic hose



Evidence collected and displayed for interested parties



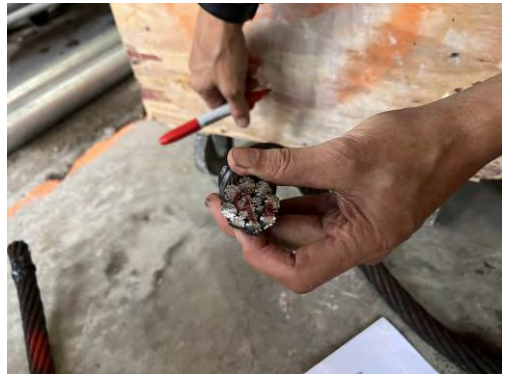
Broken heal section of the boom



Boom hoist drum with failed end



Rope section removed from
the site



Cut end of the boom hoist rope

September 27, 2023



Hydraulic hose removed with no fire damage



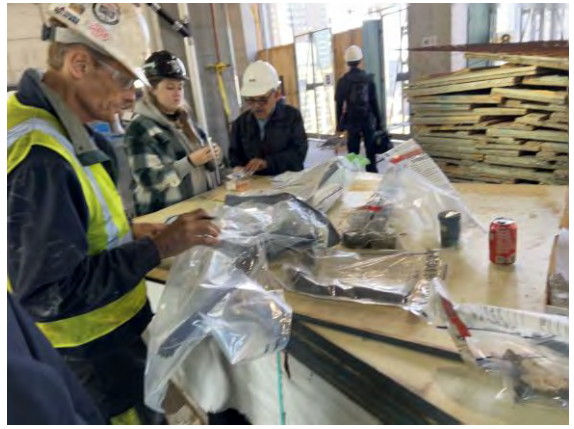
Climbing cooler pump



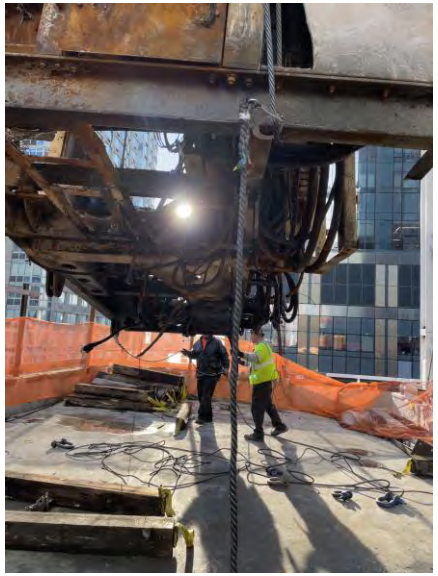
Sensor removed



Hose removed see above



Items removed from the crane on the 27th
DOI took custody

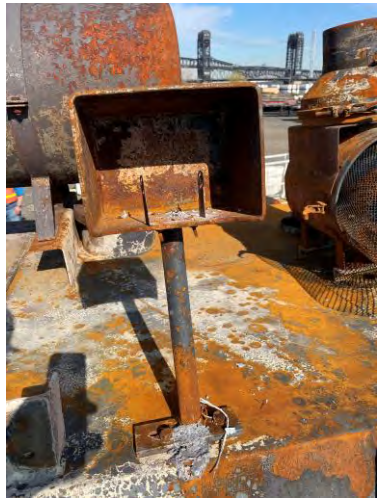


Underside of power pack

October 24, 2003



Rear Electrical panel



Housing for winch camera



Winch camera



Back of winch monitor



Side of power pack



Side of power pack



Debris removed from site immediately
After collapse

550 Tenth Avenue Crane Collapse Investigation
Field Observations of Crane LUFF Rope
February 25, 2025

Edgett Williams Consulting Group

Background:

A preliminary visual inspection was made of the LUFF rope (32mm steel wire rope), as it was initially removed from the jobsite. 3 samples of the LUFF wire rope were taken for optional future analysis.

1. The wire rope at the rupture.
2. A 2 ft section of wire rope approximately 8 ft away from the rupture site.
3. A 3 ft section of rope at the terminating thimble.

It is recognized that these above sampling areas of the LUFF rope are representative of the rope in both the area of rupture and in its undiminished strength areas.

Sept 26th Site Observations:

1. The intact steel wire rope remaining on the drum was visually inspected for signs of crown wire wear or breaks.

    a. No unusual wear was observed.



The wire rope was visually inspected at the site of rupture as shown in the following pictures.

b. The wires were void of lubricant and showed signs of surface rust.



c. The crown wire was easily bent indicating the wire has been fully annealed from its hard drawn state.



d. The wire has a gray scale on the surface and the bare wire was discolored blue/gray indicating exposure to elevated temperature.

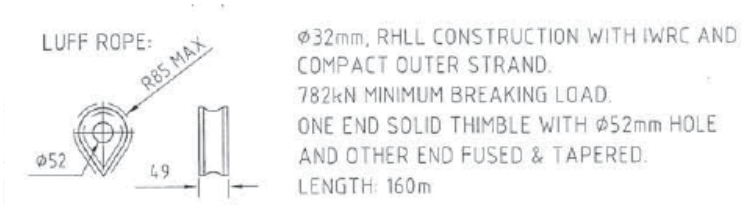


Oct 24th Off Site Observations:
A second review of the crane components was conducted where the equipment is currently located offsite. The following additional observations were made:

1. The LUFF rope diameter was confirmed to be 32mm and the main hoisting rope was confirmed to be 42mm per the crane data plate.



2. The LUFF rope construction is 8 x K26WS IWRC with compacted strands constructed of nominal 1770 MPa tensile wire. Resulting in a manufacturers minimum breaking load of 782 kN.



3. It is noted that the crane data plate calls for Right Hand Lang Lay (RHLL) construction, and the observed rope is Right Hand Regular Lay (RHRL). Regular lay and Lang's lay rope are depicted in the following diagram:



As seen in the diagrams the individual wires are oriented in line with the rope on regular lay and are at right angles to the rope for Lang's lay. Lang's lay construction is often specified to reduce the wear on sheave and drum surfaces.

Conclusions

All visual inspections of the LUFF wire rope outside of the area of heat exposure showed no signs of unusual wear or advanced wear as a result of its intended normal use. The deviation between regular lay and Lang's lay construction is deemed to have no impact on the wire rope load carrying ability nor it's reaction to rapid elevated temperature.

The LUFF wire rope as seen in pictures b, c, and d show evidence of exposure to a high level of heat at the point of rupture. This evidence is further substantiated in the Crane Tech Solutions Report estimating the temperature of the fire at the point of rope rupture to be in excess of 600 degrees Celsius. Exposure to elevated temperature will rapidly reduce the ultimate breaking strength of the wire rope. Studies of steel wire rope exposed to fire will rapidly elevate the temperature of the load carrying steel wires. This time frame may be as short as 5 to 10 minutes before the wires have reached significantly elevated temperatures. By comparison of typical wire rope wire ultimate tensile strength at ambient and elevated temperatures, it should be possible to make a reasonable determination of the wire rope breaking strength at the point of rupture. As cited in **Fire behavior of steel wire ropes: Experimental investigation and numerical analysis:** drawn wire with a crown wire tensile strength of 1800 mPa will decrease to 200 mPa at 600 degrees Celsius. This represents a decrease in crown wire tensile strength by a factor of 9.

The calculated factor of safety of the LUFF rope with the concrete load at the time of the incident was 6.0 and the calculated breaking force reduction due to elevated temperature is a factor of 9.

It is concluded that the fundamental cause of the loss of the crane payload is due to the load exceeding the ultimate strength of the rope at the point of the fire.

References

Fire behavior of steel wire ropes: Experimental investigation and numerical analysis V. Fontanari a,⇑ , M. Benedetti a , B.D. Monelli b , F. Degasperi c aUniversity of Trento, Dipartimento di Ingegneria industriale, Via Sommarive, 9, 38123 Trento, Italy bUniversity of Pisa, Dipartimento di Ingegneria Civile e Meccanica, Largo Lucio Lazzarino, 56126 Pisa, Italy c Laboratorio tecnologico impianti a fune (LaTIF), Via Provina 24, 38040 Trento, Italy

FAVELLE FAVCO CRANES

INSTALLATION, OPERATIONS, AND MAINTENANCE

CRANE TYPE	:	Tower Crane
CRANE MODEL	:	M440E
CLIENT	:	TES INC
CRANE SERIAL NO.	:	1475
DELIVERY DATE	:	MARCH 08
ENGINE TYPE	:	C-13

FAVELLE FAVCO CRANES PTY. LTD.
A subsidiary of Muhibbah Engineering Group
28 Yarrunga Street,
PRESTONS NSW 2170
SYDNEY AUSTRALIA

TELEPHONE : 61 2 9608 2000
FACSIMILE : 61 2 9607 0022
EMAIL : engineering@favellefavco.com.au

FOREWORD

This manual provides operation, maintenance, installation and parts list information for this crane.

It is intended as a guide to both the operator and the maintenance personnel to assist them in obtaining the maximum performance and life of the equipment.

The manual does not include manufacturing drawings. In the event of major repairs or replacements, FAVELLE FAVCO CRANES PTY. LTD. or their nearest representative should be contacted.

To use this manual, refer to table of contents. Then refer to the section and/or page, which contains the information. Page viii gives a list of Tables, charts and figures, which are used in this manual.

All information disclosed in this manual is to be considered confidential and proprietary by FAVELLE FAVCO CRANES PTY. LTD. and the owner. Communication of its contents to others should not take place without prior written consent FAVELLE FAVCO CRANES PTY. LTD.

FAVELLE FAVCO CRANES PTY. LTD.

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MANUAL REVISION

Responsibility

The manual holders are responsible for:

- Keeping their copies current and ensuring that all revisons are appropriately filed.
- Studying all new material issued and incorporating it into their work practice.
- Suggesting changes and contributing new text material to improve the quality of the manual.
- Disseminating information contained in revisions.

Initiating Revisions

Manual holders may initiate changes or add new text material by:

1. Marking up relevant pages with corrections or attach additions.
2. Mailing to Favelle Favco (email/ fax are accepted). Refer to front cover for mailing address.

When sending information quote following:

1. Company.
2. Senders name and contact details.
3. Crane model and serial number.

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Favelle Favco acknowledges, reviews and considers all material for inclusion in manual. Originators are advised of final dispostion of the request. Approved material is published as a revision.

When changes are made to a page, a replacement page will be issued. The new page will show the revision date, in the footer.

Filing Revisions

When a revision is received:

1. Read the text carefully.
2. Check the revision control sheet to ensure all pages have been received.
3. Remove and destroy the superceded pages.
4. Insert the revised pages in proper place.

REVISION CONTROL SHEET			
REVISION	DATE	PAGES	COMMENTS
A	OCT 08		Original issue
02/21/14	FEB 14	TOC, Section 3	Changed TOC and Section 3.8A Page 3-20-a

1 GENERAL DESCRIPTION

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1.0. General Statement

FAVELLE FAVCO CRANES are system designed and can be varied for individual requirements. The crane mainly comes in four basic configurations:

- Stationary Base
- Internal Climbing
- External Climbing
- Rail Base

The design allows for variations in the power source using diesel engine or electric motor and variations in boom length to give the exact requirements of lifting capacity and boom radius. There are also winch options to various single line speeds and hook capacities.

The crane is generally erected by means of a mobile crane on site. With the addition of an external climbing frame, the crane may then be climbed to its full height by adding tower sections. After climbing the crane to its desired height, the climbing frame may be dismantled and used for other cranes of the same model.

In the instance of internal climbing configurations, the crane upper is erected on the maximum allowable free standing towers as it is not possible to add tower sections after this stage unless and external climbing frame is utilised.

The slew mount is a rigid welded structure which is bolted to the crane tower and to which the slew bearing is fastened. The slew bearing has an integral gear to provide a drive via an hydraulic motor and gearbox situated on the machinery deck.

The machinery deck can rotate a full 360° in either direction. The machinery deck supports the power pack, the hoist and luff winches, the drivers cabin and the counterweights.

The 'A' frame or mast is pin connected to the machinery deck and carries the sheaves for the luff reeving and the boom buffer assembly.

The boom sections are of tubular steel construction, fully welded, high yield steel, pin connected with various insert lengths. All sections are jig assembled to allow interchangeability of sections for boom extension. Boom extensions in any length are available from the manufacturer.

Tower sections are of electrically welded construction and are braced for maximum torsional bending strength. Connection is made by high tensile steel bolts at each corner, developing the full strength of each corner. The tower sections have included a platform and ladders to provide access to the machinery deck.

The counterweights consist of heavy steel plate sections, which are supported on the rear of the machinery deck.

The cabin is ergonomically designed to provide maximum efficiency of operation in all weather and site conditions. All windows are of safety glass structure with side windows slide opening to provide adequate ventilation. All motion controls come readily to hand. The cabin seat is fully adjustable to provide optimum comfort. It is also equipped with lifting armrest. Excellent visibility is provided for the operator with full length front window shaped to allow full vision when looking down without need to leave his seat. Air conditioning is fitted as standard equipment.

Power for all motions is supplied by turbocharged diesel engine through which a gearbox drives the axial piston variable displacement pumps. All pumps are connected in closed loop or hydrostatic transmission system to variable displacement motors for hoist and luff motion, and a fixed displacement axial piston motor for the slew motion.

Motors drive through multi-disc brakes and two or three stages (depending on motion) planetary gearboxes, the pinions, which mesh with the individual drum gears and the internal slew ring gear.

Brakes are holding brakes only, with a minimum static capacity of 1.5 times motor torque.

All operating controls for the crane movements are by sensitive 'dead man' type hydraulic pressure related controls. These incorporate the brake control as the brakes are automatically applied when the control lever is in the central position. The control valves give stepless control to each crane motion with all motion speeds having been selected to give optimum safety in control under any load condition.

The engine and crane safety system is powered by the 24 volt engine alternator.

The key that operates the ignition switch is to be kept remote from the crane during shutdown, preventing unauthorised use or starting of engine.

Where necessary, all electric's are wired in a fail-safe mode, ie. automatic shutdown of engine, functions or switching into a safe mode of operation.

The following general crane technical brochures give tower and shipping details, as well as other relevant information such as the hoist speed curves. These are followed by the load chart and the rope specification plate.

The cranes hydraulic system will work efficiently in an ambient temperature of between 0° and 40° Celsius.

1.1 Major Crane Components

1.1.1 Slew bearing

The slew bearing is bolted to both the deck and slew mount and has an integral gear to provide a drive via one hydraulic motor and gearbox situated on the machinery deck.

1.1.2 Machinery deck

The machinery deck is a fully welded construction. It can continuously rotate in either direction, or its rotation can be also restricted to suit to customers' requirements, via an optional slew limit. The deck supports the power pack, main hoist, auxiliary hoist, luff winches, and the driver's cabin. It also accommodates the mast and the boom. Access to the machinery and cabin is provided by external platforms and ladders. An additional ladder and platform is provided for the maintenance of the mast head sheaves and rope. An internal ladder is also provided to allow access inside the slew mount adaptor for maintenance of the slew drive, transit lock internal slew ring teeth and slip ring.

Incorporated in the machinery deck is a diesel fuel tank, a sludge tank and hydraulic tank.

The bottom plate of the deck is machined to accommodate the slew ring and slew drive.

1.1.3 Mast

The mast is pin connected at the base. It carries the sheaves for the luff reeving and the boom buffer assembly. All parts are pin connected to the machinery deck. A mast monorail if supplied, provides a lifting point to assist with maintenance of large powerpack and winch items.

1.1.4 Boom

The boom sections are of tubular steel construction, fully welded, high yield steel, pin connected with various insert lengths. All sections are jig assembled to allow interchangeability of sections for boom extension. Boom extensions in standard lengths are available from the manufacturer.

All sheave pins are fitted with grease nipples and must be lubricated when boom is stowed or lowered for maintenance. (Grease regularly - refer to the Maintenance section for further details).

1.1.5 Control cabin

The cabin is ergonomically designed to provide maximum efficiency of operation in all weather and site conditions. All windows are made of safety glass with slide open side windows to provide adequate ventilation. All motion controls come readily to hand. The front window is supplied with windscreen wiper(s).

The cabin seat is fully adjustable to provide optimum comfort. Excellent visibility is provided for the operator with full-length front window configured to allow full vision when looking down without the need to leave the seat.

1.1.6 Winch, Powerpack and the Electrical system

The machinery of this crane consists of the following:

- Power pack
- Main hoist winch
- Luff winch
- Slew drive and
- Auxiliary hoist winch (if fitted)

The power pack and the winch frame are all pinned to the machinery deck.

Power for all motions is supplied by a diesel engine which indirectly drives the variable displacement axial piston pumps, through a gearbox. All motion pumps are connected in closed loop or hydrostatic transmission system to variable or fixed displacement motors for the hoist, luff and slew motion.

Motors drive through multi-disc brakes and depending on motions, includes two or three stage planetary gearboxes. The drive continue through the pinions, which mesh with the individual drum gears and the internal slew ring gear. The luff drum is fitted with a ratchet, which engages automatically whenever the engine stops or boost pressure is lost.

The disc brakes are holding brakes, with a minimum static capacity double the motor's dynamically rated torque.

All operating controls for the crane movements are by sensitive 'dead man' type electronic controls. These incorporate the brake control as the disc brakes are automatically applied when the control lever is in the central position. The control valves give stepless control to each crane motion with all motion speeds having been selected to give optimum safety in control under any load condition. The slew brakes are held off hydraulically during normal operation to avoid pendulation and are

and are applied for parking by means of a manual lever control in the operators cabin.

The crane electrical safety system is powered from the 24V control circuit.

The key that operates the ignition switch is to be kept remote from the crane during shutdown, preventing either unauthorised use or starting of engine.

Where necessary, all electrics are wired in a fail-safe mode, ie. automatic shutdown of engine, functions or switching into a safe mode of operation.

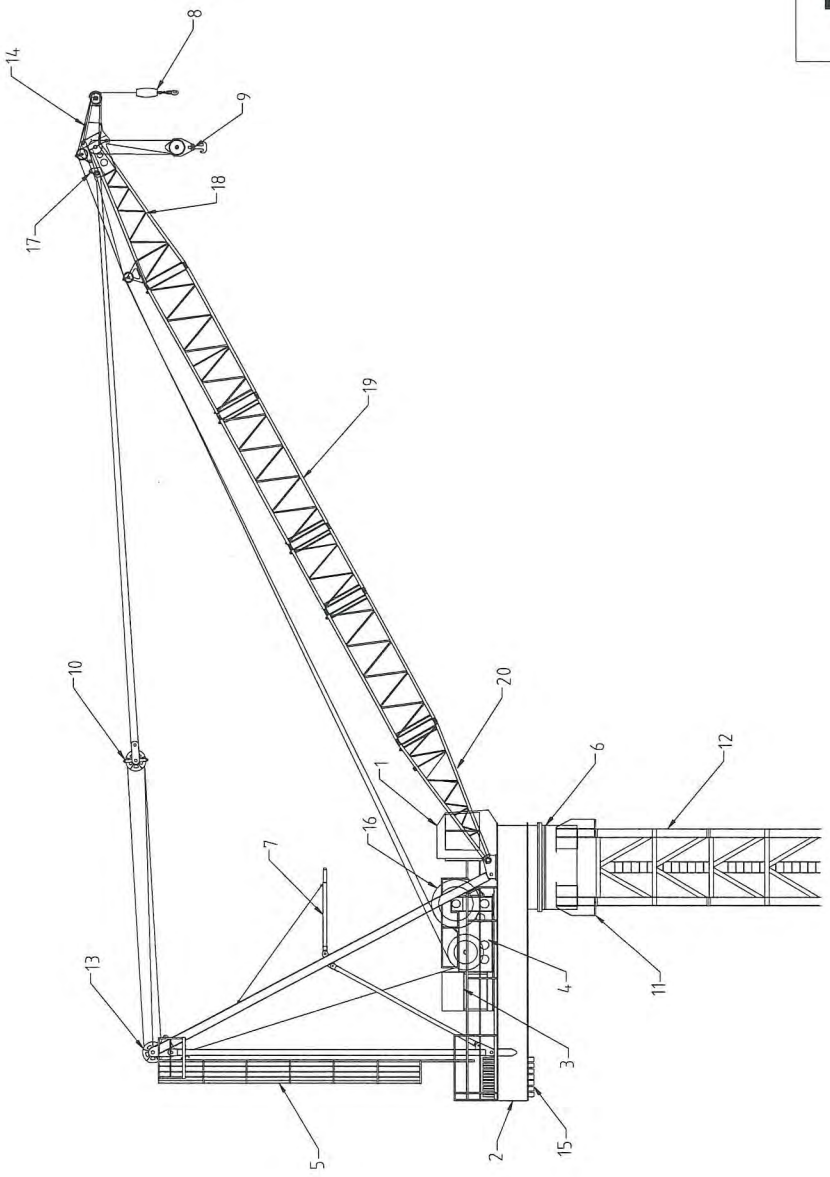
The crane's load chart and rope specification plate are located in section 6 Drawings.

Item	Description
1	MACHINERY DECK (FRONT) CABIN
2	MACHINERY DECK (BACK) & PLATFORMS
3	POWERPACK
4	WINCH UNIT
5	MAST
6	SLEW RING
7	BOOM BUFFER
8	FLY HOOK
9	MAIN HOOK
10	BRIDLE
11	SLEW MOUNT
12	TOWER SECTION
13	MAST BRIDLE
14	FLY JIB
15	COUNTER WEIGHT
16	MAIN HOIST WINCH
17	SAFE LOAD CELL
18	TOP BOOM
19	BOOM EXTENSION
20	BOTTOM BOOM

FAVELLE FAVCO Favelle Favco Cranes Pty. Ltd. A.C.N. 067 562 449

M220DX - GENERAL DESCRIPTION

M220DX Tower Crane



1.2 Safety

The importance of safe operation cannot be over emphasized. Carelessness and neglect on the part of operators, job supervisors and planners, rigging personnel, and job site personnel can result in their death or injury and costly damage to the crane or property.
The safety information in this publication is intended only as a guide to assist qualified operators in safe operation.

Favelle Favco Cranes cannot foresee all hazards that will arise in the field; therefore safety remains the responsibility of crane operator, maintenance workers and crane owner.

1.2.1 Operator qualifications

The crane shall be operated only by the following qualified personnel:
1. Designated operators
2. Trainee under the direct supervision of a designated operator
3. Inspectors and maintenance or test personnel when necessary in the performance of their duties.

ATTENTION ***No other personnel shall be allowed to enter operator's cabin while crane is in operation***

Qualified person is defined as one who by reason of training and experience is thoroughly familiar with crane operations and the hazards involved. Such a person shall be physically and mentally fit to operate cranes.

ATTENTION ***Operator training and qualifications is crane owner's responsibility***

1.2.2 Operator Conduct

1. The operator shall not engage in any practice, which diverts their attention while operating the crane.
2. The operator shall not operate the crane when physically or mentally unfit or under the influence of drugs or alcohol,
3. The operator shall be responsible for all operations under their direct control. When the safety of an operation is in doubt, the operator shall have the authority to stop the operation and refuse to continue until the unsafe conditions have been corrected.
4. The operator shall be thoroughly familiar with operation of the crane and its proper care. If adjustments or repairs are necessary of if there are know defects that impair safe operation, the crane shall not be operated until the unsafe conditions have been corrected.
5. If there is a warning sign at the start controls, the operator shall not start the engine until the sign has been removed by the person who installed it.

6. Before starting the engine, the operator shall make sure that:
   a) All daily inspection and maintenance services have been performed.
   b) All controls are in the off position and all brakes and locking devices are applied or engaged.
   c) All personnel are in the clear.
7. The operator shall test all controls, limits and communication systems at the start of each shift. Any defects found shall be corrected before operation is begun.

The operator shall not lift any loads if the machine exceeds the levelness tolerance of 0.5%. The machine must be level before lifting loads.

8. The operator shall not start crane movement if the load or designated signal person is not within their range of vision.
9. The operator shall respond to signals from the person directing the lift or from the designated signal person. When a signal person or crane follower is not required, the operator is responsible for the lift. Operator shall obey a stop signal at all times, no matter who gives the command.
10. The operator shall verify that the capacity chart being used is the correct one for how the crane is equipped (boom length, load line reeving, counterweight, etc).

WARNING ***The only load charts that may be used with this crane are those included in the Drawing Section of this manual. Do not use any other capacity charts with this crane. If capacity charts are missing contact Favelle Favco Cranes.***

11. The operator shall verify that the counterweight (if required) is in place and of the proper weight. Maximum required counterweight shall not be exceeded.
12. The operator shall perform the following operations before leaving the operators cabin for any reason:
    a) Park the crane and position the upper works so the crane does not interfere with operation of other equipment
    b) Land any attached load
    c) Move all controls to off
    d) Stop the engine
13. The operator shall perform the following operations if power or a control function fails during operation:
    a) Land all suspended loads
    b) Switch off all controls to off
14. If the crane will be operated at night, the operator shall make sure that there is sufficient lighting for safe operation. The load and landing area shall be illuminated.
15. The operator shall not operate the crane during periods of bad weather if his ability to see the load or signal person is impaired by darkness, fog, rain, snow, etc.

16. Wind can cause the crane to tip or the boom and other attachments to collapse. The operator or the designated person directing the lift shall compensate for the effect of wind load and boom by reducing speeds, or combination of both.

    Unless otherwise specified on the load chart, stop operation under the following wind conditions

    a) If the wind causes the load to swing forward past the allowable operating radius or sideways past either the boom heel pin, land the load.

    b) If the wind exceeds the limit stated on the appropriate load chart, land all loads and apply brakes.

17. Booms sections or mast are being assembled or disassembled on ground (with or without support of boom rigging) shall be securely blocked to prevent dropping of the boom section or mast.

    Workers shall not go under boom sections or mast sections when removing connecting pins.

1.2.3 Handling the load

A Size of load

1. The crane shall not be loaded beyond the applicable rated capacity
2. The operator or designated person directing the lift shall verify that the weight of the load is within the rating for the radius which the load will be lifted
3. The load chart for the crane is kept in the operator's cabin.

B Attaching the load

1. Attach the hook to the load with slings, or other suitable rigging. Each hook shall have a latch that is in proper working order. Hook latches shall not be wired open.
2. Only use sling and other rigging, which are in safe operation condition and have a rating equal to or greater than the load to be lifted.
3. Do not warp the load line around the load
4. Use suitable protection between slings and sharp edges on the load
5. Secure unused legs of a multi leg sling before handling a load with one leg of the sling.

C Lifting/ Moving the load

1. Before lifting or moving the load, the operator or the designated person directing the lift shall make the following checks:

a) The load is secured and properly balanced in the slings or lifting device before lifting the load more than few centimetres /inches.

b) The lift and swing paths are clear of personnel and obstructions.

c) The load is free to be lifted.

d) The load line is not kinked or otherwise damaged.

e) Multiple part load lines are not twisted around each other in such a manner that the lines will not separate when the load is lifted.

f) The hook is brought over load in a manner that will minimize twisting or swinging.

g) The load line and boom hoist ropes are properly spooled on the drums and seated in the sheaves.

h) The operator shall test the brakes each time a load approaching the rated load is handled by lifting the load a few centimetres/inches and positioning the control handle in neutral.

2. While lifting the load, the operator shall take the following precautions:

a) Accelerate and decelerate the load smoothly to avoid excessive stress on the crane boom and machinery.

b) Avoid sudden starts and stops while swinging. Keep the swing speed under control to prevent the load from swinging out beyond the radius at which the load can be handled and to minimize the pendulum action of the load.

c) Use taglines or other restraints to control the load when necessary.

d) Do not exceed any swing limitations (areas of operation) given on load chart.

e) Do not allow the load, the boom or any other part of the crane to contact obstructions.

f) Do not hoist, or lower, or swing the load while personnel are on the load hook

g) Avoid carrying the load over personnel. Loads, which are suspended, shall be blocked or supported by the ground or a suitable structure before personnel are allowed to work under or between them.

h) Operate with caution when using two or more cranes to lift the same load. One designated person shall be responsible for the operation when two or more cranes are used to lift the same load. The designated person shall analyse the lift and instruct all personnel involved in the proper rigging and positioning of the load and all movements to be made. Decisions such as the necessity to reduce crane ratings, load position, boom position, ground support, and speed of movements shall be in accordance with the designated persons decision

i) Do not lower the load or the boom to the point that less than two full wraps of wire remain on the respective drum.

D Holding the Load

When a load is suspended, the operator shall take the following precautions;

1. Not leave their position at the controls
2. Not allow personnel to stand or pass under the load
3. Move controls to off

E Signals

1. Signals to the operator shall be in accordance with the standard signals.
2. The operator should easily understand all signals to the operator at all times. The operator shall not respond to any signals, which are not clearly understood.
3. When it is necessary to give instructions to the operator, all crane motions shall be stopped.
4. The signal person shall:
   a) Be qualified by experience with crane operations and thoroughly familiar with the standard signals.
   b) Be positioned in clear view of the operator. The signal person's position should give him or her a clear view of the load, the crane and the operating area.
   c) Direct the load so the load does not pass over personnel.
   d) Keep unnecessary personnel out of the crane's operating area.

F Getting onto or off crane

1. Personnel getting onto or off the crane shall do so only at designated areas and only while the crane is parked.
2. When personnel use ladders to get onto and off the crane, their hands shall be free of any objects. Objects that cannot be carried in pockets or tools belts shall be lifted into place with a hand or hoist.

G Cabins, Ladders and Walkways

1. Necessary clothing and personal belongings shall be stored so they do not interfere with access to the operator's cabin or with operation of the crane
2. Tools, oil cans spare parts and other necessary equipment shall be stored it toolboxes and not allowed to lie around loose in the operators cabin or walkways and stairs. All waste shall be disposed off.

H Refuelling

1. The engine shall be stopped before refuelling the crane
2. Smoking and open flames shall be prohibited in the refuelling area

I Fire Extinguishers

1. A portable fire extinguisher with a minimum rating of 10BC shall be installed in the cabin at all time.
2. The operator and all maintenance personnel shall be thoroughly familiar with the location, use and care of the fire extinguisher.

1.2.4 Safe maintenance practices

ATTENTION ***Training/ qualification of maintenance personnel is responsibility of the crane owner.***

1. Perform the following steps before starting a maintenance procedure:
   a) Park the boom where it will not interfere with other equipment or operations
   b) Lower all loads to the ground
   c) Move all controls to off and secure all functions against movement by applying or engaging all brakes.
   d) Stop the engine and render the starting means inoperative.
   e) Place warning signs at the start controls alerting other personnel that the crane is being serviced.

ATTENTION ***Do not remove sign until it is safe to return crane to service.***

2. Do not attempt to maintain or repair any part of the crane while the engine is running, unless absolutely necessary.

   If the engine must be run, keep your clothing and all parts of your body away from moving parts. Maintain constant communication between person at controls and person performing maintenance or repair procedure.
3. Wear clothing that is relatively tight and belted.

ATTENTION ***Do not wear loose fitting clothing***

4. Wear appropriates eye protection and an approved hard hat.
5. When climbing onto the crane use both hands and the handrails, steps and ladders. Lift tools and other equipment, which cannot be carried in pockets or tools belts onto and off the crane with hand lines or hoist.
6. Hydraulic oil can cause serious injury. Make sure all hydraulic lines, fittings and components are tight and serviceable.
7. Relieve pressure before disconnecting hydraulic lines and fittings.
8. Do not remove the radiator cap while the coolant is hot or under pressure. Stop the engine, wait until pressure drops and the coolant cools, and then slowly remove the cap.
9. Avoid battery explosion: do not smoke while performing battery 1maintenance; do not short across the battery terminals to check its charge.
10. Avoid battery acid contact with skin and eyes. If contact occurs, flush the area with water and immediate consult a doctor.
11. Stop the engine before refuelling the crane.
12. Do not smoke or allow open flames in the refuelling area.
13. Hydraulic oil can be also flammable. Do not smoke or allow open flames in the area when filling hydraulic tanks
14. Never handle wire rope with bare hands. Wear leather rigging gloves
15. Only use cleaning solvents, which are non-volatile and non-flammable.

16. Do not lift heavy components by hand. Use a hoist jack, or blocking to lift components
17. Use care while welding or burning on crane. Cover all hoses and components with non-flammable shields or blankets to prevent a fire or other damage.
18. When assembling and disassembling booms, jibs or masts on ground, securely block each section to provide adequate support and alignment. Do not go under boom or mast sections while connecting bolts or pins are being removed.
19. Unless authorized in writing by Favelle Favco do not alter the crane in any way that might affect the performance. (to include welding, cutting, or burning of structural members or changing pressures and flow of hydraulic components). Doing so will invalidate all warranties and load charts and make the crane owner liable for any resultant accidents.
20. Keep crane clean. Accumulations of dirt grease, oil rags, paper and other waste will not only interfere with safe operation and maintenance but also create a fire hazard.
21. Store tools, oils cans, spare parts and other necessary equipment in toolboxes. Do not allow these items to lie around loose in the operators cabin or on walkways.
22. Do not store flammable materials on the crane.
23. Do not return the crane to service at the completion of maintenance or repair until all guards and covers have been reinstalled, trapped air has been bled from the hydraulic systems, safety devices have been reactivated, and maintenance equipment has been removed.
24. Perform a function check to ensure proper operation at the completion of maintenance or repair.

1.3 Warranty

FAVELLE FAVCO CRANES warrants its products to be free from defects in material and workmanship for a period of twelve (12) months from the date after the delivery of the project to the client. The obligation of FAVELLE FAVCO CRANES, (the company) under this warranty is limited to repairing or replacing, in the company's opinion, equipment defective in material or workmanship. All costs of shipping the product to or from the company's factory shall be to the purchaser's account. No claim under this warranty will be allowed by the company unless such claim is submitted in writing to the company within thirty (30) days of the date of discovery of the defect.

This warranty shall not apply to products which have been operated in a manner other than recommended by the company or which have been misused or neglected or damaged through an accident or which have been repaired, altered or modified or used in any manner which in the company's opinion adversely affects its performance.

This warranty and the company's obligation hereunder is in lieu of all other warranties, expressed or implied without limitation, the implied warranties of merchant ability and fitness for a particular purpose and all other obligations or liabilities, including liability for direct, indirect or consequential damages with respect to the sale of the use of the product.

No person is authorised to change or otherwise modify this warranty or assume any other liability on behalf of the company unless such change, modification or assumption is made in writing and signed by an officer of the company.

Any item of the product not manufactured by the company shall not be covered by this warranty or the implied warranties of merchant ability and fitness for a particular purpose or any other warranty from the company, such items being subject to the warranties of their respective manufacturers.

FAVELLE FAVCO CRANES

1.4 Wind Load Charts

The wind load charts are continually revised and updated according to new design standards. Therefore the wind load charts will be changed without notice. Prior to foundation calculation the engineer must ensure the wind load charts are latest update.

NOTE: ***Contact Favelle Favco Cranes for Latest Revisions on Wind Load Charts***

2 ERECTION

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2.1 Delivery Checks

2.1.1 General

Each component of the crane must be checked for immediately after delivery to site. Components can be damaged during transport, and is important that any damage incurred during transport be discovered prior to erection so that safe operation and structural integrity of the crane are not affected. Any damage must immediately be reported to Favelle Favco Cranes Pty. Ltd., who will decide whether the damaged component can be repaired or if a new part is required.

2.1.2 Check List

The following check list will be of assistance when checking a crane after delivery to the site:

Item	Crane Arrival	Check
1	Check that delivery is complete (compare with delivery dockets and delivery specification).	
2	Make a note of all damage and describe same, obtaining truck driver's name and vehicle registration number for your insurance purpose.	
3	Ensure that components have adequate support and are clear of mud, water etc., when stored on site.	
4	Structural components shall be free from deformations.	
5	Crane wire ropes shall be clean, well lubricated and stored on reels for transportation.	
6	Ensure that all connector pins, washers and fastening devices are on site and adequately lubricated ready for initial assembly.	
7	Check all oil and water levels on power pack and winch frame assembly to top up where necessary (See lubrication schedule for grades and quantities).	
8	Ensure that diesel fuel tank has enough fuel to complete erection and test.	
9	Ensure that batteries are fully charged or have at least enough capacity for several starts.	
10	Repair by touch up damaged and scuffed areas of paintwork.	

2.2 Erection Accessories

2.2.1 General

The crane is erected by means of a mobile crane to a low height, generally a minimum of four tower sections as in the case of and external climbing configuration. For internal climbing it is necessary to erect the crane upper on the total tower sections required, as it is not possible to add tower sections to and internal climbing frame. For rail mounted configurations check ballast requirements prior to erection of crane upper.

2.2.2 Mobile Crane

To select the size and capacity of the mobile crane the following conditions must be taken into consideration:

- The location on site must be taken into consideration with regard to ground conditions, access roads, ramps and available space for assembling the boom.
- The weight and dimensions of the heaviest component must be allowed for.
- Also, consideration must be given to the lifting height and working radius with which the mobile crane must work at the lift.

2.2.3 Erection Gear

All major components such as the mast, winch unit, counterweights and machine deck and boom have lifting lugs for each component.

Ensure that adequate slings, webbing sling and tackle are available on site and conform to the local statutory requirements.

Chains must not be used under any circumstances on boom section as these sections are manufactured from thin wall, high tensile tube.

Lifting beams must be of adequate strength and conform to the requirements of the relevant authorities.

2.2.4 Impact Gun

A suitable impact gun will be required to adequately tighten the tower bolts. Ensure that the necessary drive reducers are available to fit the sockets used. Tightening torques for lightly oiled bolts for climbing frame to tower, tower to tower or tower to slew ring mount, are listed in drawing A4-9900.578 at the end of Section 2 (Figure 2.2).

2.2.5 Slew Ring Bolt Sockets

Again, ensure that spare sockets are available although it is possible to use heavy duty impact sockets 3/4" or 1" drive. Note that hardened steel washers are required on the top and bottom ring bolts, between bolt or nut and the crane flange. No washer required in contact with slew ring. Refer to the slew ring assembly drawing, in the drawing section 6.

2.2.6 Reeving Rope and Sock

A manila or hemp reeving rope complete with 'wire rope sock' will be required to assist the reeving of the luff and hoist wire ropes. Ensure that the 'sock' will pass over the respective 'buttons' on the wire ropes.

2.2.7 Drum Reel Support

A stand for the reels of wire rope will be required so that the luff wire and hoist wire may be winched on to their respective drums without kinking and twisting.

2.2.8 Erection Pendants (optional)

The two erection pendants connect the boom assembly to the mast and assist in reeving of luff rope, by temporarily supporting the boom.

2.2.9 Climbing Collars

When ladder climbing, climbing collars must be used to support the crane tower and are connected to the building to transfer the loads imposed by the crane. If the collar is located between tower panel points, towers may have to be reinforced, or use box reinforced towers at collar/Lateral support. see drawing in this section.

2.2.10 Building Ties

When climbing externally, building ties are required to horizontally support the towers. Towers may have to be reinforced, or use reinforced towers if ties are placed away from horizontal members of the tower section.

2.3 Crane Erection - General

On completion of starter leg foundation base for either external or internal climbing cranes. The point below should be considered before erection of crane.

1. The crane components have been checked and are in working condition.

2. If internal climbing tower is required, ensure tower support guide collar and lateral bracing is present.

3. Adequate mobile cranage, including lifting slings, erection gear etc., is available.

4. Adequate construction crew is present and appropriate tools available for the job.

5. A service Engineer be notified to commission the crane on completion of erection.

ATTENTION ***If the wind speed exceeds 10m/s or bad weather is predicted, erecting or climbing shall not take place.***

2.4 Erection of Tower Crane with Internal Ladder Climber Frame

There are two options, depending on the building site requirements for erection of internal climbing cranes.

ATTENTION ***The free standing height of the crane above the top support collar depends on the type of tower section, local weather and the conditions of the surrounding structure. It must be confirmed by Favelle Favco and/or the responsible site engineer for each application.***

2.4.1 Option 1

The bottom climbing section, including the climbing cylinders, is erected and bolted onto cast-in starter legs. The correct number of towers as planned for the building are then erected on the bottom section. The slew mount is then bolted onto the top tower. When all the bolts have been correctly tightened, the tower is ready to receive the crane upper section.

2.4.2 Option 2

When the building is part erected, the crane tower can be supported in the building. The tower will require two supports at a vertical spacing of a minimum of 12m (for standard components). One support can be the building floor or a support collar which is mounted to the building. The bottom climbing section is lowered through the building to its support position. The correct number of towers are erected on the bottom tower and the mount is installed. When the vertical and lateral supports are in place, and all the bolts have been correctly tightened, the tower is ready to receive the crane upper section.

NOTE: ***When climbing internally, additional tower sections can only be added if a multipurpose slew ring mount is used and an external climbing frame is available to suit the tower sections. It is impossible where transition tower are used and where the total mass of tower and crane exceeds the climbing cylinder lifting capacity.***

ATTENTION ***When bolting or placing climbing frame, make certain that the ladders between floors coincide with the flippers in the internal ladder climbing frame.***

Tightening torques for lightly oiled bolts for climbing frame to tower, tower to tower or tower to slew ring mount, are listed in drawing A4-9900.578 at the end of Section 2.

Hydraulic hoses from control valves in climbing frame are threaded through all tower sections and secured. Hose ends are carefully rolled up and stored on top tower platform ready for climbing operation.

For climbing frame assembly and hydraulic climbing circuit refer to Section 6 "Drawings".

2.5 Internal Ladder Climbing Details

To aid in the understanding of the following procedure, refer to diagram shown.

The initial climbing operation must always be carried out under the supervision of a commissioning engineer, who will

1. Instruct the crane driver of correct operation and climbing procedures.
2. ensure that the climbing cylinders are full of oil and that there is no possibility of air being trapped in the cylinders, and
3. Check and adjust the safety throttling valves on both cylinders.

Before commencement of climbing, ensure that the tower will be guided by climbing collars at two positions throughout the complete operation. These guides must be at least 11 metres apart for the use of tower sections and are steel frames attached to the building steelwork. Refer to the site service structures engineer for building reactions, from which a climbing configuration can be established.

The crane must be balanced and the skid guides of the climbing collars must be accurately positioned clearing the tower leg by approximately 3 mm. If the crane moves out of vertical due to inadequate guiding, lateral loads imposed by the crane on the supporting structure will be significantly increased once operation is resumed.

Balancing the crane is dependent on the boom length and is accomplished as follows:

30 tonne Counter weight		
Boom Length	**Mass on Hook**	**Approx. Balance Boom Radius**
24.7 m	5.1 T	22.5 m
29.3 m	3.3 T	27.5 m
33.9 m	1.9 T	32.5m
38.5 m	0.8 T	37.5 m
47.7 m	0 T	38.5 m
52.3 m	0 T	36.0 m
56.9 m	0 T	36.5 m
61.5 m	0 T	34.5 m

Connect the climbing hoses to the climbing frame taking care not to allow dust or foreign matter to enter the system. Dust caps are provided, however, these are sometimes lost during previous climbing exercises.

The climbing control valve located at the front of the winch unit is locked in supplying oil to the bottom control valve, with the engine throttle set at approximately 1500 - 1800 rpm. The crane should commence to rise slowly, when control valve in internal climbing section is operated. If there is not visible movement, check for obstructions or an out of balance condition.

NOTE ***While extending the two (2) climbing cylinders, the oil level in the hydraulic tank will drop below the minimum level and the annunciator in the cabin indicates visual and audible.***

ATTENTION ***Under no circumstances must the oil tank be topped up at this condition, as the tank will overflow when cylinders are retracted***

Raise the crane, for the first time, approximately 2.0 metres to enable the upper pivoting brackets to support the crane on the ladder.

Lower the crane by reversing the climbing control valve until the load is taken on the upper pivoting brackets. Further retract the cylinders until climbing foot pivoting supports can rest on the next bottom rung of the ladder.

Care must be taken to equalise the retraction rate of the cylinders, by means of the manually controlled balancing valve located at the base of the tower, to ensure that the support beam remains in the horizontal position.

NOTE ***It is recommended to lower the crane with engine at approximately 1000rpm***

Repeat climbing procedure as above, lifting crane two rungs at a time, until lower pivoting brackets support the crane on the first of lower climbing support frame.

ATTENTION ***While the crane rests on the first supporting climbing collar and is laterally supported by the first and second collar (11 m minimum distance) a third collar must be fitted before climbing can commence.***

WARNING ***Before operating the crane in this new position always ensure that the crane is checked at the two levels of lateral support. These supports must be located at a position no more than 150mm from a panel point (junction between a horizontal brace and the tower leg). If this is not practically possible, the tower must be reinforced accordingly***

At no time should lateral loading be applied to any of the pivoting brackets.

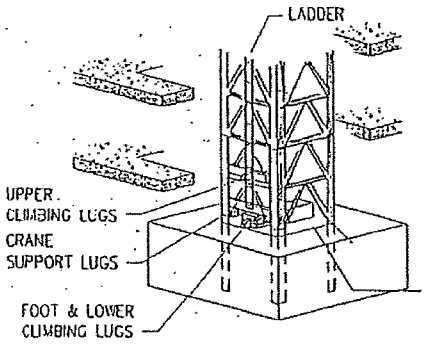
For climbing procedures refer to the following drawings.

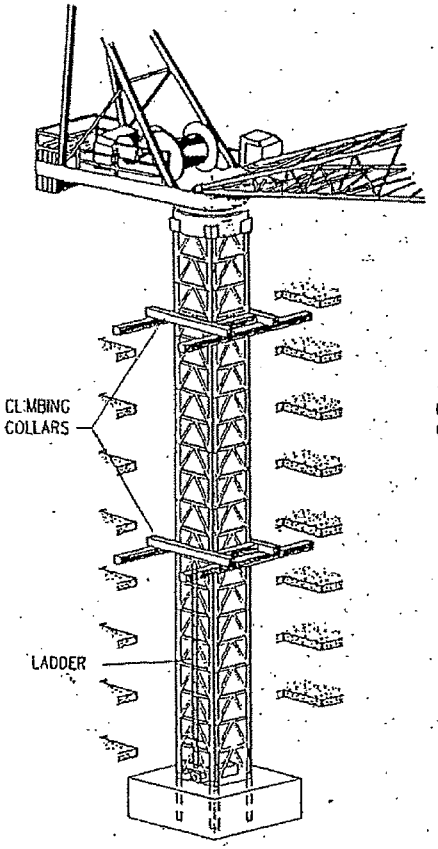
INTERNAL LADDER CLIMBING PROCEDURE

1 Install climbing collars and ladder Balance the crane upper , remove the base bolts and raise the crane, using hydraulic rams , allowing the climbing supports to skid past and then rest on a ladder rung . climb the ladder in this manner.

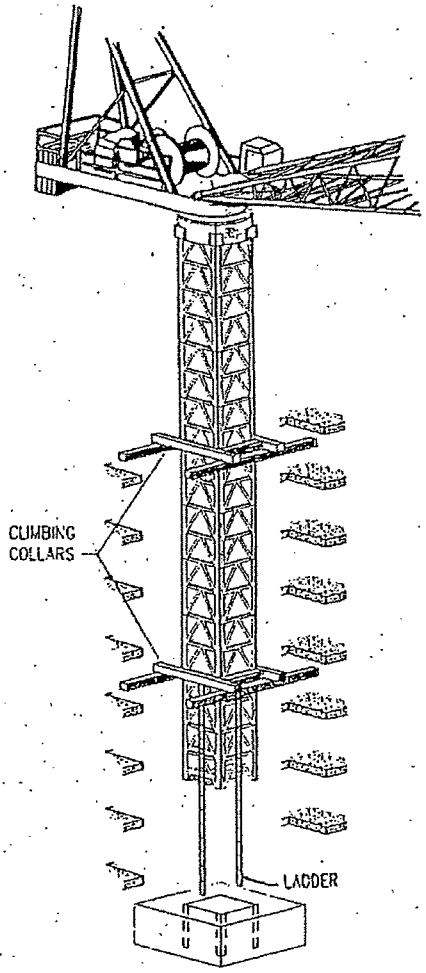
2 Climb through the first collar allow the crane supports to rest on the collar . Engage collar chocks to support the crane laterally .

3 Move the ladder to the second collar and install a third collar

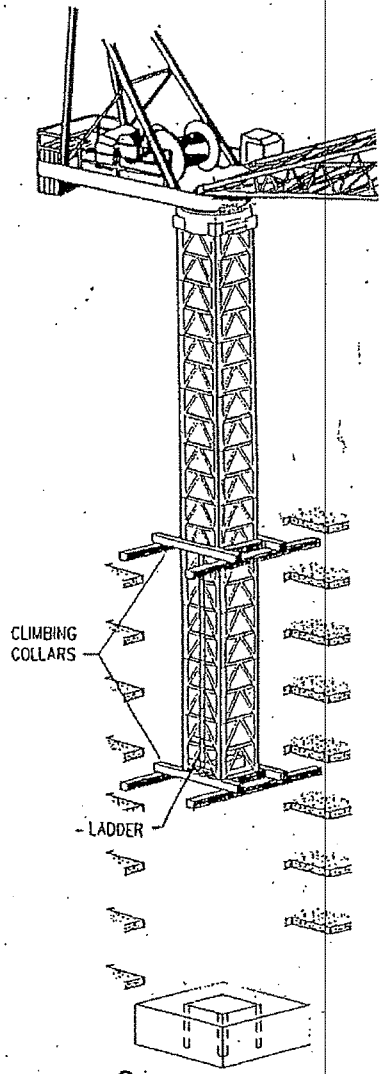




1



2



3

2.6 Erection of Tower Crane with Internal (3 beam) Climbing Frame (if applicable)

There are two options, depending on the building site requirements for erection of internal climbing cranes.

ATTENTION ***The free standing height of the crane above the top support collar depends on the type of tower section, local weather and the conditions of the surrounding structure. It must be confirmed by Favelle Favco and/or the responsible site engineer for each application.***

2.6.1 Option 1

The bottom climbing section, with cylinders but excluding the climbing beams, is erected and bolted onto cast-in starter legs. The correct number of towers as planned for the building are then erected on the bottom section. The slew mount is then bolted onto the top tower. When all the bolts have been correctly tightened, the tower is ready to receive the crane upper section.

2.6.2 Option 2

When the building is part erected, the crane tower can be supported in the building. The tower will require two supports at a vertical spacing of a minimum of 12m (for standard components). One support can be the building. The bottom climbing section is lowered through the building to its support position. The correct numbers of towers are erected on the bottom tower and the mount is installed. When the vertical and lateral supports are in place, and all the bolts have been correctly tightened, the tower is ready to receive the crane upper section.

NOTE

1. ***If in doubt about procedures, request for detailed drawing, showing the correct requirements.***
2. ***When climbing internally, additional tower sections can only be added if a multipurpose slew ring mount is used and an external climbing frame is available to suit the tower sections. It is impossible where transition towers are used and where the total mass of tower and crane exceeds the climbing cylinder lifting capacity.***

ATTENTION ***When bolting or placing climbing frame, make certain that the beams conform with the position of blockouts in the walls if applicable.***

Tightening torques for lightly oiled bolts for climbing frame to tower, tower to tower or tower to slew ring mount are listed in drawing A4-9900.578 at the end of Section 2.

Hydraulic hoses from control valves in climbing frame are threaded through all tower sections and secured. Hose ends are carefully rolled up and stored on top tower platform ready for climbing operation.

When the crane upper is assembled and crane is operational, climbing beams must be fitted to the climbing frame as follows :-

- Fit solid bearing plates to or under the climbing cylinders to spread the load of complete crane onto the concrete foundation.
- Lift the crane and fit the two extendible outer beams.
- Slowly retract climbing cylinder to rest beams on starter legs and fit centre beam to the cylinders.
- In case of hydraulic or pneumatic operated beams, hook up all piping ready for first climb.

NOTE ***Crane tower to be laterally supported in two positions with a maximum gap of 3mm on all sides during fitting, supports to be a minimum of 12 metres apart.***

2.7 Internal 3-Beam Climbing Details

Tightening torques for lightly oiled bolts for climbing frame to tower, tower to tower or tower to slew ring mount are listed in drawing A4-9900.578 at the end of Section 2.

Hydraulic hoses from control valves in climbing frame are threaded through all tower sections and secured. Hose ends are carefully rolled up and stored on top tower platform ready for climbing operation.

When the crane upper is assembled and crane is operational, climbing beams must be fitted to the climbing frame as follows :-

- Fit solid bearing plates to or under the climbing cylinders to spread the load of complete crane onto the concrete foundation.
- Lift the crane and fit the two extendible outer beams.
- Slowly retract climbing cylinder to rest beams on starter legs and fit centre beam to the cylinders.
- In case of hydraulic or pneumatic operated beams, hook up all piping ready for first climb.

NOTE ***Crane tower to be laterally supported in two positions with a maximum gap of 3mm on all sides during fitting, supports to be a minimum of 12 metres apart.***

2.7 Internal 3-Beam Climbing Details

To aid in the understanding of the following procedure, refer to diagram shown.

The initial climbing operation must always be carried out under the supervision of a commissioning engineer, who will

1. Instruct the crane driver of correct operation and climbing procedures.
2. ensure that the climbing cylinders are full of oil and that there is no possibility of air being trapped in the cylinders, and
3. Check and adjust the safety throttling valves on both cylinders.

Before commencement of climbing, ensure that the tower will be guided at two positions throughout the complete operation. These guides must be at least 11 metres apart for the use of tower sections and are steel frames attached to the building steelwork. Refer to the site service structures engineer for building reactions, from which a climbing configuration can be established.

The crane must be balanced and the guides accurately positioned clearing the tower leg by approximately 3 mm. If the crane moves out of vertical due to inadequate guiding, lateral loads imposed by the crane on the supporting structure will be significantly increased once operation is resumed.

Balancing the crane is dependent on the boom length and is accomplished as follows:

30 tonne Counter weight		
Boom Length	**Mass on Hook**	**Approx. Balance Boom Radius**
24.7 m	5.1 T	22.5 m
29.3 m	3.3 T	27.5 m
33.9 m	1.9 T	32.5m
38.5 m	0.8 T	37.5 m
47.7 m	0 T	38.5 m
52.3 m	0 T	36.0 m
56.9 m	0 T	36.5 m
61.5 m	0 T	34.5 m

Connect the climbing hoses to the climbing frame taking care not to allow dust or foreign matter to enter the system. Dust caps are provided, however, these are sometimes lost during previous climbing exercises.

The climbing control valve located at the front of the winch unit is locked in supplying oil to the bottom control valve, with the engine throttle set at approximately 1500 - 1800 rpm. The crane should commence to rise slowly, when control valve in internal climbing section is operated. If there is not visible movement, check for obstructions or an out of balance condition.

NOTE ***While extending the two (2) climbing cylinders, the oil level in the hydraulic tank will drop below the minimum level and the annunciator in the cabin indicates visual and audible.***

ATTENTION ***Under no circumstances must the oil tank be topped up at this condition, as the tank will overflow when cylinders are retracted***

At no time should lateral loading be applied to any of the pivoting brackets

For climbing procedures refer to the following drawings.

Raise the crane sufficiently to enable the outer climbing support beams 'A' and 'C' to be extended on the next higher floor. Stage two as shown on drawing.

Lower the crane by reversing the climbing control valve until the load is taken on the outer support beams 'A' and 'C'. Retract the cylinders until the centre climbing support beam 'B' can be extended as well. Stage three as shown on drawing.

Care must be taken to equalise the rate of the cylinders, by means of manually controlled balancing valve located at the base of the tower, to ensure that the support beam remains in the horizontal position.

REPEAT CLIMBING (STAGE 1)

With the legs in the centre support beam extended, taking the weight. Retract the legs in the outer support beams. Climb to the new position and repeat the procedure. Stage two is as shown on drawing.

WARNING ***Before operating the crane in this new position, always ensure that the crane is checked at the two levels of lateral support. These supports must be located at a position no more than 150mm from a panel point junction between a horizontal brace and the tower leg. If this is not practically possible, the tower must be reinforced accordingly.***

At no time should lateral loading be applied to the supporting beams A, B or C.

Fit guides to the floors above as shown on drawing with a maximum clearance of 3mm each side. The following diagram illustrates the above internal climbing procedure.

INTERNAL CLIMBING

1. Telescopic internal sections of beam B are extended at both ends and supported on the building. The telescopic sections of beams A and C are retracted.

2. Crane, lower and climbing frame, to which beams A and C are attached, are lifted by hydraulic rams.

3. Telescopic sections of beams A and C are extended to support the crane. Telescopic sections of beam B are retracted. Hydraulic cylinders lift beam B to the level of beams A and C. Telescopic sections of beam B are extended.

2.8 Disassembly of Internal Climbing Crane

The description of the disassembly of internal climbing tower is to be used as a guide only for site preparations and planning. The actual disassembly procedure must be produced and approved by leading authorities before any disassembly work commences.

WARNING ***If the wind speed exceeds 10m/s or bad weather is predicted, disassembly or climbing should not take place.***

For disassembly of internal climbing tower crane, it is recommended that a suitable capacity recovery crane to be used in disassembly.

1. Use the Crane Reeving switch to bridge limit switches.
2. Remove hoist hook.
3. Reeve excess hoist rope on drum and secure rope end.
4. Uncouple electrical cables from boom (i.e. Load Cell Angle, Lighting, boom angle indicator). Label and secure the uncoupled cables.
5. Next stage is to remove the luff ropes. Use option (B) if a high capacity recovery crane is available.
    A. Using a lower capacity recovery crane and erection pendents.
        a) Attach erection pendents from mast anchor point to boom.
        b) Land bridle on bridle platform
        c) Secure bridle on bridle platform
        d) Remove bridle and pendent ropes
        e) Unreeve luff ropes
        f) Remove boom sections starting from the boom top
        g) Once all sections are removed forward of boom erection pendents. Attach slings to boom bottom and boom extension.
        h) Let secondary crane take up boom load
        i) Remove erection pendents from mast
        j) Remove boom heel pins
        k) Remove part boom assembly from crane.
    B. Using a high capacity crane.
        a) Attach slings to boom to lifting points
        b) Let secondary crane take up boom load
        c) Land bridle on bridle platform
        d) Secure bridle on bridle platform
        e) Unreeve luff rope
        f) Remove boom heel pins
        g) Remove boom assembly from crane
6. Attach slings on mast lifting lugs (if necessary slew and position crane).
7. Uncouple electrical cables from mast. Label and secure the uncoupled cables.
8. Remove bottom mast lug pins
9. Remove mast assembly from crane.

10. Remove counter weights.
11. Uncouple hydraulic hoses and electrical cables from Power Pack. Cap hydraulic hose ends to prevent contamination of hydraulic system. Label and secure the uncoupled cables.
12. Remove winch Power pack from crane deck.
13. Attach slings to rear split deck and take up slack.
14. Remove split deck pins and remove rear split deck.
15. Remove front deck with cabin.
16. Uncouple slip ring electrical cables.
17. Remove climbing frame.
18. Remove slew mount.
19. Remove any standing towers.

2.9 Erection of Tower Crane with External Climbing Frame (if applicable)

A minimum of four tower sections must be bolted to the cast-in starter legs.

Bolt sections alternative, so that the ladders match.

Bolt the slew ring mount to the top of the tower ensuring that;

- The front monorail lug is facing the direction where future tower sections would be lifted from, and
- Adequate space is available for the crane to climb down the side of the building.

Tightening torques for lightly oiled bolts for climbing frame to mount, tower to tower and tower to slew ring mount are listed in drawing A4-9900.578 at the end of Section 2.

Mount top platforms to climbing frames to assist in assembly to slew ring mount. Bolt frame ties or bracings, all pieces are match marked.

Check bolt identification for all bolts other than previously mentioned and tighten as set in drawing A4.9900.578 at the end of Section 2.

Connect climbing supports to the cylinder heads and secure to the top of the bottom tower with clamps provided.

Install hoses from one cylinder to the other as set out on climbing circuit. Prevent the ingress of dirt in any open connection and tighten all connections properly.

The slew ring as well as the machined face of the machinery deck must be free of any contamination to prevent possible distortion of the slew ring.

ATTENTION ***For climbing frame assembly and hydraulic climbing circuit refer to Section 6 "Drawings".***

2.10 External Climbing Details

The climbing operation must always be carried out under authorised supervision to ensure:

1) The climbing cylinders are full of oil and free from any trapped air;

2) The safety throttling valve on each cylinder is adjusted correctly; and

3) The correct procedure is adopted.

PROCEDURE

Remove the lower part of the deck access ladder and stow it on the deck.

Lift the monorail and secure it to the slew mount.

Remove the electrical supply to the deck.

Ensure that tower lateral supports are in place and chocked, then lift the next tower section to the monorail and position on the trolley.

Apply the slew brakes and fit the climbing hoses to the climbing valve, ensuring that no dirt or other foreign matter is allowed to enter the hydraulic system.

The crane must be balanced and the skid guides of the climbing frame accurately positioned clearing the tower leg by approximately 3 mm. If the crane moves out of vertical due to inadequate guiding, lateral loads imposed by the crane on the supporting structure will be significantly increased once operation is resumed.

Balancing the crane is dependent on the boom length and is accomplished as follows:

30 tonne Counter weight		
Boom Length	**Mass on Hook**	**Approx. Balance Boom Radius**
24.7 m	5.1 T	22.5 m
29.3 m	3.3 T	27.5 m
33.9 m	1.9 T	32.5m
38.5 m	0.8 T	37.5 m
47.7 m	0 T	38.5 m
52.3 m	0 T	36.0 m
56.9 m	0 T	36.5 m
61.5 m	0 T	34.5 m

Luff out the boom to the theoretical balance position and only then commence loosening the mount to tower connecting bolts. As the bolts are loosened it may be necessary to luff in or out until the crane 'floats' on the tower and until this situation arises the bolts should not be removed entirely.

Connect the climbing hoses to the climbing frame taking care not to allow dust or foreign matter to enter the system. Dust caps are provided, however, these are sometimes lost during previous climbing exercises.

The crane upper can then be climbed by means of the control valve located at the front of the winch. This valve is placed in such a position as to allow the operator full vision of the lifting operation through the access trap door in the machinery deck. The engine throttle should be set at 1500 rpm.

Climb until the opening is just sufficient to accept the tower section which can then be 'trolleyed' into position. By reversing the climbing control valve the crane upper can then be lowered until the 'tower to tower' connecting bolts can be fitted and tightened to the specified torque.

If only one tower section is to be added to the crane, upper can then be lowered fully onto the tower section and the 'tower to tower' connecting bolts fitted and tightened.

WARNING ***If more than one tower section is to be added, two bolts in each corner must be fitted and handtightened before lifting the next tower section or if any slewing, however small, is to be done.***

Tightening torques for lightly oiled bolts for climbing frame to mount, tower to tower and tower to slew ring mount, are listed in drawing A4-9900.578 at the end of Section 2.
Upon completion of the climbing operation, ensure that all tower bolts have been tightened to the specified torque. Lower the monorail beam to the ground and disconnect the climbing hoses. Ensure that all dust caps and plugs have been replaced.

Replace lower access ladder and electricals.

The sketch below illustrates the external climbing procedure.

NOTE ***While extending the two (2) climbing cylinders, the oil level in the hydraulic tank will drop below the minimum level and the annunciator in the cabin indicates visual and audible.***

ATTENTION ***Under no circumstances must the oil tank be topped up at this condition, as the tank will overflow when cylinders are retracted***

EXTERNAL CLIMBING

1 Crane lifts additional lower section and suspends it from extendable monorail. Bolts of top lower section are removed at A.

2 Hydraulic ram lifts top section of crane and climbing frame.

3 Additional lower section is drawn into the climbing frame and bolted at B and A.

To climb down, the reverse procedure is followed.

2.11 Disassembly of External Climbing Crane

The description of the disassembly of external climbing tower is to be used as a guide only for site preparations and planning. The actual disassembly procedure must be produced and approved by leading authorities before any disassembly work commences.

WARNING ***If the wind speed exceeds 10m/s or bad weather is predicted, disassembly or climbing should not take place.***

For disassembly of external climbing tower crane, climb the crane down as low as possible. It is recommended that a recovery crane to assist in disassembly of work.

1. Remove tower sections to lower crane (Reverse of climbing procedure).
2. Use the Crane Reeving switch to bridge limit switches.
3. Remove hoist hook
4. Reeve hoist rope on drum
5. Uncouple electrical cables from boom (i.e. Load Cell Angle, Lighting, boom angle indicator). Label and secure the uncoupled cables.
6. Next stage is to remove the luff ropes. Use option (B) if there is a secondary crane available.
   A. Using a lower capacity crane.
      a) Attach erection pendents from mast anchor point to boom
      b) Land bridle on bridle platform
      c) Secure bridle on bridle platform
      d) Unreeve luff rope
      e) Remove bridle and pendent ropes
      f) Remove boom sections starting from the boom top
      g) Once all sections are removed forward of boom erection pendents. Attach slings to boom bottom and boom extension.
      h) Let secondary crane take up boom load
      i) Remove erection pendents from mast
      j) Remove boom heel pins
      k) Remove part boom assembly from crane.
   B. Using a high capacity crane.
      a) Attach slings to boom lifting points.
      b) Let secondary crane take up boom load
      c) Land bridle on bridle platform
      d) Secure bridle on bridle platform
      e) Unreeve luff rope
      f) Remove boom heel pins
      g) Remove boom assembly from crane
7. Attach slings on mast lifting lugs.
8. Uncouple electrical cables from mast. Label and secure the uncoupled cables.
9. Remove bottom mast lug pins

10. Remove mast assembly from crane.
11. Remove counter weights
12. Uncouple hydraulic hoses and electrical cables from Power Pack. Cap hydraulic hose ends to prevent contamination of hydraulic system. Label and secure the uncoupled cables.
13. Remove winch Power pack from crane deck
14. Attach slings to rear split deck and take up slack.
15. Remove split deck pins and remove rear split deck.
16. Remove front deck with cabin.
17. Uncouple slip ring electrical cables.
18. Remove external climber side panels
19. Remove slew mount
20. Remove any standing towers.

2.12 Crane Erection of Upper Structure

Depending on the availability of suitable cranage for erection, the machinery deck can be installed either bare or partially assembled with cabin and slew drive and with fuel in the appropriate tank. It is recommended that the deck is suitably secured to the hook with at least four slings or chains, which must be adjustable in length to have the slew ring mounting surface as level as possible.

Tighten slew ring bolts with lightly oiled threads to the appropriate torque (as stated on drawing A4.9900.578 in Section 2.

Fit access ladder in centre of machinery deck.

Assemble slew drive if supplied separately.

Fit winch and powerpack assembly to machinery deck and bolt securely to the pedestals provided.

Uncouple both limit switches.

Winch, powerpack and slew drive can now be made operative:

a) Hook up engine fuel lines to tank in deck.
b) Hook up engine throttle cable to cabin.
c) Hook up control lines to cabin.
d) Hook up electric plugs to cabin.
e) Hook up hoses to slew drive.

If pre-erection check has been undertaken, the power pack can now be started and used as required. Otherwise the following must be adhered to:

a) Refer to engine manual under "storage"
b) Check pump drive gearbox level
c) Check hoist, luff and slew drive gearbox levels
d) Check hydraulic oil tank level, remove water from tank if present, top up with new clean oil.
e) Exchange filter elements if necessary.
f) Check relief valve settings, pressure switch settings.
g) Test run all motions.
h) Check all piping
i) Check needle valve on hoist motor is tightly closed.
k) Check needle valve on slew motor is closed.

Fit the counterweights and secure into position.

Connect mast, complete with sheaves, braces, ladders and boom buffer to machinery deck. All pins to be slightly greased and securely locked into position.

The complete boom is assembled on the ground together with pendant ropes and bridle, which is temporarily supported on the boom.

Lift boom with slings only to prevent damage and connect to the machinery deck. Hold boom in position until luff rope can take the load or hold with erection pendants if available.

With the luff rope usually stored on the hoist drum, the luff system is reeved by running the reeving rope through the sheaves and using the luff drum as windlass. Both rope ends to be securely locked into position.

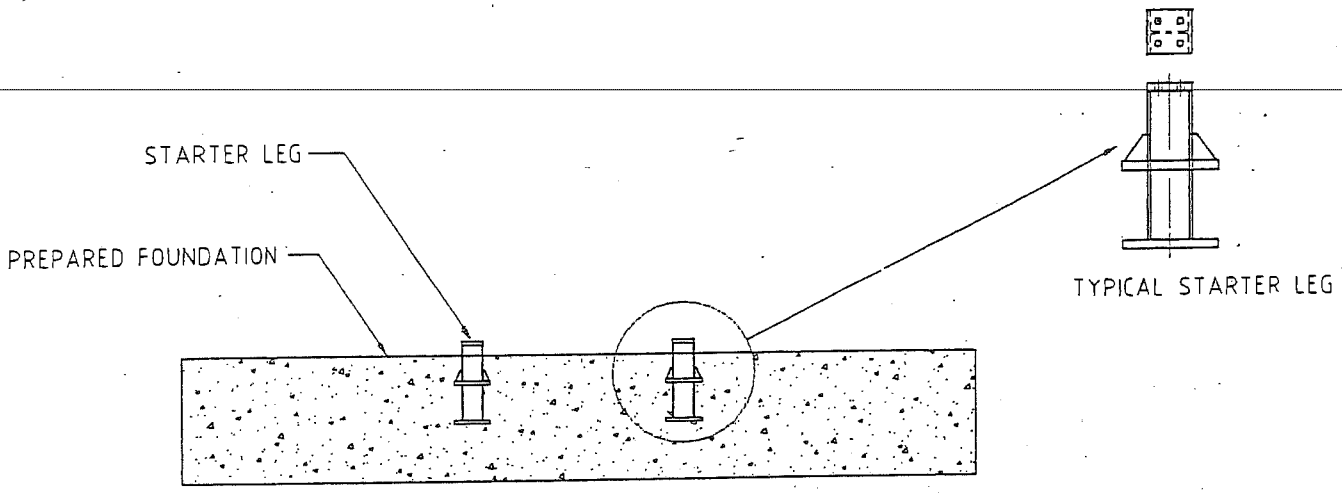
Remove temporary bridle support as soon as bridle lifts off the boom.

Reeve the hoist rope as shown on reeving diagram. When using the rope from a rope reel on the ground, ensure that the rope is laid tightly under pressure onto the drum to prevent loose laid layers under the outer working layer while the crane is still on only a few tower sections or, in case of internal climbing, on the lower floors, fit rope ends with great care to both the drum and the hook or boom head when in double fall.

Fit and connect hydraulic hoses to luff in deceleration & stop limit, and bleed lines.

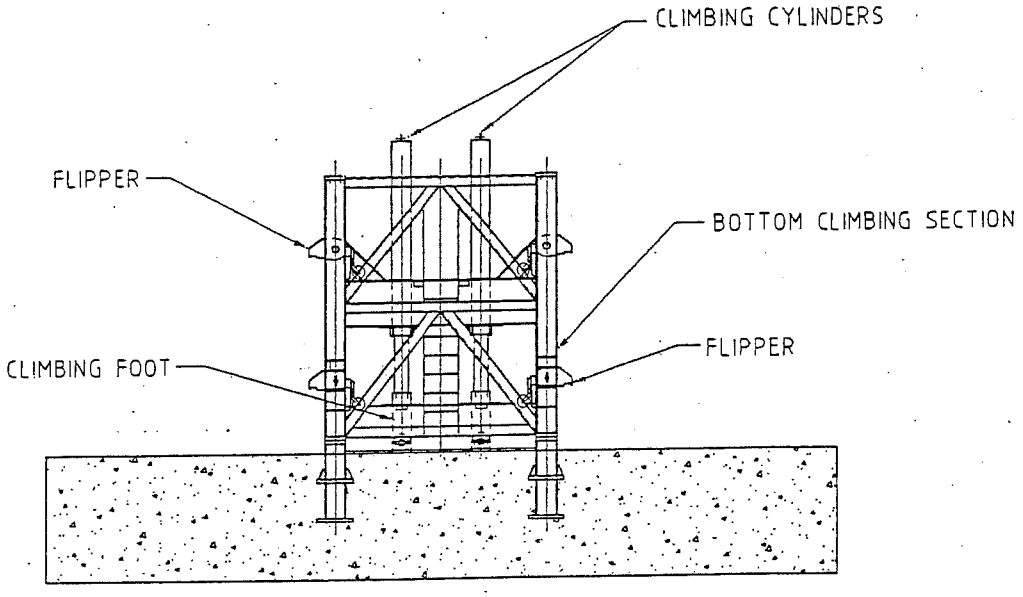
Re-connect both the luff and the hoist limit switches on the winch and adjust the luff limit to its maximum and minimum radius position. Check load charts for radius settings according to boom length.

Final checks prior to load testing and/or actual work must be undertaken. For drawings refer Section 6.



(1) ERECT THE CRANE'S BASE (INCLUDING THE CAST-IN STARTER LEG) ON THE PREPARED FOUNDATION.

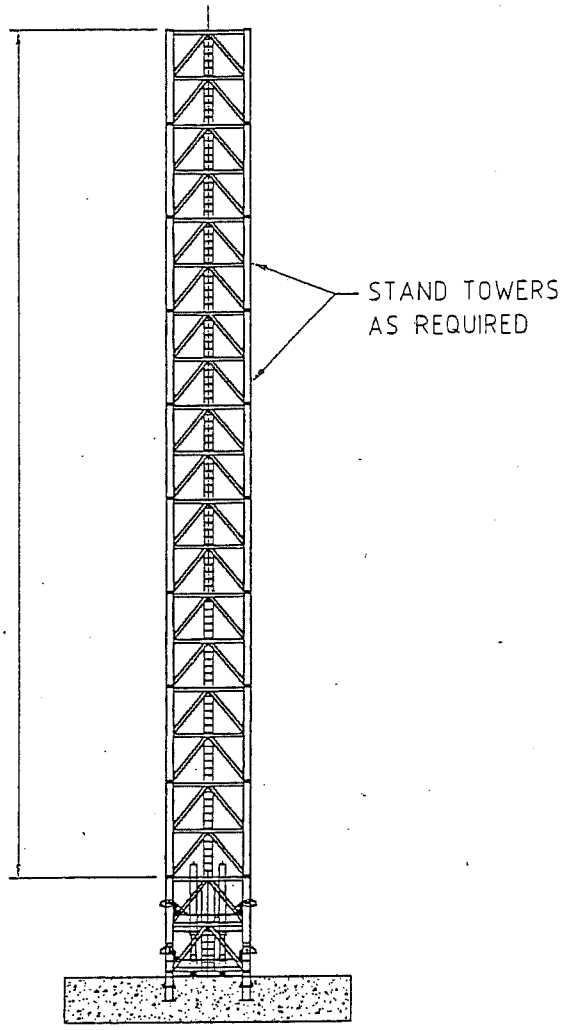
(USE TOWER AS TEMPLATE).

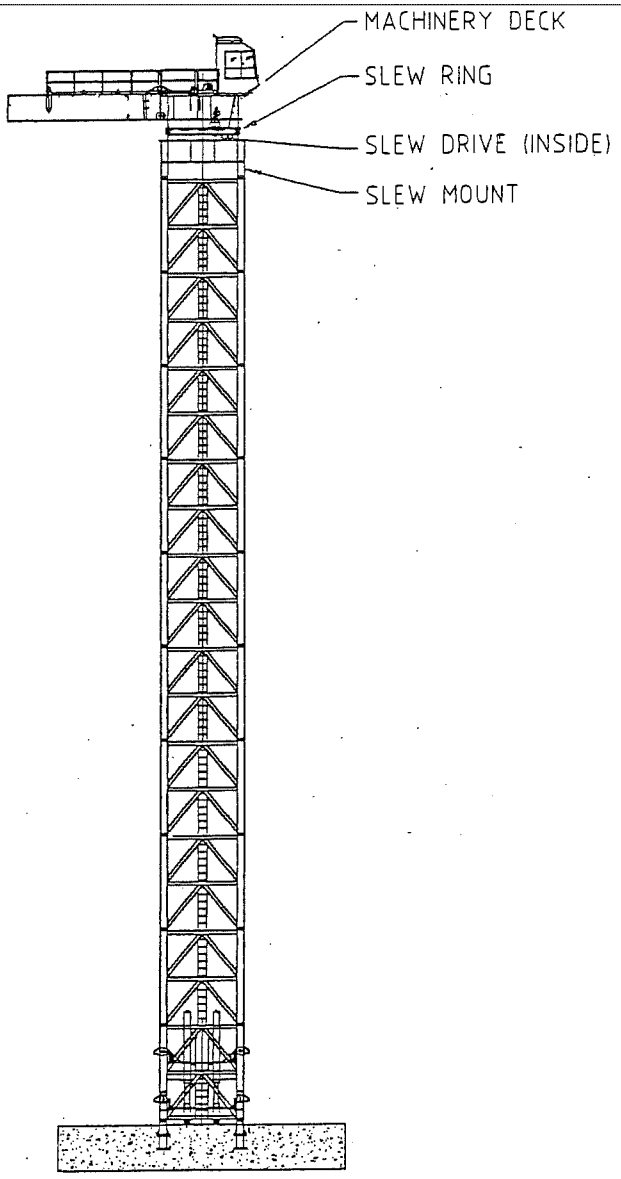


(2) ERECT THE BOTTOM TOWER (CLIMBING OR OTHERWISE)

CAUTION:

ENSURE TOWER IS POSITIONED WITH CLIMBING SUPPORTS IN CORRECT SIDE FOR SUBSEQUENT CLIMBING.
IF INTERNAL CLIMBING ENSURE CYLINDERS ARE FITTED BEFORE ERECTION.





(3) THE CORRECT NUMBER OF TOWERS APPROVED FOR SITE ARE THEN ERECTED.

CAUTION:

1. ENSURE HEAVY TOWERS ARE ERECTED FIRST (IF APPLICABLE).
2. ENSURE REINFORCED TOWERS ARE PROPERLY POSITIONED IN LINE WITH CLIMBING SEQUENCE. SEE TYPICAL CLIMBING ARRANGEMENT.

(4)
1. CONNECT THE SLEW MOUNT ONTO THE TOP TOWER. FOR TIGHTENING TORQUES, REFER TO TABLE 2.7 IN THE CRANE'S MANUAL, AND IF NECESSARY DRAWING E011.
2. FIT CABIN SUPPORT PLATFORM, SIDE PLATFORMS, ACCESS LADDERS AND HANDRAILS TO DECK.
3. BOLT THE CONTROL CABIN INTO POSITION.
4. LIFT AND FIT THE MACHINERY DECK ASSEMBLY INCLUDING THE SLEW DRIVE AND SLEW RING TO THE SLEW MOUNT.

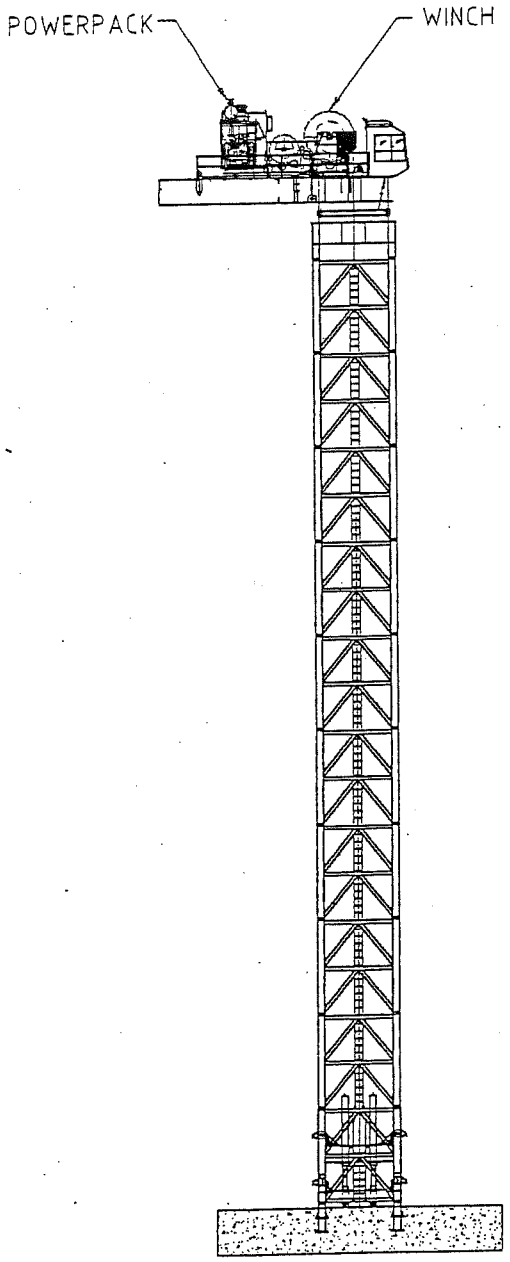
FAVELLE FAVCO

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A.C.N. 067 562 449

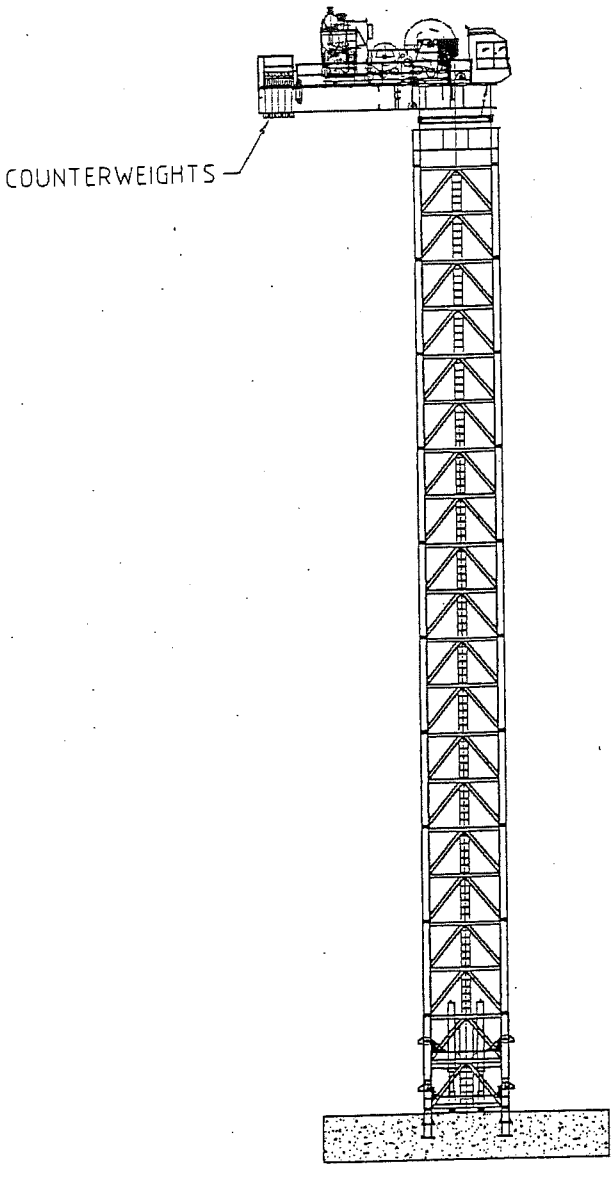
A subsidiary of Muhibbah Engineering (M) BHD

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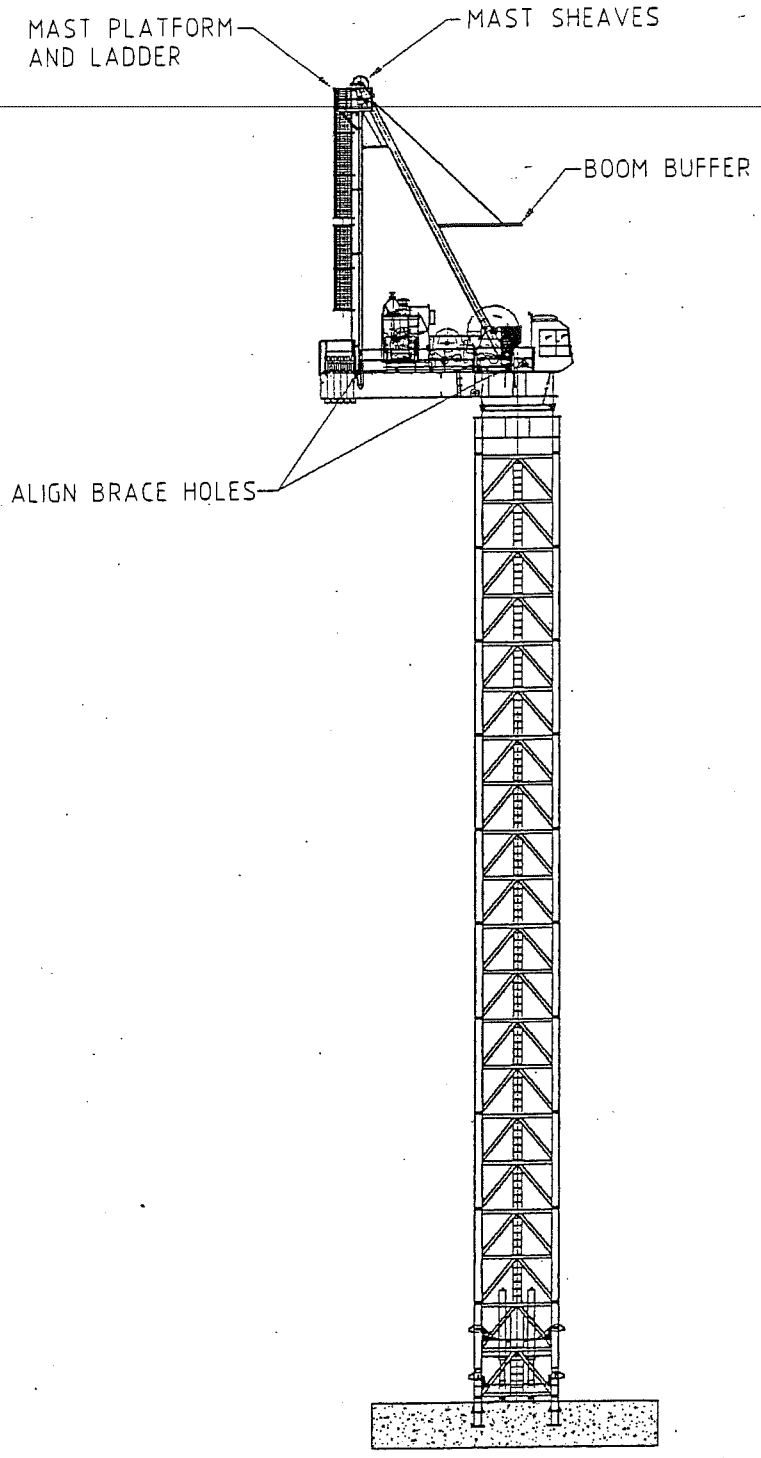
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(5) FIT WINCH & POWERPACK TO MACHINERY DECK AND PIN SECURELY IN PLACE.

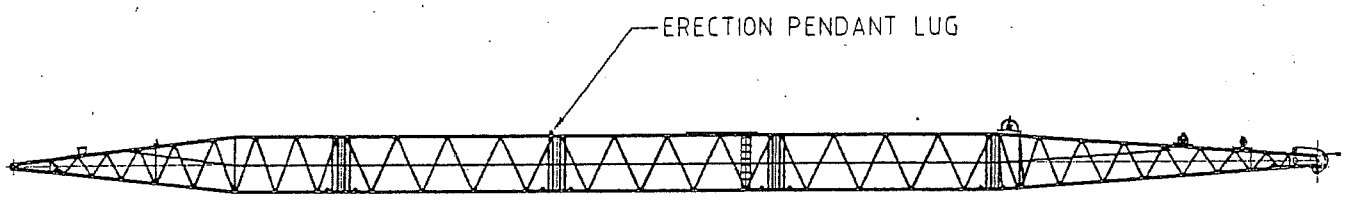


(6) 1. FIT ALL COUNTERWEIGHTS AND SECURE INTO POSITION ON DECK.
2. FIT HANDRAILS AROUND COUNTERWEIGHT.

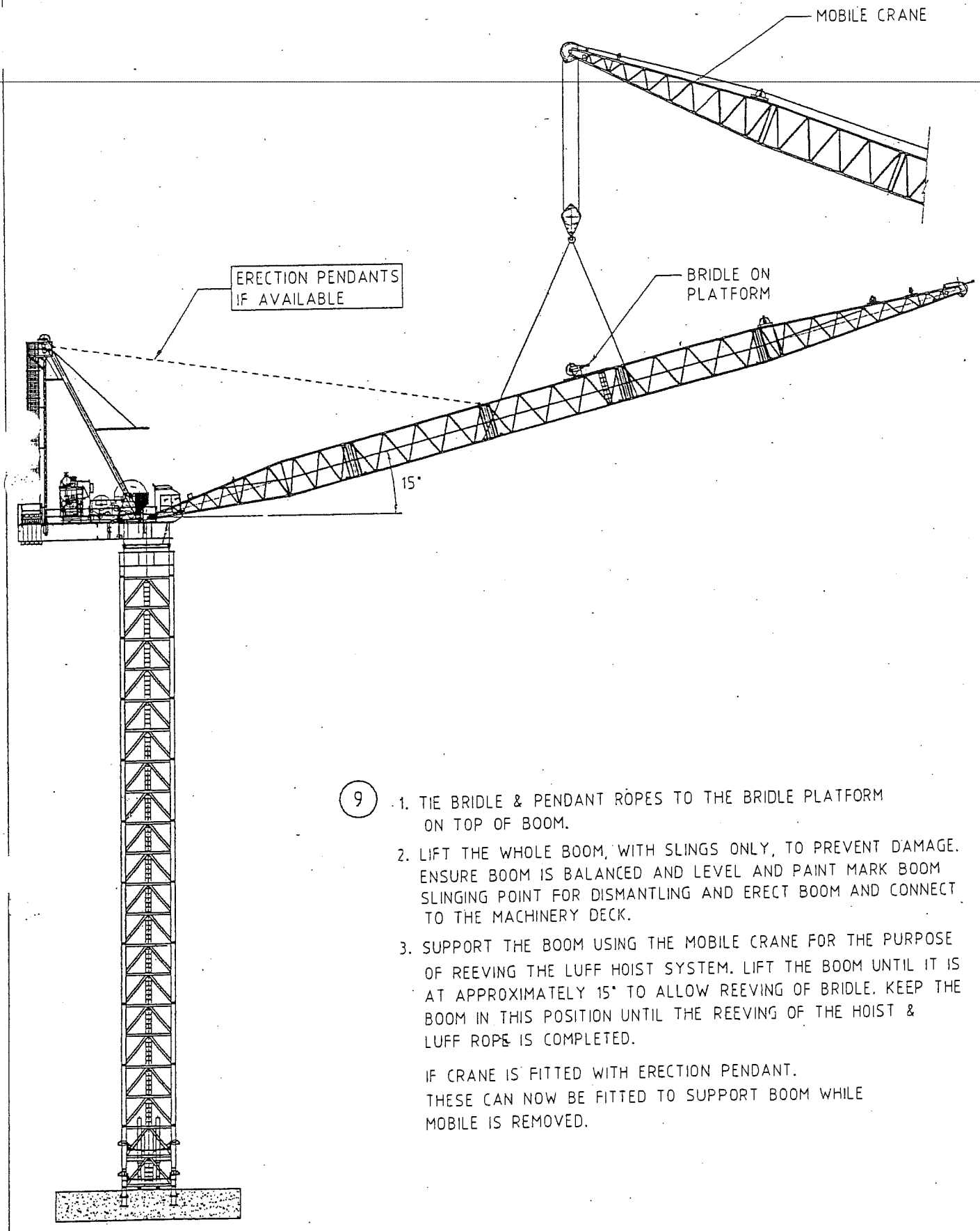


(7) ENSURE LADDERS & PLATFORMS ARE FITTED TO MAST. ERECT MAST, COMPLETE WITH SHEAVES, BRACES AND BOOM BUFFER TO MACHINERY DECK. LOWER CAREFULLY INTO POSITION. ALL PINS TO BE SLIGHTLY GREASED AND SECURELY LOCKED INTO POSITION.

(8) ASSEMBLE THE COMPLETE BOOM ON THE GROUND. SEE BELOW



NOTE. ROADS CLOSE TO THE SITE MAY HAVE TO BE CLOSED TEMPORARILY TO MAKE SPACE FOR THE ASSEMBLY OF THE BOOM.



(9)

1. TIE BRIDLE & PENDANT ROPES TO THE BRIDLE PLATFORM ON TOP OF BOOM.
2. LIFT THE WHOLE BOOM, WITH SLINGS ONLY, TO PREVENT DAMAGE. ENSURE BOOM IS BALANCED AND LEVEL AND PAINT MARK BOOM SLINGING POINT FOR DISMANTLING AND ERECT BOOM AND CONNECT TO THE MACHINERY DECK.
3. SUPPORT THE BOOM USING THE MOBILE CRANE FOR THE PURPOSE OF REEVING THE LUFF HOIST SYSTEM. LIFT THE BOOM UNTIL IT IS AT APPROXIMATELY 15° TO ALLOW REEVING OF BRIDLE. KEEP THE BOOM IN THIS POSITION UNTIL THE REEVING OF THE HOIST & LUFF ROPE IS COMPLETED.

IF CRANE IS FITTED WITH ERECTION PENDANT.
THESE CAN NOW BE FITTED TO SUPPORT BOOM WHILE MOBILE IS REMOVED.

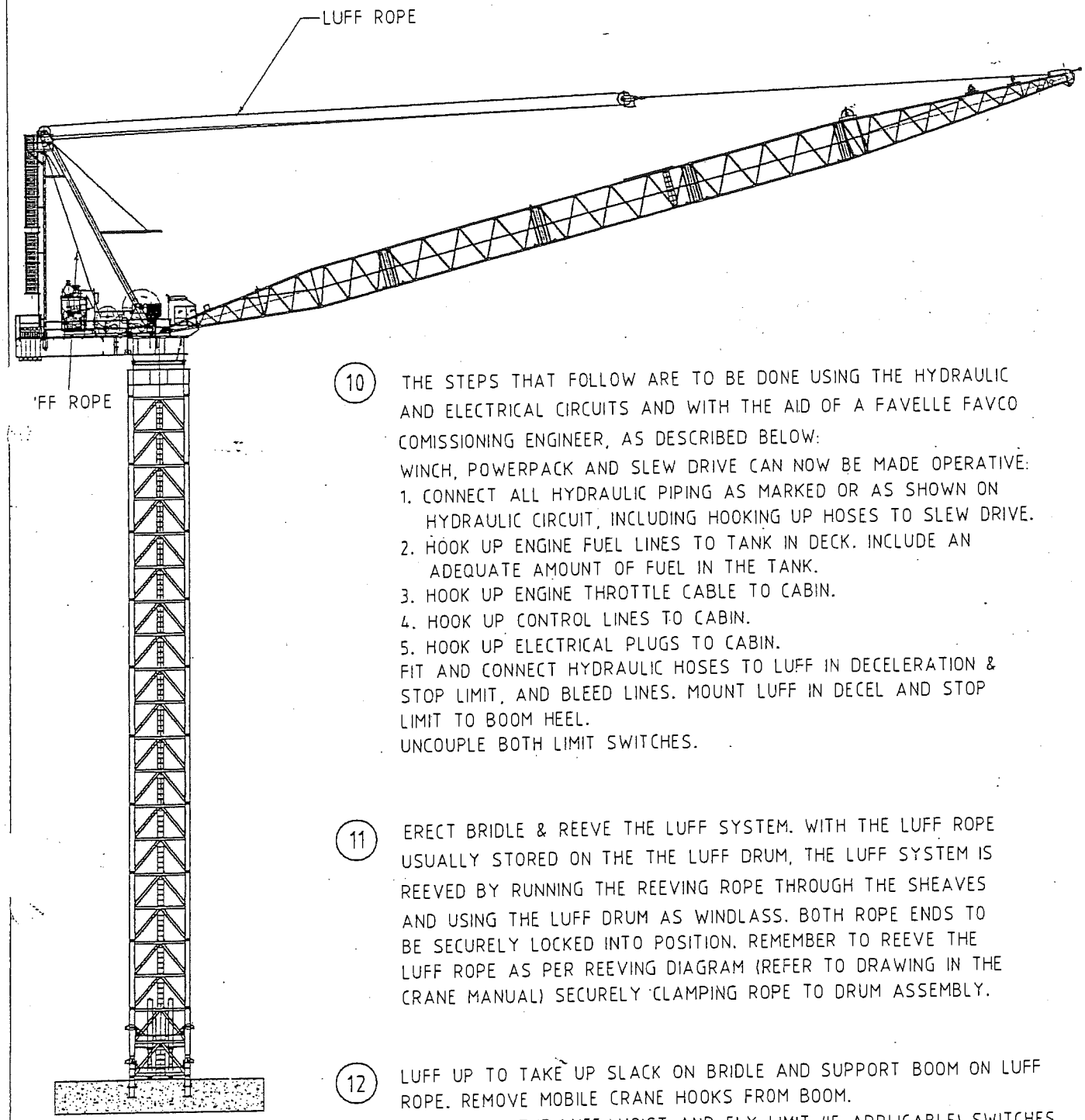
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STDSEQ07



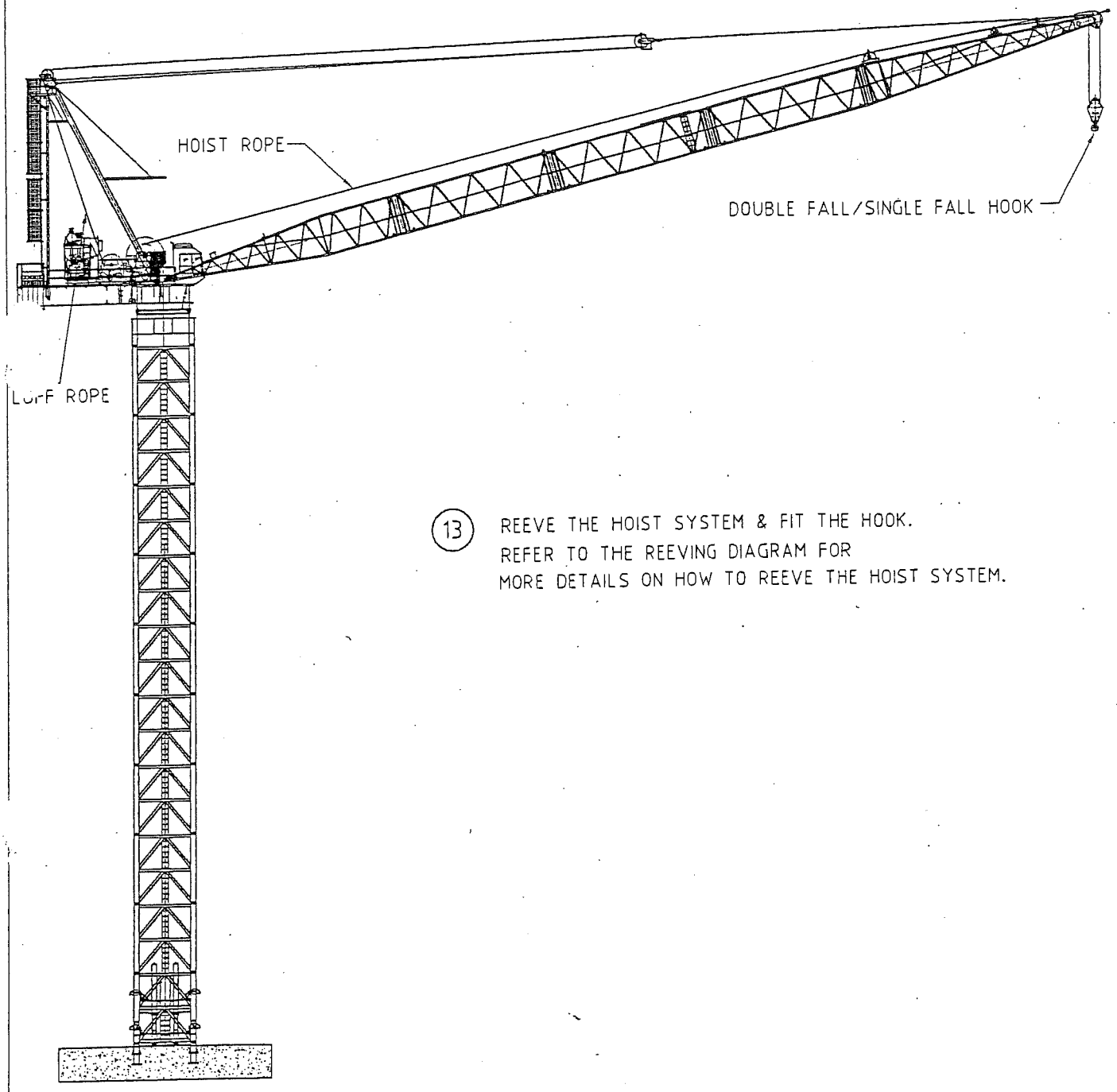
(10) THE STEPS THAT FOLLOW ARE TO BE DONE USING THE HYDRAULIC AND ELECTRICAL CIRCUITS AND WITH THE AID OF A FAVELLE FAVCO COMISSIONING ENGINEER, AS DESCRIBED BELOW:
WINCH, POWERPACK AND SLEW DRIVE CAN NOW BE MADE OPERATIVE:

1. CONNECT ALL HYDRAULIC PIPING AS MARKED OR AS SHOWN ON HYDRAULIC CIRCUIT, INCLUDING HOOKING UP HOSES TO SLEW DRIVE.
2. HOOK UP ENGINE FUEL LINES TO TANK IN DECK. INCLUDE AN ADEQUATE AMOUNT OF FUEL IN THE TANK.
3. HOOK UP ENGINE THROTTLE CABLE TO CABIN.
4. HOOK UP CONTROL LINES TO CABIN.
5. HOOK UP ELECTRICAL PLUGS TO CABIN.

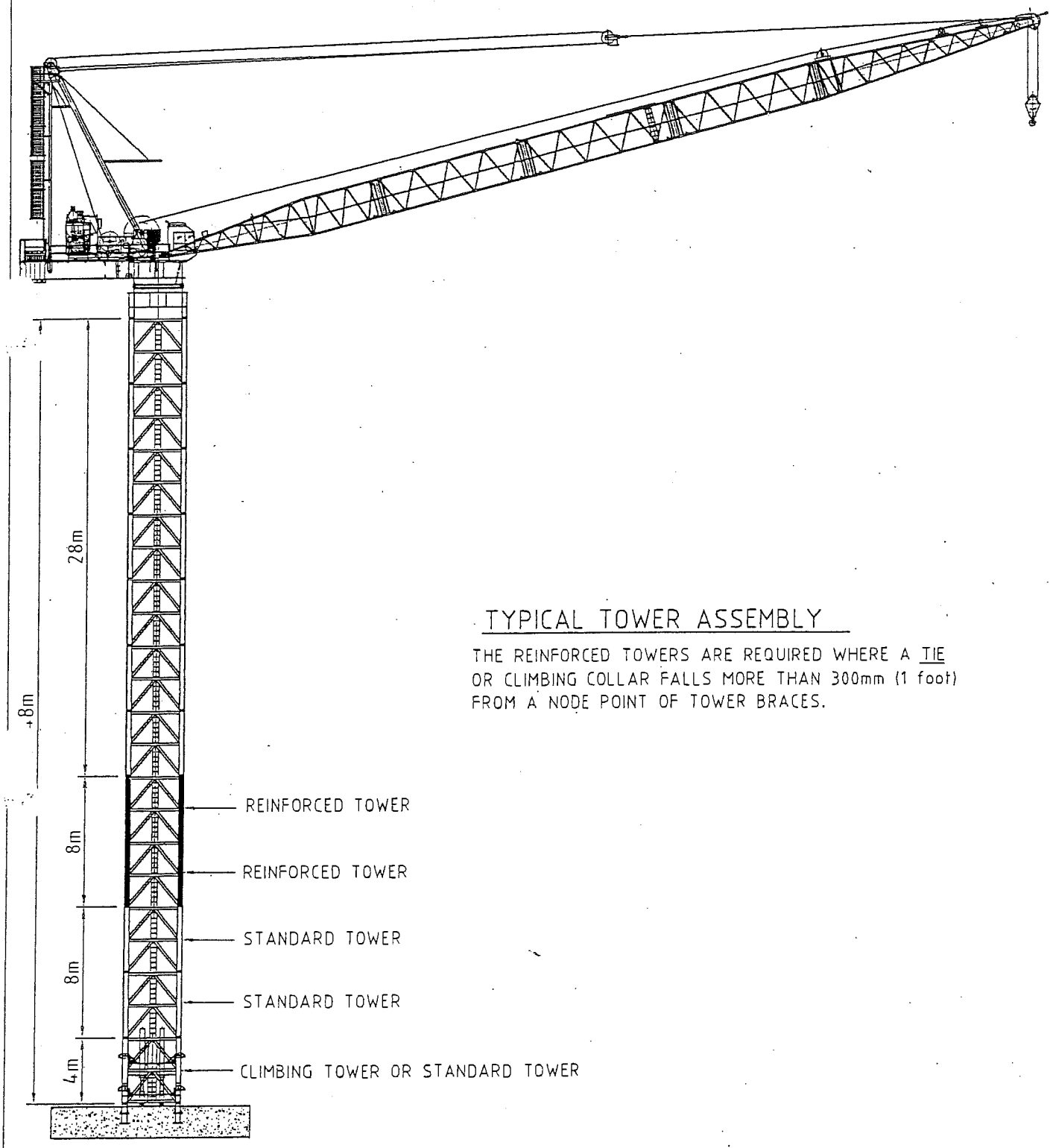
FIT AND CONNECT HYDRAULIC HOSES TO LUFF IN DECELERATION & STOP LIMIT, AND BLEED LINES. MOUNT LUFF IN DECEL AND STOP LIMIT TO BOOM HEEL.
UNCOUPLE BOTH LIMIT SWITCHES.

(11) ERECT BRIDLE & REEVE THE LUFF SYSTEM. WITH THE LUFF ROPE USUALLY STORED ON THE THE LUFF DRUM, THE LUFF SYSTEM IS REEVED BY RUNNING THE REEVING ROPE THROUGH THE SHEAVES AND USING THE LUFF DRUM AS WINDLASS. BOTH ROPE ENDS TO BE SECURELY LOCKED INTO POSITION. REMEMBER TO REEVE THE LUFF ROPE AS PER REEVING DIAGRAM (REFER TO DRAWING IN THE CRANE MANUAL) SECURELY CLAMPING ROPE TO DRUM ASSEMBLY.

(12) LUFF UP TO TAKE UP SLACK ON BRIDLE AND SUPPORT BOOM ON LUFF ROPE. REMOVE MOBILE CRANE HOOKS FROM BOOM.
RE-CONNECT THE LUFF, HOIST AND FLY LIMIT (IF APPLICABLE) SWITCHES ON THE WINCH AND ADJUST THE LUFF LIMIT TO ITS MAXIMUM AND MINIMUM RADIUS POSITION. CHECK THE LOAD CHARTS FOR RADIUS SETTINGS ACCORDING TO BOOM LENGTH. ADJUST THE HOIST LIMITS.



(13) REEVE THE HOIST SYSTEM & FIT THE HOOK.
REFER TO THE REEVING DIAGRAM FOR
MORE DETAILS ON HOW TO REEVE THE HOIST SYSTEM.



TYPICAL TOWER ASSEMBLY

THE REINFORCED TOWERS ARE REQUIRED WHERE A TIE OR CLIMBING COLLAR FALLS MORE THAN 300mm (1 foot) FROM A NODE POINT OF TOWER BRACES.

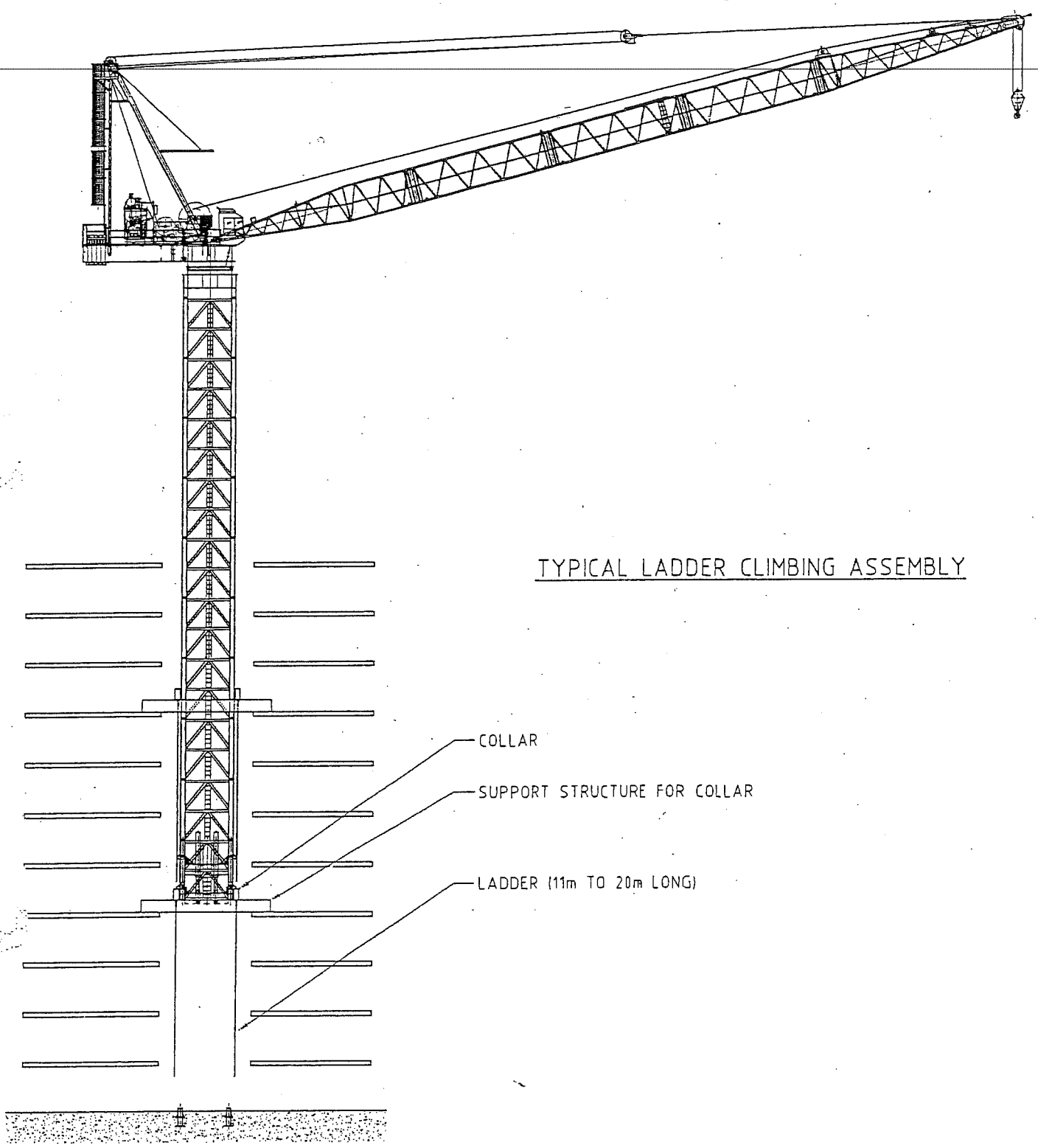
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TITLE

STDSEQ10



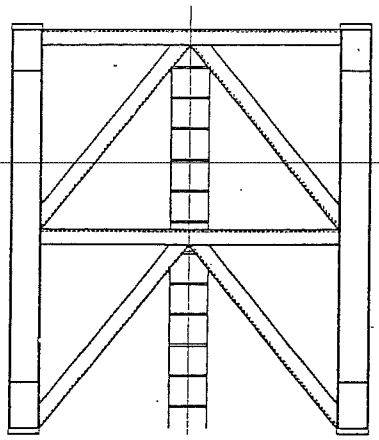
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TITLE

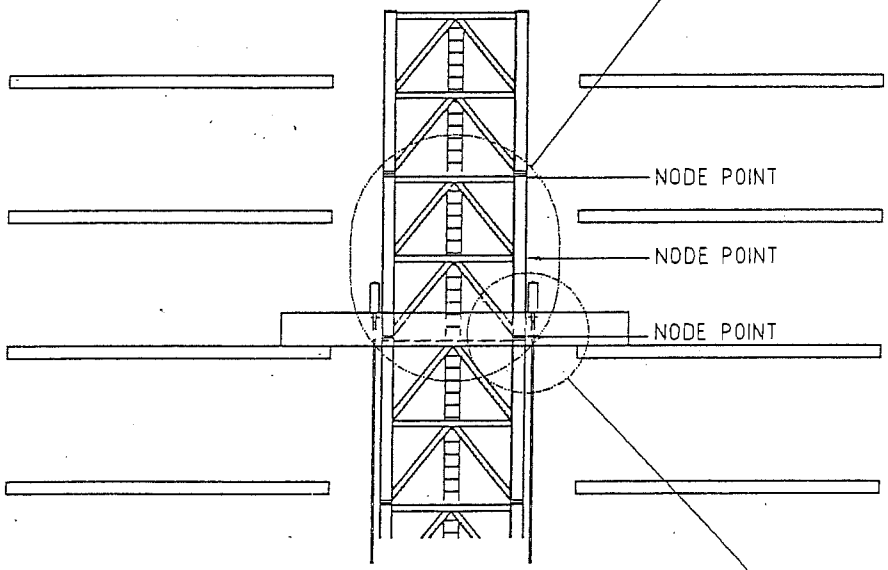
STDSFA11

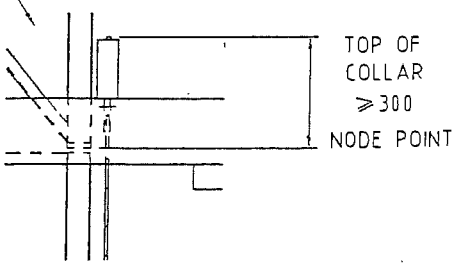
TYPICAL LADDER CLIMBING ASSEMBLY

REFER TO CLIMBING SEQUENCE. REINFORCED TOWER IS REQUIRED WHERE TOP OF COLLAR OR TIE IN CASE OF EXTERNAL CLIMBING IS MORE THAN 300mm (1 foot) FROM NODE POINT.



REINFORCED TOWER





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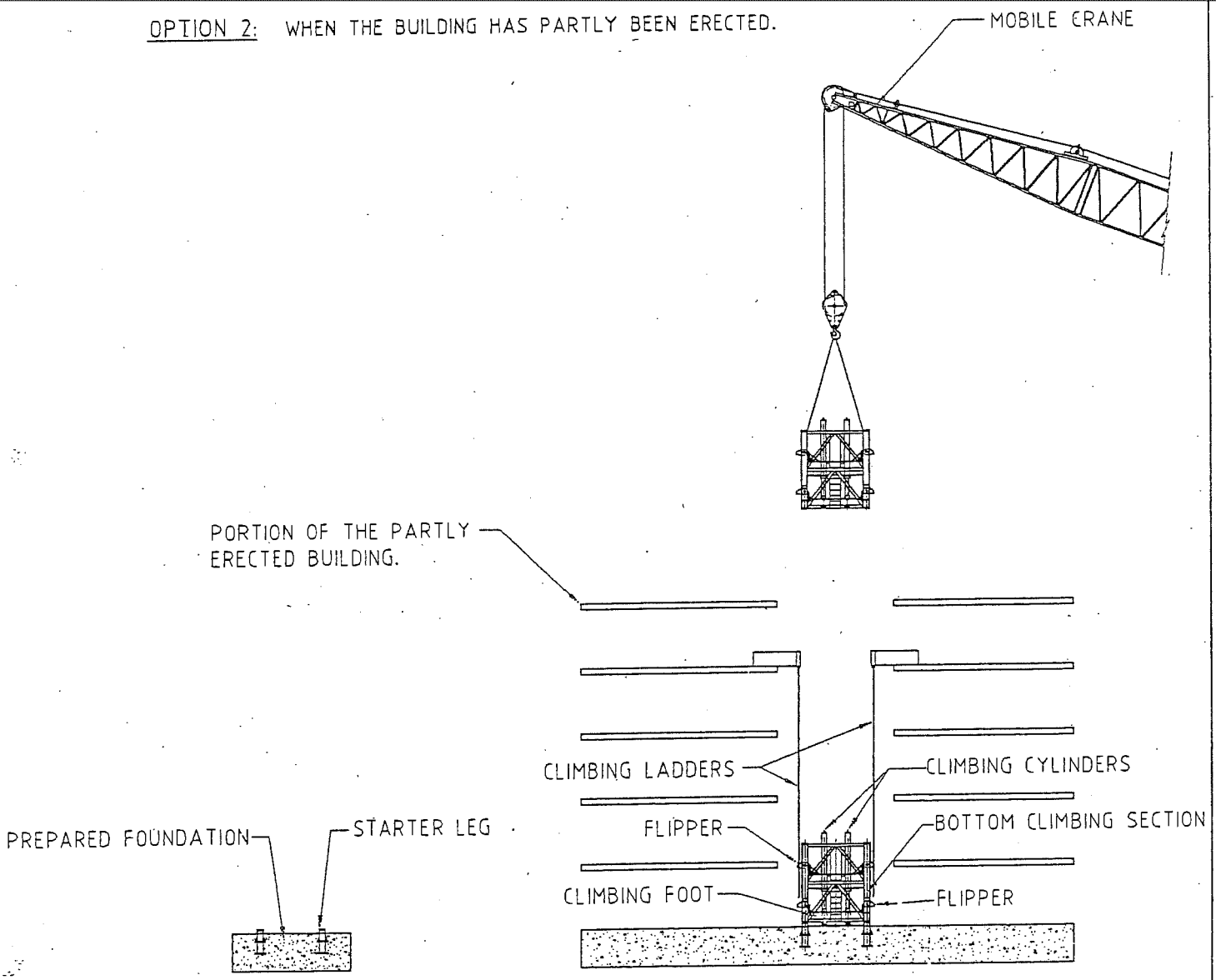
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TITLE

STDSEQ12

CLIMBING SEQUENCE FOR INTERNAL CLIMBER

OPTION 2: WHEN THE BUILDING HAS PARTLY BEEN ERECTED.



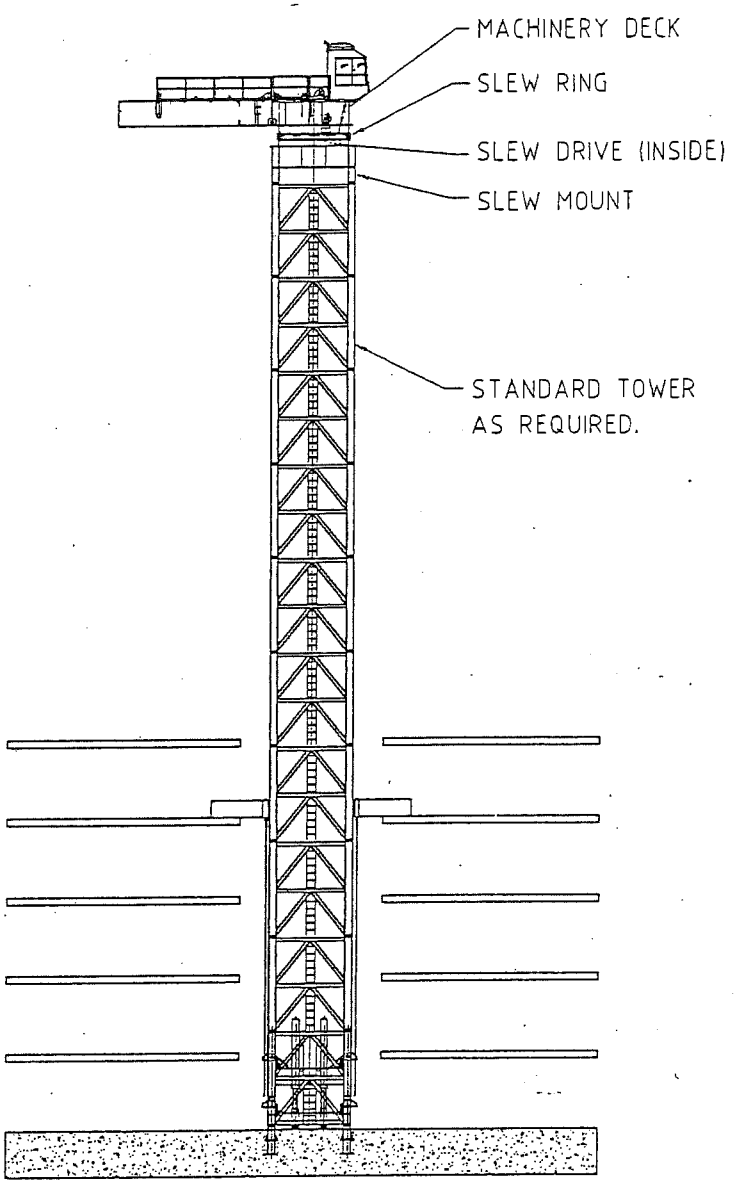
(1) ERECT THE CRANE'S BASE (INCLUDING THE CAST-IN STARTER LEG) ON THE PREPARED FOUNDATION.

(2) LOWER THE CLIMBING TOWER (INCLUDING THE CLIMBING CYLINDERS) THROUGH THE BUILDING TO ITS SUPPORT POSITION.

CAUTION:
ENSURE FLIPPERS ARE POSITIONED SO THEY WILL BE ALIGNED WITH THE LADDERS AND COLLARS IN THEIR PLANNED LOCATION.

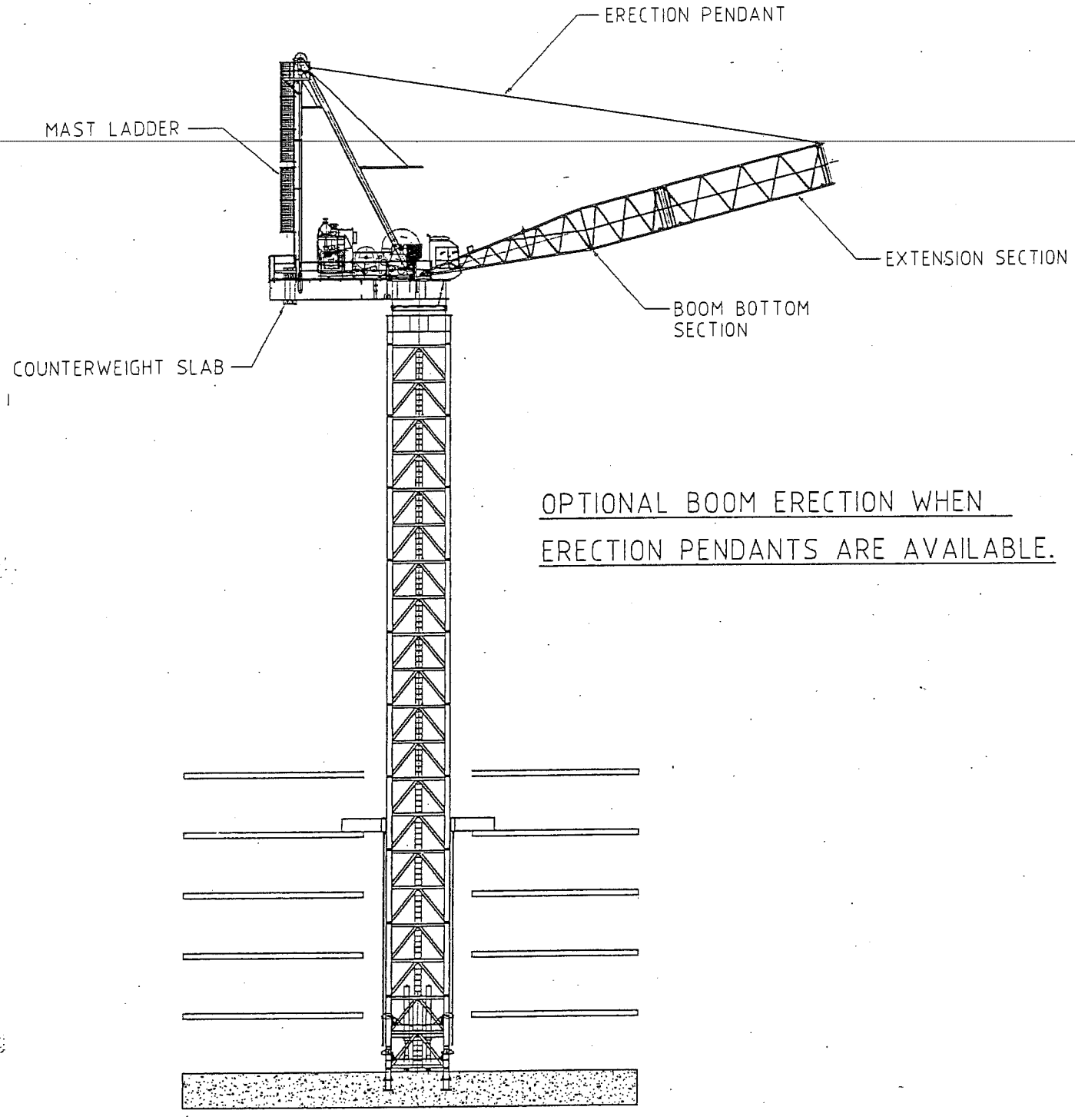
CLIMBING SEQUENCE FOR INTERNAL CLIMBER

OPTION 2: WHEN THE BUILDING HAS PARTLY BEEN ERECTED (cont'd)



(3)

1. THE CORRECT NUMBER OF TOWERS APPROVED FOR SITE ARE THEN ERECTED ON THE BOTTOM TOWER.
2. CONNECT THE SLEW MOUNT ONTO THE TOP TOWER (FOR TIGHTENING TORQUES, REFER TO TABLE 2.7, IN THE CRANES MANUAL OR DRAWING E011.
3. FIT CABIN SUPPORT PLATFORM, SIDE PLATFORMS, ACCESS LADDERS AND HANDRAILS TO DECK.
4. BOLT THE CONTROL CABIN INTO POSITION.
5. LIFT AND FIT THE MACHINERY DECK ASSEMBLY INCLUDING THE SLEW DRIVE AND SLEW RING TO THE SLEW MOUNT.



OPTIONAL BOOM ERECTION WHEN ERECTION PENDANTS ARE AVAILABLE.

(1)

1. FIT "SOME" COUNTERWEIGHTS AND SECURE INTO POSITION ON DECK.
2. ERECT MAST LADDER & PLATFORM.
3. ERECT THE BOOM BOTTOM SECTION & EXTENSION SECTION USING PENDANT ROPES.

N.B: LIFT THE BOOM SECTION WITH SLINGS ONLY TO PREVENT DAMAGE AND CONNECT TO THE MACHINERY DECK. HOLD THE BOOM SECTION IN POSITION UNTIL THE ERECTION PENDANTS CAN TAKE THE LOAD.

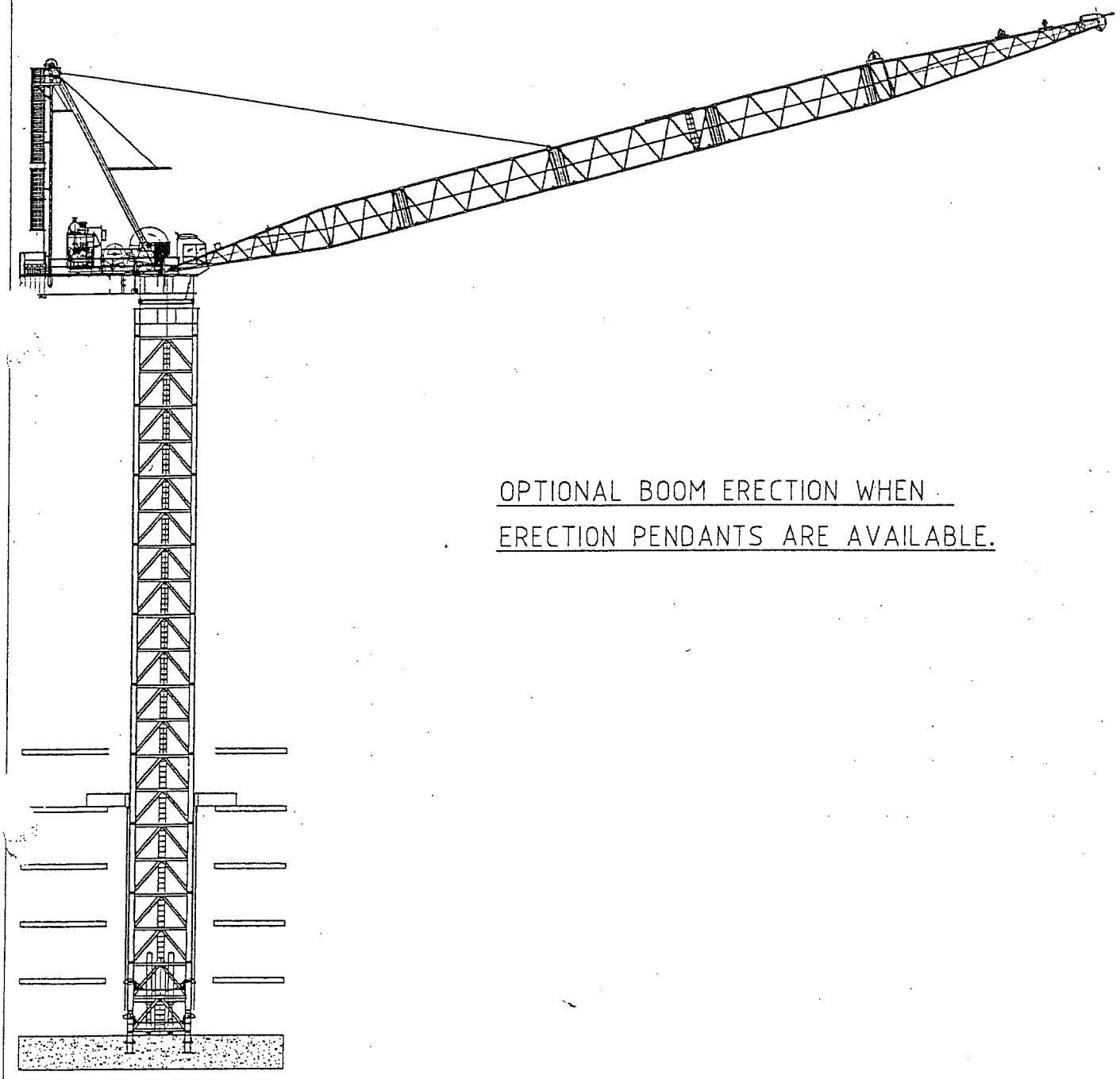
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TITLE
CRANE ERECTION SEQUENCE

STDSEQ15



OPTIONAL BOOM ERECTION WHEN
ERECTION PENDANTS ARE AVAILABLE.

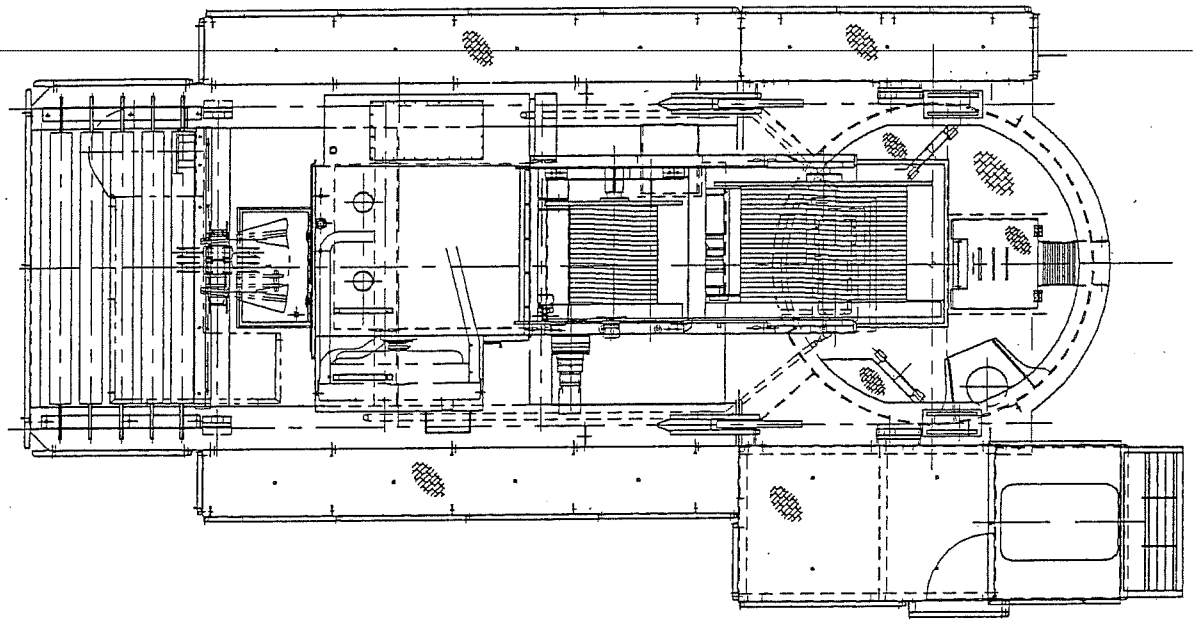
(2) 1. FIT THE REST OF THE COUNTERWEIGHTS AND SECURE INTO POSITION.
2. ERECT THE REST OF THE BOOM SECTIONS (INCLUDING THE BOOM TOP SECTION).

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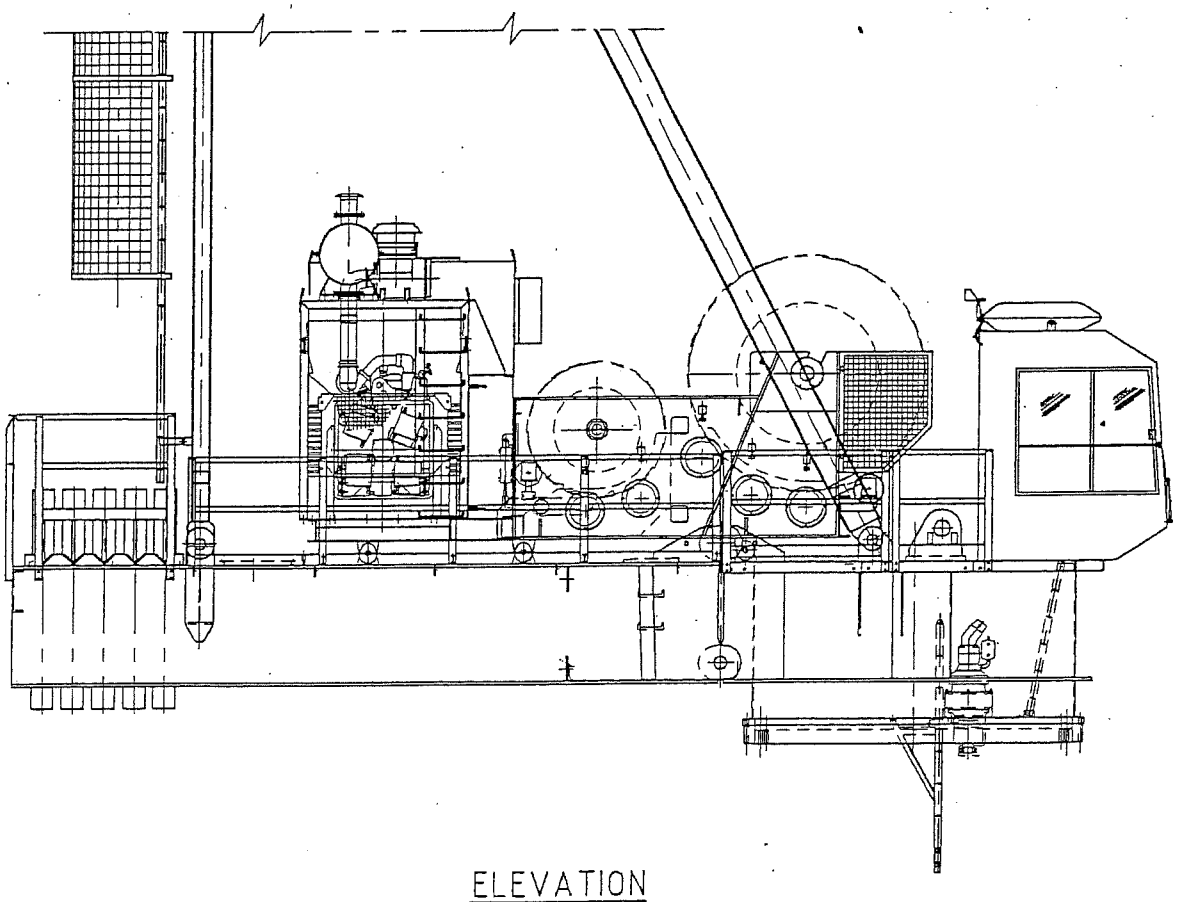
TITLE
CRANE ERECTION SEQUENCE

STDSEQ16

TYPICAL DECK ASSEMBLY AT STAGE 7



PLAN



ELEVATION

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TITLE

CRANE ERECTION SEQUENCE

STDSEQ17

2.13 Crane Lightning Protection Connection

Copper rod attached on boom top and earthed slipring/tower system should be employed to protect the crane in the event of a direct lightning strike.

(1) Install the lightning arrester and cable as attached on the lightning arrester assembly.

(2) Run the earth cable along the boom, down to the machinery deck.



It is the crane owner's responsibility to ensure the crane is properly earthed.

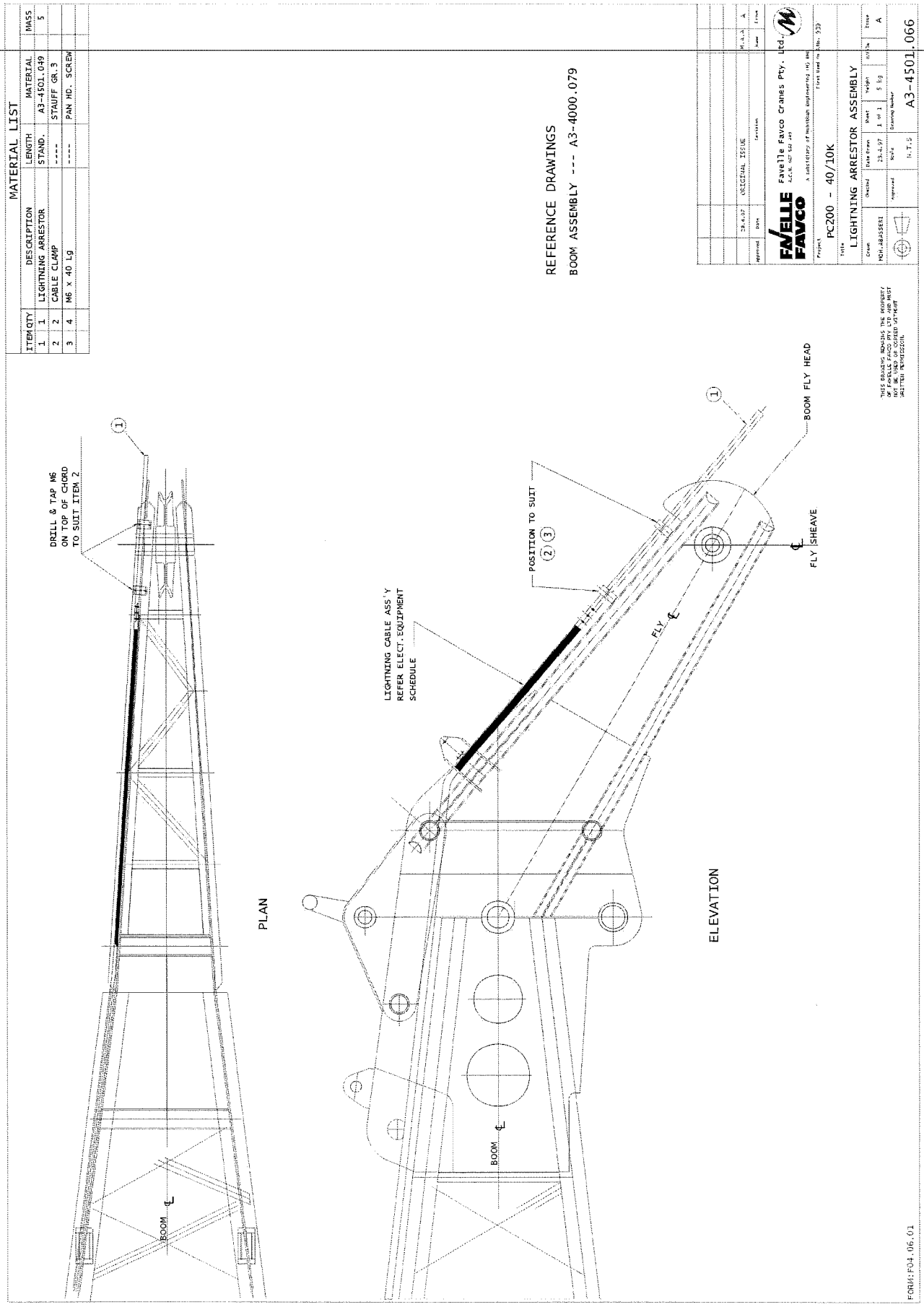


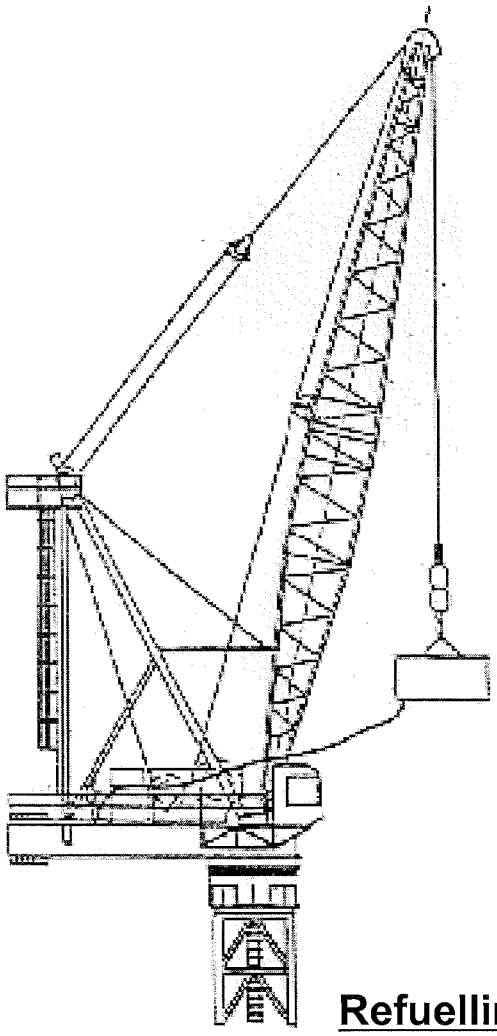
Figure 2-1 Lightning Rod Attachment Details

2.14 Refuelling of Crane

There are a few different procedures to refuel the crane. The suggested procedure is as described below:

1) Hoist the fuel tank up until it is just above the cabin or higher to attain an appropriate fluid head to allow the fuel to flow.
2) Luff in the boom until the refuelling hose is close it the machinery deck so that the hose can be reached and obtained by the maintenance personnel.
3) The hose is than inserted into the filler breather opening, and the fuel is allowed to flow into the tank. Check dipstick for tank level or level gauge if fitted.
4) Reverse Steps 1- 3 to lower the empty refuelling tank onto the ground.

WARNING ***When refuelling switch off the crane engine and all electricals. Ensure the engine is cooled down. Keep all flame away from the refuelling point.***



Refuelling of cranes

2.15 CRANE FASTENER TORQUE

FORM:F04.03.03 DO NOT SCALE FROM DRAWING IF IN DOUBT ASK FFC PTY LTD ENGINEERING DEPT.

GENERAL FASTENER TORQUES

IMPERIAL SERIES (CLEAN DRY THREADS) - BLACK FASTENERS

FASTENER SIZE IN INCHES (COARSE PITCH)	GRADE 5 SAE		GRADE 8 SAE		HEX SOCKET CAP SCREW	
	Ft-lbs	Nm	Ft-lbs	Nm	Ft-lbs	Nm
1/4	7	10	10	14	15	20
5/16	15	21	21	29	30	41
3/8	27	36	38	51	54	73
7/16	43	58	60	82	86	116
1/2	65	89	92	125	131	177
9/16	94	128	133	180	188	255
5/8	130	176	184	249	260	353
3/4	231	313	326	442	462	626
7/8	372	504	525	712	744	1009
1	558	756	787	1070	1120	1510
1 1/8	688	933	1120	1510	1580	2140
1 1/4	971	1320	1570	2130	2230	3020
1 3/8	1270	1730	2060	2800	2920	3960
1 1/2	1690	2290	2740	3710	3880	5260
1 5/8	2090	2840	3390	4600	4810	6520
1 3/4	-	-	4320	5860	6120	8300

METRIC SERIES (CLEAN DRY THREADS) - BLACK FASTENERS

FASTENER SIZE IN mm	GRADE 4.6		GRADE 8.8		GRADE 10.9	
	Nm	Ft-lbs	Nm	Ft-lbs	Nm	Ft-lbs
M 6	4	3	9	7	13	10
M 8	9	6	22	16	32	23
M 10	17	13	44	32	63	46
M 12	30	22	76	56	109	80
M 14	-	-	122	90	174	129
M 16	73	54	189	139	271	199
M 20	143	106	369	272	528	390
M 24	247	183	638	470	912	673
M 30	492	363	1312	968	1820	1340
M 36	-	-	2293	1691	3170	2340

METRIC SERIES (CLEAN DRY THREADS) FLUOROCARBON COATED FASTENERS

FASTENER SIZE IN mm	GRADE 8.8		GRADE 10.9	
	Nm	Ft-lbs	Nm	Ft-lbs
M 12	46	34	65	48
M 14	73	54	105	77
M 16	113	84	162	120
M 20	222	163	317	234
M 24	382	282	548	404
M 27	571	421	803	592
M 30	787	581	1090	803

NOTES (D)

1. THESE TORQUE VALUES ARE ONLY TO BE USED FOR GENERAL FASTENERS NOT SLEW RING OR TOWER FASTENERS
2. NOT FOR USE ON METRIC STRUCTURAL BOLTS
3. FOR SLEW RING FASTENER TORQUES REFER TO SHEET 2
4. FOR TOWER FASTENERS REFER TO SHEET 3
5. FOR REFERENCE 1 Ft-Lb = 1.356 Nm / .738Ft-Lbs = 1.000Nm
6. FOR OTHER COATING APPLICATIONS SEE ENGINEERING DEPARTMENT (PRACTICAL TEST OF BOLT ELONGATION)
7. LIGHTLY LUBRICATED MEANS THE USE OF A LIGHT MINERAL OIL FOR LUBRICATION DO NOT USE OTHER FRICTION REDUCTING COMPOUNDS
8. CLEAN DRY THREADS MEANS BOLTS AS SUPPLIED WITH NO ADDITIONAL LUBRICATING COATING APPLIED

REFERENCES

1. A3-9900.214 CRANE FASTENER TORQUES
2. MA4-9900.069 FLUROCARBON COATED FASTENER TORQUES
3. CALCULATION NO.: A4.0990.008 CRANE FASTENER PRELOADING TORQUES

Checked	Date	Revision	ECN	Drawn	Rev.
	05.05.08	NOTES 1 AND 3 MODIFIED 7 AND 10 REMOVED	-	NPV	D
A.Mc	04.04.08	SEE SHEET 2	-	NPV	C
J.C.F	30.03.07	LANDSCAPE TO PORTRAIT	-	J.M.	B
X	06.10.06	ORIGINAL ISSUE	-	J.M.	A

Cat.	Item	Q'ty	Description	kg
	-	-	-	-

Title: CRANE FASTENER TORQUES — First Used On S/No. -

Drawn	Checked	Date Drawn	Sheet	Weight	Issue
J.M.	G.G.	06.10.06	1 of 3	NA	D

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Scale	Approved	Drawing Number
NA	M.P.	A4-9900.578
	Eng. Approved	

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SLEW RING FASTENER TORQUES

SLEW RING UNC/UNF SERIES (LIGHTLY OILED)
BLACK FASTENERS

FASTENER SIZE IN INCHES	HOLE DIA mm DIN/ISO 273	GRADE 8	
		Ft-lbs	Nm
UNC 5/8"-11	18	184	249
UNC 3/4"-10	21	326	442
UNC 7/8"-9	25	525	712
UNC 1"-8	27.5	787	1067
UNC 1 1/8"-7	32	1116	1510
UNC 1 1/4"-7	35	1570	2130
UNF 5/8"-18	18	208	282
UNF 3/4"-16	21	363	493
UNF 7/8"-14	25	579	785
UNF 1"-12	27.5	862	1170
UNF 1 1/8"-12	32	1250	1700
UNF 1 1/4"-12	35	1740	2360

SLEW RING METRIC SERIES (LIGHTLY OILED)
BLACK FASTENERS (SEE NOTE 11)

FASTENER SIZE IN mm	HOLE DIA mm DIN/ISO 273	GRADE 10.9		
		Ft-lbs	Nm	
M 12	14	80	109	
M 14	16	129	174	
M 16	17.5	199	271	
M 18	20	276	374	
M 20	22	390	530	
M 24	26	673	913	
M 27	30	987	1340	
M 30	33	1340	1810	
M 33	36	1820	2470	
M 36	39	2340	3173	C
M 39	42	3028	4107	C
M 42	42	3747	5080	C
M 45	48	4677	6342	C

SLEW RING METRIC SERIES
(CLEAN DRY THREADS)
FLUOROCARBON COATED FASTENERS

FASTENER SIZE IN mm	HOLE DIA mm DIN/ISO 273	GRADE 10.9	
		Ft-lbs	Nm
M 20	22	234	316
M 24	26	404	548
M 27	30	592	803
M 30	33	803	1088

NOTES

1. THESE TORQUE VALUES ARE ONLY TO BE USED FOR SLEW RING FASTENERS NOT GERNERAL OR TOWER FASTENERS
2. NOT FOR USE ON METRIC STRUCTURAL BOLTS
3. FOR STANDARD FASTENER TORQUES REFER TO SHEET 1
4. FOR TOWER FASTENERS REFER TO SHEET 3
5. FOR REFERENCE 1 Ft-Lb = 1.356 Nm / .738Ft-Lbs = 1.000Nm
6. FOR OTHER COATING APPLICATIONS SEE ENGINEERING DEPARTMENT (PRACTICAL TEST OF BOLT ELONGATION)
7. FOR SLEWRING BOLTS LARGER THAN M30 HYDRAULIC TENSIONING DEVICES ARE REQUIRED
8. LIGHTLY LUBRICATED MEANS THE USE OF A LIGHT MINERAL OIL FOR LUBRICATION DO NOT USE OTHER FRICTION REDUCTING COMPOUNDS
9. CLEAN DRY THREADS MEANS BOLTS AS SUPPLIED WITH NO ADDITIONAL LUBRICATING COATING APPLIED
10. STAINLESS STEEL BOLTS ARE NEVER TO BE USED IN A TENSION SITUATION DUE TO CORROSION PITTING
11. SLEW RING FASTENERS LARGER THAN M30 SHOULD PREFERENTIALLY BE TIGHTENED USING A HYDRAULIC STRETCH TENSIONER. THE VARIABILITY OF FRICTIONAL FACTOR CAN RESULT IN SIGNIFICANT VARIABILITY OF BOLT PRELOAD WHEN USING TORQUING TOOLS; WHICH COULD RESULT IN DAMAGE TO THESE FASTENERS IN EXTREME CASES.

Cat.	Item	Q'ty	Description	kg
	-	-	-	-

Checked	Date	Revision	ECN	Drawn	Rev.
	04.04.08	SEE SHEET 1	-	NPV	D
A.Mc	04.04.08	ADDED TORQUE VALUES FOR M36,	-	NPV	C
		M39, M42, M45. ADDED NOTE 11			
J.C.F	30.03.07	LANDSCAPE TO PORTRAIT	-	J.M.	B
	06.10.06	ORIGINAL ISSUE	-	J.M.	A

Title: CRANE FASTENER TORQUES — First Used On S/No. -

Drawn	Checked	Date Drawn	Sheet	Weight	Issue
J.M.	G.G.	06.10.06	2 of 3	NA	D

Scale	Approved	Drawing Number
NA	M.P.	A4-9900.578
	Eng. Approved	

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TOWER FASTENER TORQUES

TOWER FASTENER (LIGHTLY OILED & HARDENED WASHERS) BLACK FASTENERS		
FASTENER SIZE IN INCHES	FAVCO 70T	
	Ft-lbs	Nm
1 1/4"	1590	2160
1 1/2"	2770	3760
1 3/4"	4370	5930
2"	6570	8910

NOTES

1. THESE TORQUE VALUES ARE ONLY TO BE USED FOR TOWER BOLTS NOT GERNERAL OR SLEW RING FASTENERS
2. NOT FOR USE ON METRIC STRUCTURAL BOLTS
3. FOR STANDARD FASTENER TORQUES REFER TO SHEET 1
4. FOR SLEW RING FASTENERS REFER TO SHEET 2
5. FOR REFERENCE 1 Ft-Lb = 1.356 Nm / .738Ft-Lbs = 1.000Nm
6. FOR OTHER COATING APPLICATIONS SEE ENGINEERING DEPARTMENT (PRACTICAL TEST OF BOLT ELONGATION)
7. LIGHTLY LUBRICATED MEANS THE USE OF A LIGHT MINERAL OIL FOR LUBRICATION DO NOT USE OTHER FRICTION REDUCTING COMPOUNDS
8. CLEAN DRY THREADS MEANS BOLTS AS SUPPLIED WITH NO ADDITIONAL LUBRICATING COATING APPLIED
9. STAINLESS STEEL BOLTS ARE NEVER TO BE USED IN A TENSION SITUATION DUE TO CORROSION PITTING

					05.05.08	SEE SHEET 1	-	NPV	D
					A.Mc	04.04.08	SEE SHEET 2	-	NPV	C
					J.C.F	30.03.07	LANDSCAPE TO PORTRAIT	-	J.M.	B
	-	-		-		06.10.06	ORIGINAL ISSUE	-	J.M.	A
Cat.	Item	Q'ty	Description	kg	Checked	Date	Revision	ECN	Drawn	Rev.

Title	First Used On S/No.	Drawn	Checked	Date Drawn	Sheet	Weight	Issue
CRANE FASTENER TORQUES	-	JM	G.G.	06.10.06	3 of 3	NA	D

FAVELLE FAVCO Favelle Favco Cranes Pty. Ltd. A.B.N. 29 067 562 449 A subsidiary of Muhibbah Engineering (M) BHD	Scale NA	Approved M.P.	Drawing Number A4.9900.578
		Eng. Approved G.G.	

Figure 2-2 Crane Fastener Torques

3 OPERATING INSTRUCTIONS

3.1 General 3-2
3.2 Crane Safety 3-2
3.3 Description of Safety Equipment 3-5
3.4 Cabin 3-9
3.5 Check Lists 3-12
3.6 Operating Instruction 3-17
3.7 Lifts 3-19
3.8 Handling of Heavy Loads 3-20
3.9 Crane Shut Down and Out of Operation Condition 3-21
3.10 Emergency Load Lowering Procedure (Main Hoist and Fly Hoist) 3-23
3.11 Standard Hand Signals 3-24

3.1 General

This section of the manual covers operations and safe use of the crane.

The crane operator should read through this section to gain a basic understanding of crane operation and safety, before attempting to operate the crane. This section covers routine operations, heavy lifting safety precautions as well as emergency procedures.

By reading though this section the crane operator should become familiar with the safety equipment available to ensure the crane be operated safely.

Instructions on the operations of the crane is also explained to familiarise the operator with this particular crane.

3.2 Crane Safety

3.2.1 Prior to Crane Operations

These are some of the safety precautions the crane operator should observe.

1. Only qualified operators should be permitted to operate the crane. Thorough training in **accident prevention** is essential.

2. Unauthorised personnel should be prevented from gaining access to the crane.

3. The operator must be physically and mentally fit, to operate the crane.

4. The crane must be operated by a person who is familiar with this crane's limitations, safety equipment and operating instructions.

5. The directions of your local inspection authority concerning the operation of this equipment should be posted inside the control cabin.

6. Never alter any equipment or change any pressure settings without prior written permission from Favelle Favco Cranes Pty. Ltd.

7. Never heat, weld or oxy-cut on the boom sections or any other structural components without prior permission and procedures given by Favelle Favco Cranes Pty. Ltd.

8. Strictly adhere to the daily check list in this section to avoid untimely crane shut down or failure.

9. The operator should be instructed to check the operation of the main hoist, fly hoist and luff brakes, as well as the luff ratchet.

10. The operator should be instructed to report any occasion when a rope becomes kinked or displaced from a sheave or rope drum. This situation requires careful checking of the rope. Operations should stop if a dangerous condition exists.

11. Report any cases of excessive wear, faults, unusual noise or other irregularities immediately.

12. The crane should only be serviced when out of operation.

13. Keep the equipment in a clean condition to avoid accidents.

3.2.2 During Crane Operations

These are some of the safety precautions the crane operator should observe.

1. Ensure the crane has sufficient fuel and oils to prevent unexpected shutdowns when working.

2. Do not operate the crane if any limits or safety equipment are out of order.

3. The crane should not be operated in winds exceeding speed of 20m/s (including gusts). Immediately lower all loads, and stop using the crane.

4. Under strong wind conditions bulky loads should be handled with care.

5. Never divert your attention while operating.

6. Pay attention to the appointed signalman only.

7. Do not start crane operation until signalman or load is in full view.

8. Obey an emergency signal at any time no matter who gives it.

9. If there is any doubt as to safety, refuse to handle loads until safe conditions exist.

10. Conveyance of persons on the hook is prohibited.

11. Control levers must be operated steadily at all times.

12. Observe engine tachometer during operations to avoid stalling or load run-away.

13. Never lift a load in excess of the rated load capacity chart. Pay attention to the overload system.

14. Do not use limit switches as stopping devices.

15. Do not lift more than one separately rigged load at a time.

16. Do not leave the operating seat when a load is on the hook or with crane running.

17. Do not load fly hoist, when a load is on the main hook, and vice versa.

18. Never swing a load over people. Use the warning horn.

19. Use tag lines for handling bulky loads.

20. Dragging heavy loads along the ground is a dangerous practice and is prohibited.

21. Once the hook has reached a landing, stop hoisting down. This is to avoid slackening of the wire rope, which may result in the incorrect re-reeling on the winch drum.

3.3 Description of Safety Equipment

3.3.1 General Description

Motion control levers provided in the cabin consist of a joystick type control and single or dual function lever controls.

All controls increase the speed of each motion proportionally to the deflection of the levers from the neutral position.

NOTE ***All control levers are of the 'deadman' type which spring return to the neutral position upon their release.***

The slew brake is operated by a manually operated control valve. The slew brake is applied only when boom is to be held in position during heavy winds. The crane show be weather vaned when out of service.

The main hoist, fly hoist and luff brakes are released whenever the motion control levers are moved from the neutral position. These brakes automatically apply when the control levers are returned to neutral.

Other controls and related equipment are as described in the next sub-sections.

A Microprocessor Unit

The freely programmable controller ESX works independently as a measuring, driving or controlling device for sensor-actuator management and is capable of executing a number of separate or related tasks in real time.
The ESX was developed especially for use under harsh conditions and extreme temperatures, functioning from -40 to +85 degree Celsius in vehicles and machines.
All inputs and outputs are protected against short circuit to ground or to voltage overload and have a built-in diagnostic capability

B Boost Pressure Switch

When boost pressure drops excessively (or is lost) the boost pressure switches stops all motions and apply all brakes(except slew)

C Emergency Stop

This is a palm push lock down button mounted on the operator's control panel. When activated, it ceases all motions, applies all brakes, engages luff ratchet and shuts down engine.

D Luff Drum Pawl

This provides a positive lock on the luff drum and engages with engine shutdown. A light is provided on the control panel to indicate when the luff pawl is engaged.

E Pressure Cut Off

The hoist, fly and luff pumps are fitted with a pressure cut off system, which de-strokes the pumps when the system reaches a set pressure.

F Luff in Deceleration and Stop

When the incoming boom operates the deceleration and motion stop limit valve, luff motion automatically decelerates and when it reaches minimum radius stops the luff motion.

G Boom Buffer

The buffer is spring operated. This provides a load on the boom at low radius to ensure that a slack luff rope is not possible near minimum radius, with a heavy wind from the front.

H Limit Switches & Alarms

Main Hoist

The hoist limit switch is operated through the shaft on the drum gearing. The limit switch automatically resets when the motion is driven in the opposite direction.

The up limits must be set with the boom at maximum radius and starting with the up limit.

The up working limit is set approximately 5 metres below the boom head. When reached it stops the hoist up motion and applies the hoist brakes.

NOTE **A minimum of 3 full turns of rope must remain on the drum at the lowest hoist limit.**

Luff

Like the hoist limit switch, the luff up ultimate and luff limit switch is operated on the drum gearing. The luff up limit and deceleration hydraulic value is mounted at boom pivot.

The luff out limit is set at maximum radius. When triggered it stops the luff down motion and applies the luff brakes.

Luff in ultimate limit stops the motor and all crane motions. If this limit is tripped, the reason must be determined by a qualified person and rectified before the limit can be bridged over and the crane restarted. illustrates the geared cam limit switch.

GEARED CAM LIMIT SWITCH

Snap action switches with change over function are operated by maintenance free moulded gears.

Switches as well as reduction gears, reduction being selected to suit maximum drum turns, are housed in a reinforced polycarbonite enclosure with IP66 protection.

Adjustment of limit switch is infinitely made on the cam disc by means of a self-locking worm gear.

Worm gear is operated by either a 10mm screw driver or 4 mm allan key.

NOTE ***Only the white worm gears are used to adjust limit switch position.***

Block adjustment

The planetary gear construction allows a block adjustment in addition to individual contact adjustment from the usable revolution 6.5. The final gear stage is also provided with an adjustable worm, coloured black. All cam discs can be commonly adjusted by means of this adjusting worm. The relative adjustments of the individual contacts to each other are not modified.
Standard cam discs are supplied with 20 rises. Other cam angles at extra price. The following picture illustrates the geared cam limit switch.

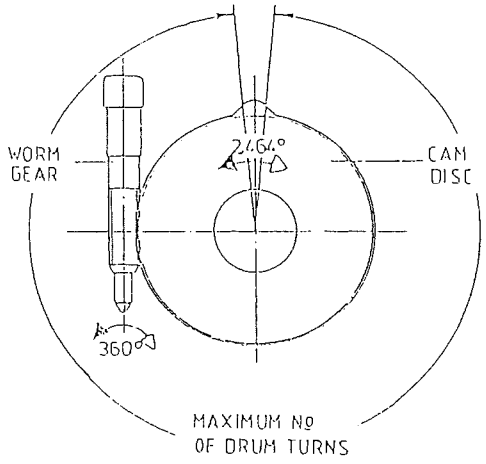


Figure 3-1 Gear Cam Limit Switch

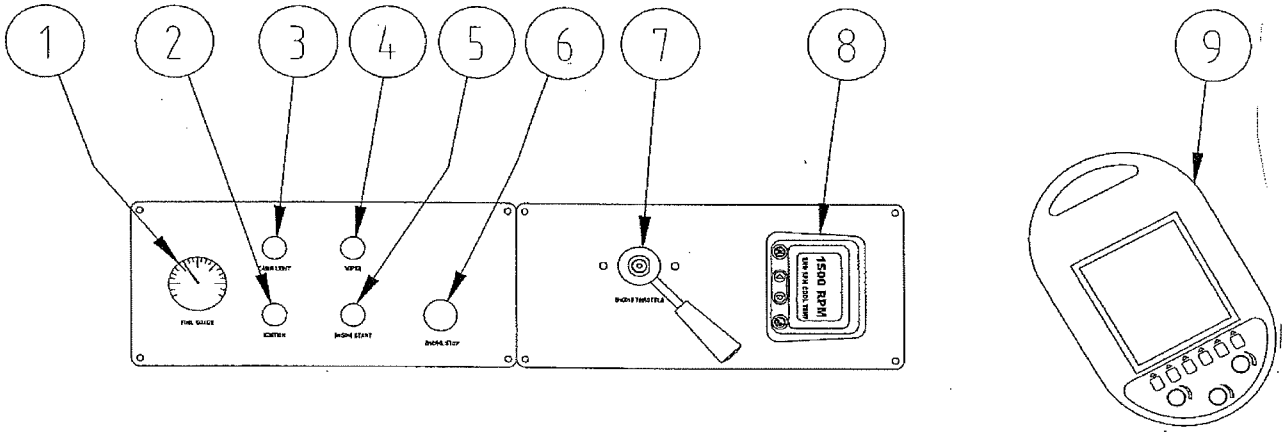
3.4 Cabin

3.4.1 Cabin Layout

Refer to Cabin Assembly drawing in section 6 for more details

3.4.2 Control Panel

The Control Panel provides the operator with visual indication of the crane's conditions. The panel instrumentation consists of actual gauges indicating operating parameters.



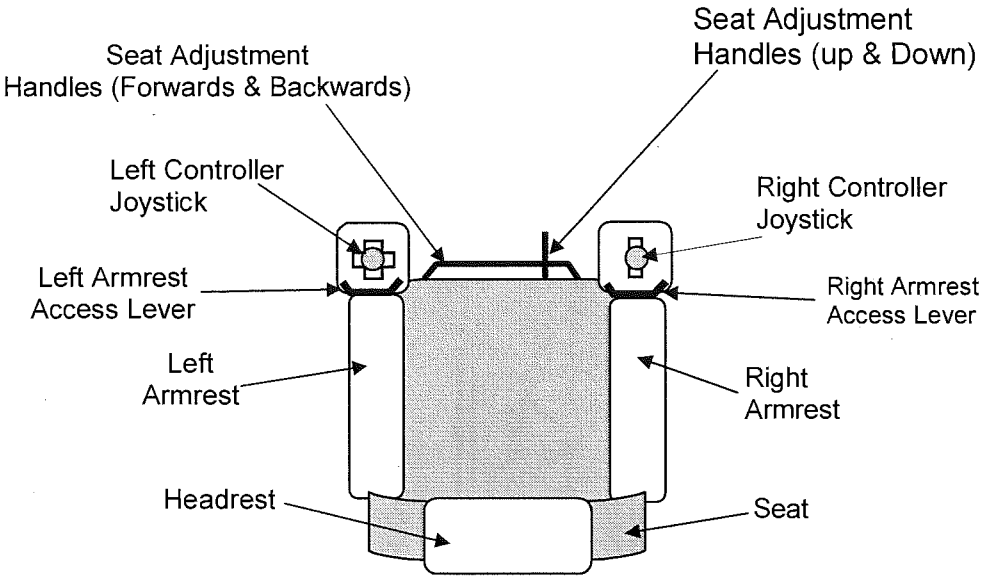
No.	Description	No.	Description
1.	Fuel Gauge	6	Emergency Stop
2.	Ignition	7	Engine Throttle
3.	Cabin Light	8	Engine Management System Display
4.	Wiper	9	Display Unit
5.	Engine Start		

Figure 3-2 Control PaneL

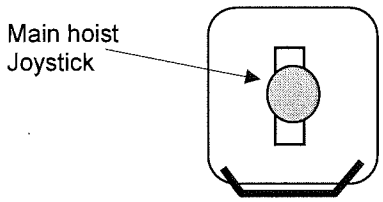
1. **Fuel Gauge** is an analogue meter showing fuel status in the crane. .
2. **Ignition** is a turn key switch to start engine and electrics.
3. **Cabin Light** activates the internal cabin lights.
4. **Wiper** is a turn switch to operate windscreen wipers.
5. **Engine Start** is a push switch to start the engine. Do not continuously hold the Engine Start Button for long periods. Apply pulses to start engine.
6. **Emergency Stop** when applied shuts down the engine.

7. **Engine Throttle** lever is used to adjust the engine speed. Refer to the engine manual for engine characteristics, before operating the crane.
8. **Engine Management System** describes the engine status.
9. **Display Unit** it displays the boom radius, boom angle, load on hook, crane alarms and selected load charts. Refer to Chapter 8 for more information.

3.4.3 Seat

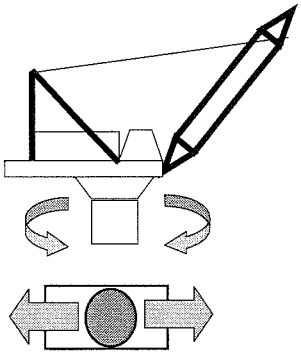


- Right Controller Joystick operates the main Hoist winches. The joystick is either pushed forward for line out or pulled back for line in.



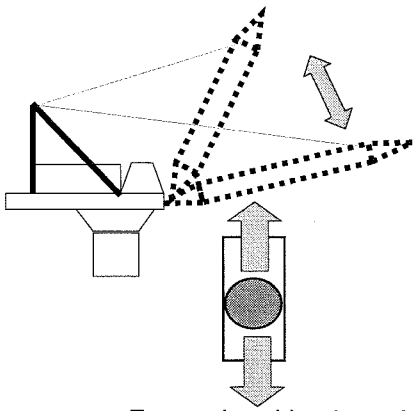
Right Controller Joystick

- Left Controller Joystick operates the Luff Motors and the pedal operates the slew rotation. Forward and backward motion of joystick controls the Luffing of the boom, while pressing left and right pedal motion controls the slew rotation.



Left & Right motion control slewing

Left Controller Slew motions



Forward and backward motions control luffing

Left Controller Joystick motions

3.5 Check Lists

3.5.1 DAILY

According to the usage of this crane, "daily check list" means inspection either by the crane operator or the maintenance personnel whenever the crane is to be operated.

It is imperative that the crane operator is informed by the previous operator or the person responsible for the crane of any shut down or problem.

It must be noted, that the following daily checks do not include all specific direction given for the diesel engine.

A Check prior to engine start:

Item	Check Prior to Engine Start	Check
1.	Check for sufficient fuel oil to avoid untimely engine shut down during operation.	
2.	Check radiator water level (Check for leaks).	
3.	Check pump drive gearbox and/or gearbox oil level (Check for leaks). **ATTENTION** **Do not overfill.**	
4.	Check hydraulic oil level tank level. **ATTENTION** **Do not overfill.**	
5.	Visually check for oil leakage around the powerpack and the winch.	
6.	Visually check for leakage or damage in the air and non-mechanical systems.	
7.	Check hoist, luff and fly ropes for defects. Refer to Section 0 for more details on rope inspection. Ensure that ropes are laying in all sheaves and correctly on their drums. The ropes shall be free of kinks, loose strands or rust.	

B Engine Start:

Warm up diesel engine as recommended in the engine manual supplied, then continue with checks. Drive all motions at half speed only while checking, as the hydraulic system needs warming up. Refer to table 4-1 page4.17 for hydraulic oil operational temperature limits.

ATTENTION ***Do not lift any loads while the hydraulic system is warmed.***

Items	Start Instruction	Check
1	Reset circuit breakers, if disengaged, to supply electric power to the engine and crane safety system (if applicable).	
2	Reset emergency stop button if latch down type is used.	
3	Shift throttle control to low idle and then turn start key and push start button. Allow the engine 5 minute to warm up	
4	Should the engine fail to start, rectify possible cause.	

C Checks during the warm up period (prior to operation):

Items	Checks During Warm Up	Check
	Check filter visual indicators. Replace elements if required.	
	Check hydraulic pipework for leakage.	
	Check oil levels (Engine, hydraulic drive units)	
	Drain water from air tank and filter.	
	Check engine tachometer.	
	Check safe load indicator and run a comparison with the mechanical radius indicator on the boom.	
	Release slew brake.	
	Check main 'hoist up' limit function	
	Check boom buffer positions. Both buffers must be of equal length when the boom is away from them.	
	Check 'luff in' deceleration and motion cease limit.	
	Check horn.	
	Check 'dead man' controls. Ensure that all controls return to zero position by themselves.	
	Check that there is absolutely no motion creep with brakes applied. If any motion is detected, immediately shut down the crane and contact a qualified maintenance personnel. **ATTENTION** ***With brakes released, creep up in both hoists and luff is possible, as the pumps can be set slightly off centre to avoid the load or boom drop with heavy loads.***	
	Check engine throttle control and tachometer when oil is sufficiently warmed up.	
	Check oil tank temperature before any heavy work is required. The minimum temperature shall not be less than 25-35 degrees Celsius, depending on the oil type. Refer to the Maintenance section of this manual for further information.	
	Check engine oil level (dipstick).	
	Check 'annunciator' panel to ensure visual and audible alarm is working.	
	Check the fuel gauge (if fitted) in cabin.	
	Check the operation of the luff drum pawl.	
	Check that load chart for applicable boom length is installed in the cabin.	
	Check hoist brake.	

	Check emergency stop is working.	
	Check 'luff down' limit	
	Check emergency lowering needle valve(s) is present and tightly closed.	
	Ensure windows are clean.	
	Determine that wind is not excessive for crane use and type of lift.	
	Check aviation warning light(s) are working.	
	Visually check for loose, missing, or corroded bolts, pins, keepers or cotter pins.	
	Visually check loose gear to be used, such as slings, sling hooks and shackles (if applicable).	

3.5.2 MONTHLY

NOTE

1. ***Items 2 to 8 are to carried out with engine running.***
2. ***Items 9 to 19 are be carried out with all crane motions***

Items	Monthly Checks	Check
1	Check main hoist, fly hoist and luff ropes for defects. Ensure that ropes are laying in all sheaves and correctly on their drums.	
2	Check engine oil level (dipstick).	
3	Check radiator water level (cap and dip stick).	
4	Check pump drive gearbox oil level.	
5	Check hydraulic oil level indicator on the hydraulic oil tank.	
6	Check safe load indicator and run a comparison with mechanical boom radius indicator.	
7	Check the 'annunciator' panel to ensure visual and audible alarms are working.	
8	Check the fuel gauge in cabin.	
9	Check the operation of the luff drum pawl.	
10	Check that load chart for applicable boom length is installed in the cabin.	
11	Check hoist brake	
12	Check 'hoist up' limit.	
13	Check emergency stop is working	
14	Check throttle control.	
15	Check 'luff in' deceleration and motion cease limit.	
16	Check 'luff down' limit.	
17	Check 'dead man' controls.	
18	Check emergency lowering needle valve(s) is present and tightly closed.	
19	Check needle valve on slew pump is closed.	
20	Ensure windows are clean.	
21	Check aviation warning light(s) are working.	
22	Visually check for oil leakage around the powerpack and the winch.	
23	Visually check for leakage or damage in the air and non-mechanical systems.	
24	Visually check for loose, missing, or corroded bolts, pins, keepers or cotter pins.	

25	Visually check loose gear to be used, such as slings, sling hooks and shackles (if applicable).	
26	Further check all control mechanisms for proper adjustment, excessive wear of components, and contamination by foreign matter.	

3.6 Operating Instruction

Prior to starting the diesel engine and during the warm up period, the operator is required to check the crane according to the daily checklist.

When the crane is assembled for the first time, circuit breakers in the electric cubicle must be engaged to provide power. Ignition is switched on and the annunciator shows low oil and boost pressure until engine is started. The safe load indicator is also switched on through the ignition switch and shows boom radius, load in tonnes and permitted load in tonnes.

NOTE ***When the crane is started with cold and thick hydraulic oil in the system, the filter bypass may indicate on the annunciator until the hydraulic oil warms up.***

Motion control valves are of the 'dead man' type and motion speeds are in direct proportion to the deflection of the lever from the neutral position.

Care must be taken at all times to ensure that all motion controls are operated smoothly and progressively and not 'plugged' or 'counter switched' before the load stops.

EXAMPLE *Pull the lever from zero to approximately half stroke and a pressure between 5 and 18 bar actuates the pump from zero to full displacement. The rest of the valve stroke, giving a pressure from 18 to 28 bar destrokes the hydraulic motor towards its minimum displacement if the load on the hook allows. Adjustment within the motor is automatic towards faster speed, if the torque required is satisfied. This only applies to the main hoist and luff motions.*

The safe load indicator(SLI), which continually shows the radius, actual and permitted load at any specific radius must be observed at all times. This is to avoid tripping the motion cutout while luffing out. When overload condition occurs, the operator should immediately luff in or lower the load to the ground.

Further information on using the SLI can be found in Section 8 of this manual and the SLI operator' manual (if supplied).

ATTENTION

1. ***All crane alarms are provided as an operator's aid only and should not be solely relied on. The operator should be aware at all times of the permitted safe working load, the current load on the hook and the current radius.***

2. ***To ensure enough power for operation, the engine should be operated at full RPM.***

CAUTION

Observe operation of brakes and luff ratchet frequently to ensure correct operation. All brakes and the luff ratchet should be in the applied position when the engine is not running.

3.6.1 Slew brake control

During normal operation, the brake control lever is in the working position (brake open). If during windy conditions the boom must be held in its position for a prolonged period, the valve can be moved into the lock position after motion has stopped (brake closed).

WARNING

Do not apply the slew brake while the crane is slewing

3.7 Lifts

All lifts are undertaken by observing the safe load indicator for the hoist in operation.

To check the load, tension the rope by pulling the control valve slowly in the up direction. Release lever immediately when either indicator shows overload.

If the indicator shows overload, then the load must be lightened, or the lifting radius reduced.

ATTENTION ***Pay strict attention to the safe load indicator when luffing out with a heavy load to avoid overloading the crane.***

3.8 Handling of Heavy Loads

When raising heavy loads the control is pulled slowly to accelerate the load to maximum hoist speed.

NOTE ***The engine high idle RPM will drop by 10% under maximum load conditions.***

Lowering speeds for heavy loads (above ¾ full load) should be limited to about half of full speed by reducing both engine speed and pump stroke control.

If during operation a further drop is observed, immediately back-off the controls to avoid stalling of the engine.

During lowering of a load or the boom, ensure that the engine revolutions must never get too high to avoid serious damage to engine, pumps and motors. Immediately back off motion control if over-speeding starts to occur.

ATTENTION

1. ***Should a load or the boom ever accelerate out of control, never counter switch controls, let all controls go and hit the emergency stop button to arrest load or boom.***
2. ***Observe Tachometer***

3.9 Crane Shut Down and Out of Operation Condition

Engine and hydraulic components should be allowed a sufficient "cooling off" period prior to shutdown.

Running engine at approximately half speed for at least 5 minutes after crane has been working hard should be sufficient for cooling off purposes.

Before leaving the cabin, ensure that all windows are closed. Switch off all lights and shut cabin door securely.

Before leaving the crane, a visual check of componentry should be undertaken and the maintenance supervisor or the responsible person informed of any discrepancies.

WEATHERVANE

Cranes free standing with 360° slewing.

Whenever the crane is left unattended (without driver in control), it must be put into the weathervane mode before the engine is shut down.

Proceed as follows:

1. Swing crane boom away from the general wind direction that is so the wind comes from behind the crane. Luff out the boom as much as possible, taking account that a change in wind direction will not cause a collision with the boom.

2. With slew brake released or open, close needle or lock valve on the control panel tightly to lock in the slew release pressure.

3. Proceed to the power pack and open the needle valve on the slew pump fully to assist oil flow across the ports.

4. When returning to normal duty, the needle valve on the control panel must be fully opened and the needle valve on slew motor tightly closed before commencing work.

WEATHERVANE

Cranes standing in pairs or when slewing is restricted by a building nearby.

There are options available for this case.

1. The cranes can be weathervaned with the boom at an intermediate radius, to avoid collision. This will increase the out of service loads on the crane and tower structure. Seek approval from Favelle Favco for suitable tower configuration, free standing heights and collar spacing prior to crane erection.

2. The boom can be weathervaned in the prevailing wind direction and tied with slack ropes to the building to restrain its movement. Alternatively the hook can be tied to the building with the boom at maximum possible radius, and the slew brake applied. Incorrect use if this method can lead to crane overload.

3. In both cases, seek approval from Favelle Favco for suitable tower configurations, free standing heights and collar spacing prior to crane erection.

For further information on weathervaning of cranes with restricted movement contact Favelle Favco.

3.10 Emergency Load Lowering Procedure (Main Hoist and Fly Hoist)

In case of failure, the load on the hook must be lowered manually. This is crucial if the failure cannot be fixed in a short period.

Proceed as follows for the hoist in operation:

CAUTION ***Check regularly that the needle valves are closed tightly. Loss of performance and overheating will occur if the valves are slightly open. Familiarise yourself with the location and operation of these emergency lowering valves.***

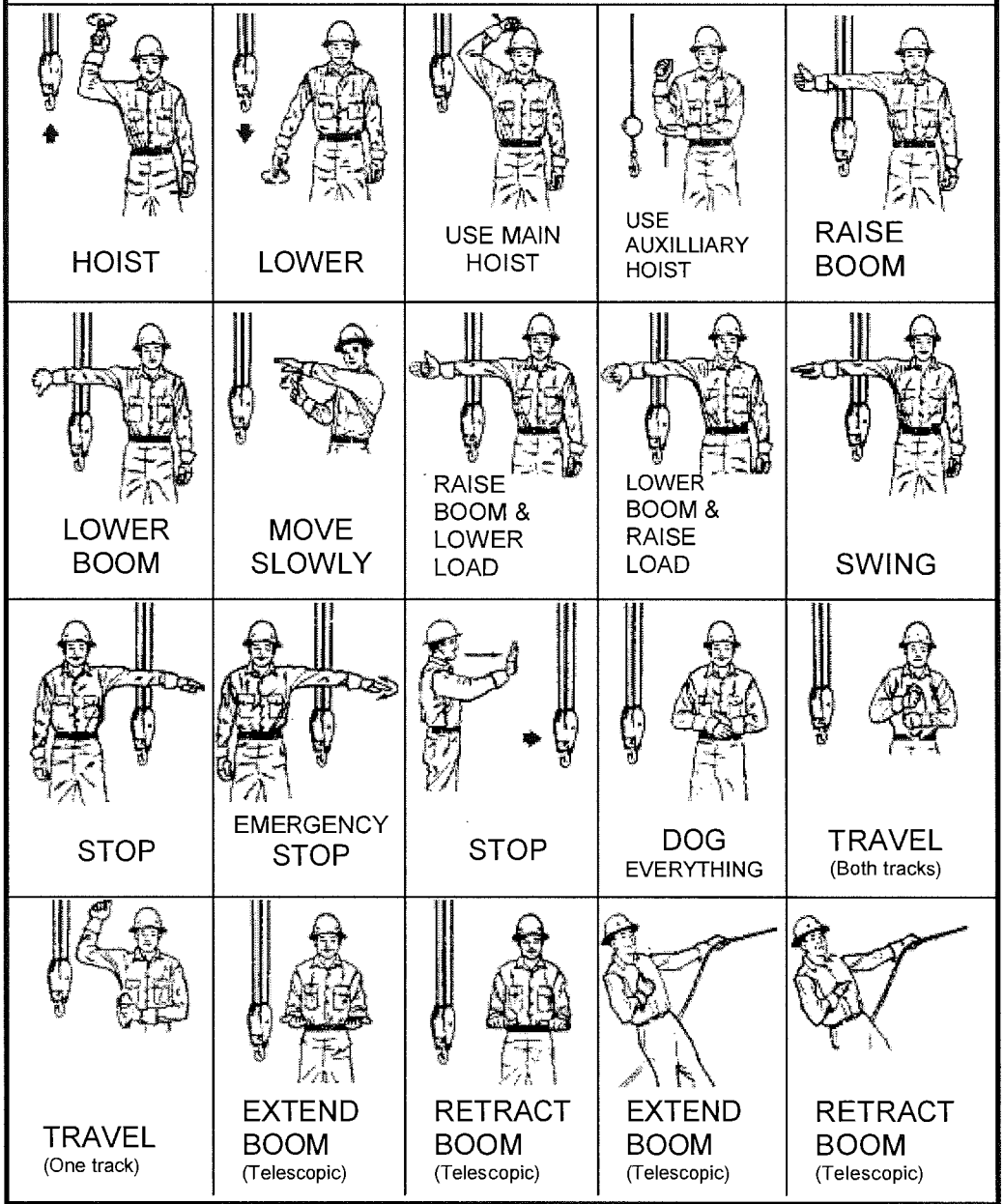
1. Connect hose from hand pump to hoist brake.
2. Fully open the emergency needle valve on the pump/motor.
3. Slowly pump open the brakes until the load lowers slowly.
4. If the load lowers too quickly immediately release pressure to the brakes at hand pump with release valve.
5. Repeat procedure until load is safely on the ground.
6. Disconnect handpump and securely close needle valve.

NOTE ***The brakes are fail-safe (spring on), with hydraulic pressure release.***

3.11 Standard Hand Signals

STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS

Extracted from American National Standard Crawler, Locomotive and Truck Cranes (ANSI B30.5 – 1968), with permission of the publisher, The American Society of Mechanical Engineers, United Engineering Center, 345 E. 47th Street, New York, NY 10017.



Standard crane hand signals

Favelle Favco Cranes Pty Ltd.
A subsidiary of Muhibbah Engineering (M) BHD

Figure 3-3 Standard Hand Signals

COMMANDS	ACTIONS
HOIST UP	With forearm vertical, forefinger pointing up, move hand in small horizontal circle.
LOWER MAIN	With arm extended downward, forefinger pointing down, move hand in small horizontal circles.
USE MAIN HOIST	Tap first on head; then use regular signals.
USE AUXILLIARY HOIST	Tap elbow with one hand, then use regular signals.
RAISE BOOM	Arm extended, finger closed, thumb pointing upward.
LOWER BOOM	Arm extended, fingers closed, thumb pointing downward.
MOVE SLOWLY	Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist slowly shown as an example).
RAISE BOOM & LOWER LOAD	With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.
LOWER BOOM & RAISE LOAD	With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.
SWING	Arm extended, point with finger in direction of swing boom.
STOP	Arm extended, palm down, hold position rigidly.
EMERGENCY	Arm extended, palm down, move hand rapidly right and left.
STOP	Arm extended, palm down, hold position rigidly.
DOG EVERYTHING	Clasp hand in front of body.
TRAVEL(Both tracks)	Use both fists in front of body, making a circular motion about each other, indicating direction of travel: forward or backward.
TRAVEL(One track)	Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body.
EXTEND BOOM(Telescopic booms)	Both fists in front of body with thumbs pointing outward.
RETRACT BOOM(Telescopic booms)	Both fists in front of body with thumbs pointing toward each other.
EXTEND BOOM(Telescopic boom)	One Hand Signal. One fist in front of chest with thumb tapping chest.
RETRACT BOOM(Telescopic boom)	One Hand Signal. One fist in front of chest, thumb pointing outward and heel of fist tapping chest.

4 MAINTENANCE

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4.2. Maintenance - Detailed 4-3
4.3. Recommended Oils and Greases 4-16
4.4. Ropes - General 4-21
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4.6. Sheave Inspection 4-33
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4.8. Service and Repair of Fluid and Electrical Components 4-37
4.9. Maintenance Log 4-42

4.1 Preventative Maintenance - General

This section of the manual covers routine maintenance recommendations for the crane.

The owner must establish a regular maintenance schedule, suited to the specific application and local conditions, using this manual as a guide in conjunction with component manufacturer's manuals.

It is recommended that the owner of this crane clearly defines the responsibilities of the crane operators (drivers) and the maintenance personnel.

As experience is gained by the owner, and operating schedules established, the following recommended procedures and checks should be modified to suit the operating pattern.

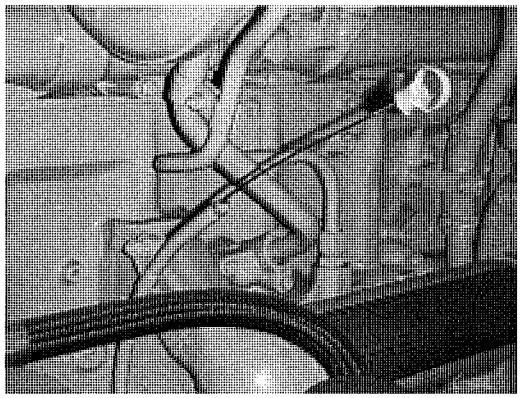
For this reason, specific quantities and times are not specified for normal maintenance procedures, eg. greasing, fuelling, inspections, etc. These requirements should be determined by observation, and practical application of established maintenance procedures.

A maintenance log book should be used to establish the required schedule. This log book should contain the SLEW RING CLEARANCES record.

In later sub-sections, we recommend periodical checks, lubrication schedule and system maintenance. These are based on an annual usage of 2000 hours.

4.2 Maintenance - Detailed

ATTENTION ***Read the following sub-sections in conjunction with Lubrication Diagram***

Letter	Description
A	**Diesel Engine** Maintenance instructions for diesel engine must be taken from separate "Engine Manuals" or refer to pages at the end of this section.  Engine Oil Dip Stick  Engine Oil Filter Check for: - Oil filter - Fuel filter - Coolant level - Drive belt tensions - Electrical leads and hoses - Oil leakages - Battery condition
B	A thorough examination of the crane should be carried out after the initial 100 hours of operation. **ATTENTION** ***Bolts, screws and hydraulic fittings should be checked and re-tightened if necessary.*** For recommended bolt tightening torques, refer to figure 2-2 Crane Fastener Torque.

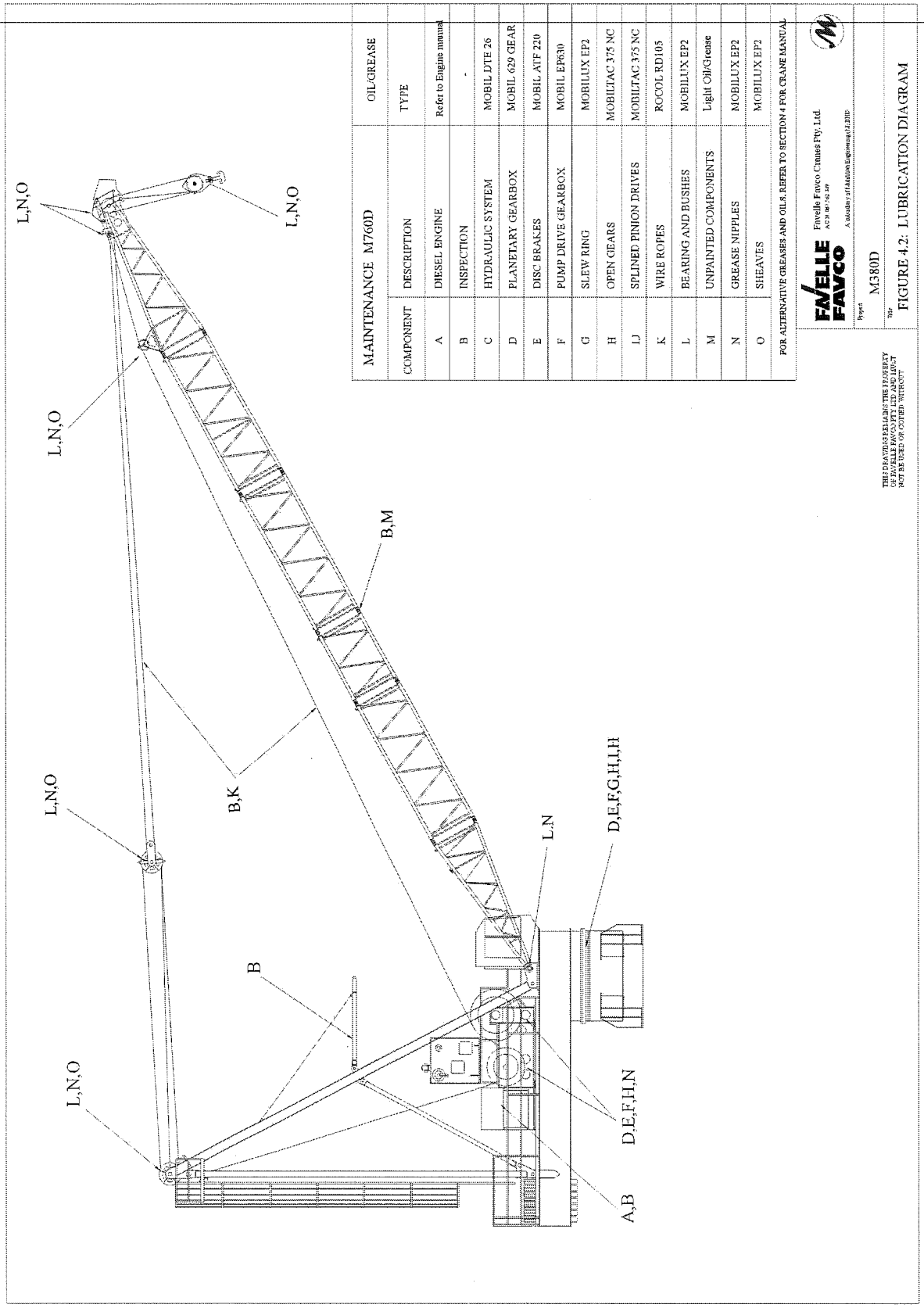


Figure 4-1 Lubrication Diagram

C

Hydraulic system

Maintenance of the hydraulic system mainly involves changing the oil and oil filter elements.

Typical system maintenance checks are :

a) Check for the filter bypass warning light on the annunciator panel when starting the engine.
b) Check tank oil level regularly, with crane absolutely level.
c) Top up with correct oil as specified.

NOTE ***Do not overfill hydraulic oil tank, as the oil might overflow through breather during operation.***

d) Use clean oil receptacles.
e) Check filler breather on tank for clogging.
f) Check the system instrumentation ie. ensure pressure gauges, etc., are functioning satisfactorily.
g) After each 100 hours operation or during general service of crane, drain off 1 litre of oil from tank to remove any condensed water. If water is present, drain until removed and top up with clean oil.
h) Frequency of hydraulic oil change depends on the cleanliness of the oil. Compare tank oil with a sample of new oil and if in doubt ask an oil company for assistance in evaluating suitability of oil for further use.
i) Check for external leaks. Repair immediately.
j) Check that pipework is sound. Where rubber hose is used, ensure that no chafing has occurred.
k) Check that all system pressures are normal for the application.
l) When a maintenance shutdown occurs it is advisable to examine the oil tank for sludge and foreign matter, and completely clean if necessary. This is imperative if a component failure has occurred.

Refer to Section 4.2 for Recommended Oils and Greases

D

Planetary gearboxes (motion drives)

The first oil change must be carried out after the initial 50-100 hours of operation, with subsequent changes every 2500 hours or 12 months, which ever occurs first.

These intervals may be modified, depending on actual operating conditions.

During oil change, we recommend that the inside of the gearbox is flushed out with flushing fluid recommended by the lubricant manufacturer. Check that there are no metallic parts with unsual dimension in the magnetic plug of the gear unit and in any multi-disk brake.

Oil should be changed when hot to prevent build up of sludge deposit.

Oil levels should be checked once per month.

ATTENTION ***When checking oil levels in gear units equipped with a multi-disk brake or hydraulic motor, if the levels have risen, this means that oil is penetrating either from the brake seals or from the motor rotary seal.***

If more than 10% of total oil capacity has to be added, check for oil leaks.

Oil level on horizontal mounted boxes is on the centreline. Figure 4-2 illustrates the winch drive gearbox maintenance.

Vertical mounted boxes (slew drives) are filled to the top through the Expansion tank.

1. Remove Expansion tank plug
2. Fill until oil reaches the min. mark.
3. With the gear running under steady steady-state thermal condition and the oil at its expansion add oil to the maximum, but not exceeding maximum.
4. Run the gear until all air pockets are eliminated.

Due to the lesser usage, change oil in slew drives every year.

Figure 4-3 illustrates the slew gearbox maintenance.

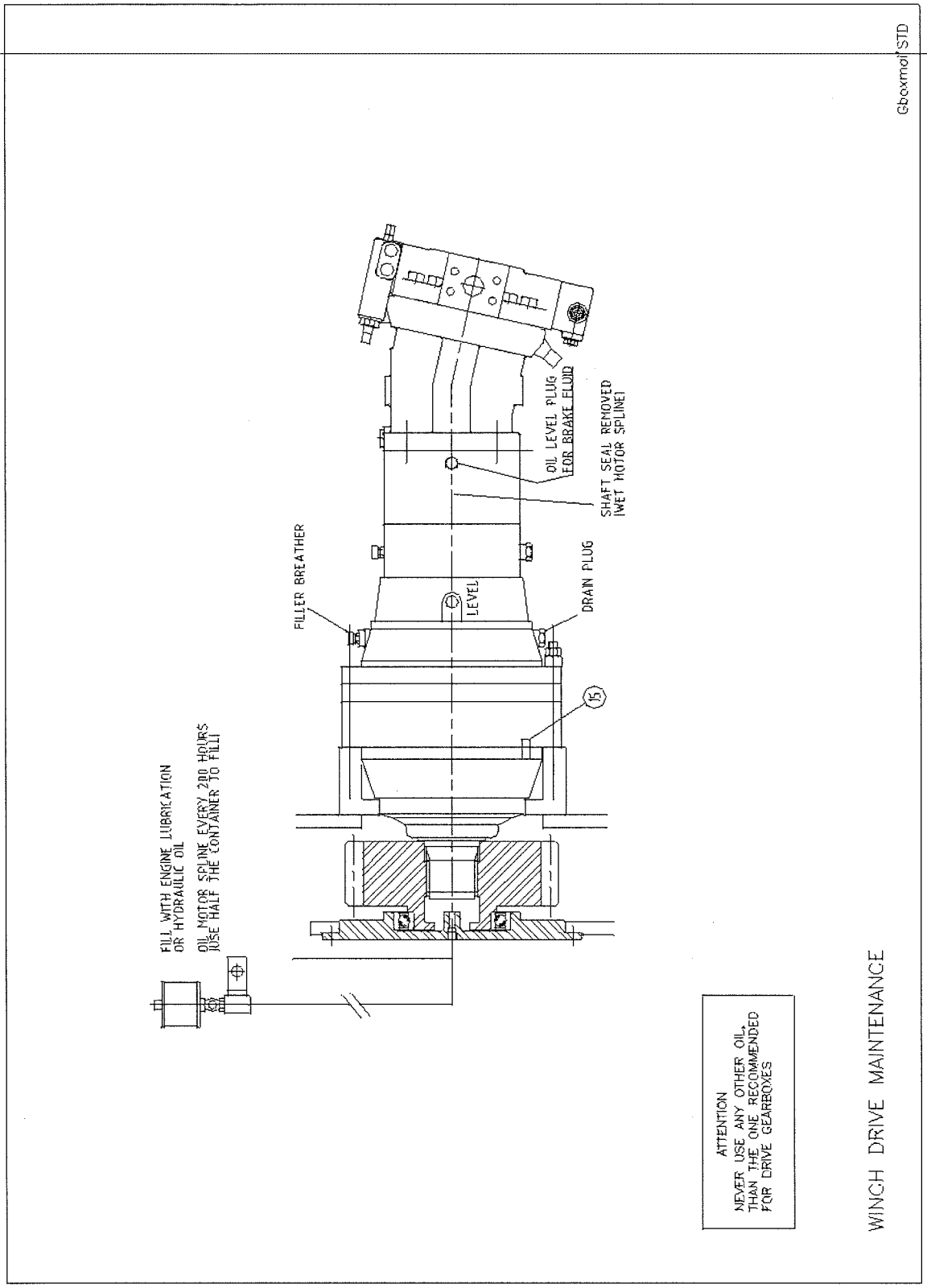


Figure 4-2 Hoist and Luff Drive Maintenance

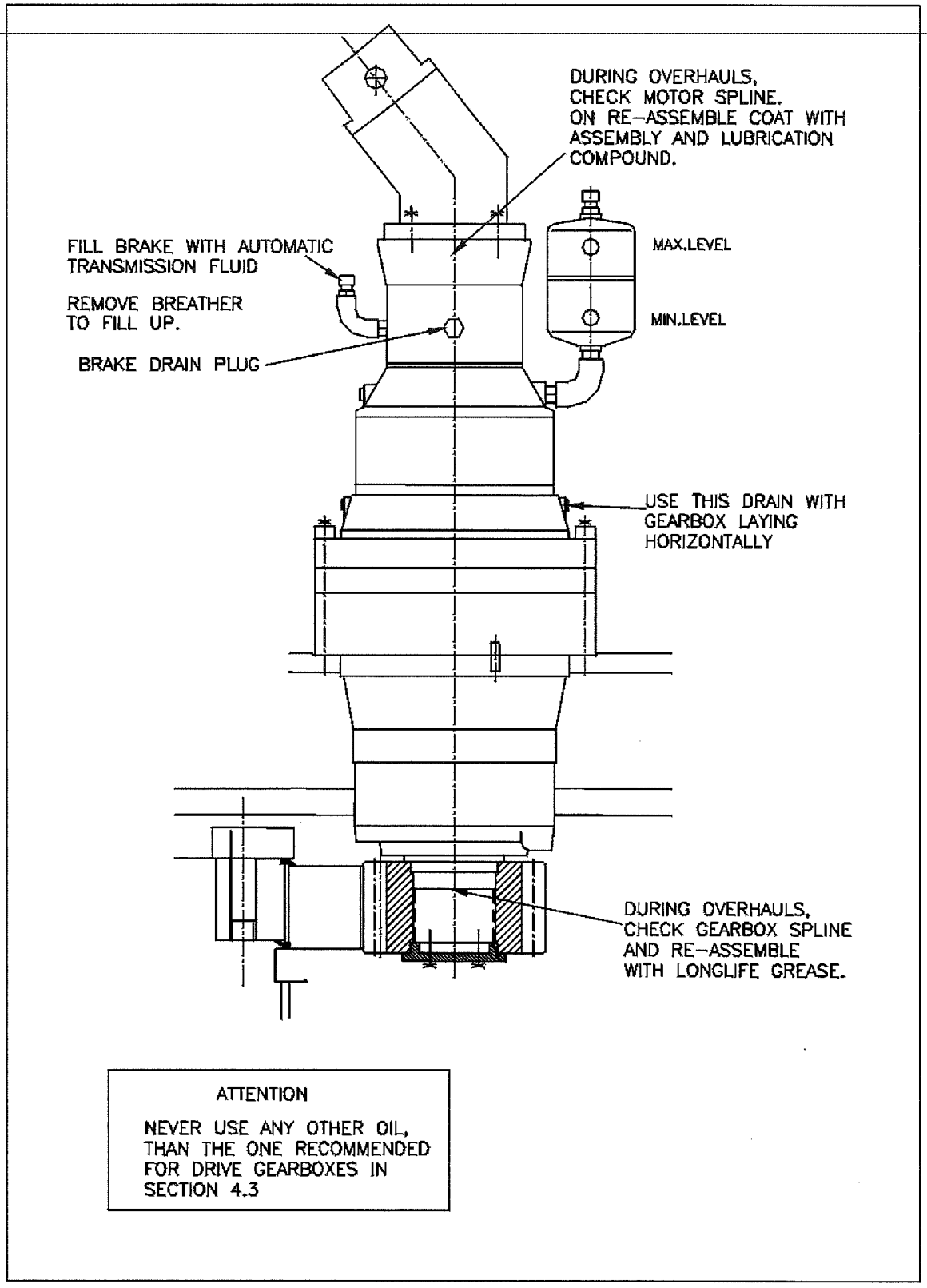


Figure 4-3 Typical Slew Drive Maintenance

E Disc brakes (part of planetary gearboxes)

Refer to Figure 4-4 for details of disc brake maintenance.

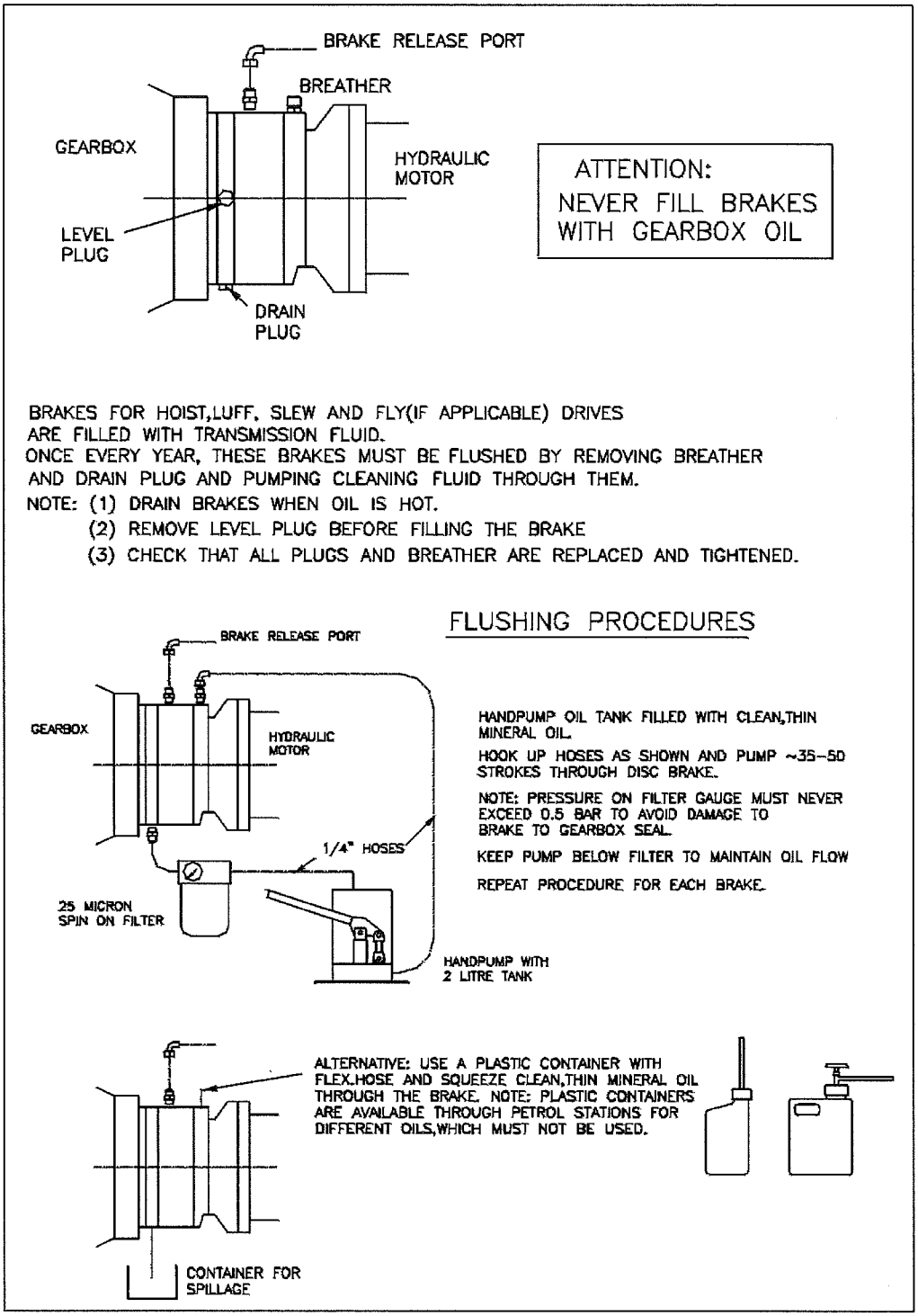


Figure 4-4 Brake Maintenance

F

Pump drive gearbox (if applicable)

The first oil change must be carried out after initial 50 hours of operation, with subsequent changes every 500 - 1000 hours or every 6 months, which ever occurs first.

These intervals may be modified, depending on actual operating conditions.

During oil change, we recommend that the inside of the gearbox is flushed out with flushing fluid recommended by the lubricant manufacturer.

Oil should be changed when hot to prevent build up of sludge deposit.

Oil levels should be checked once per month.

If more than 10% of total oil capacity has to be added, check for oil leaks.

If oil level rises, pump shaft seal or engine seals may be faulty and must be replaced.

Oil level is indicated by the maximum notch on the measuring stick (part of breather) or oil tank.

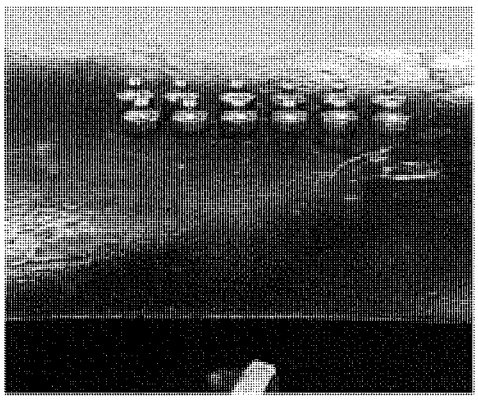
G

Slew ring

Lubricating intervals depend on the operating conditions. This is generally every 100 operating hours for ball bearings, or every 50 operating hours for roller bearings.

The grease filling is there to reduce friction, seal the bearing and provide protection against corrosion. Therefore, the bearing must always be greased liberally so that a collar of fresh grease forms around the whole circumference of the bearing gaps and seals. The bearing should be rotated during relubrication.

During periods of down time (3 months), the crane should be slewed to form a collar of fresh grease around the slew ring circumference. This is to ensure fresh grease forms at the seals and the bearing gaps around the slew ring. Grease till it leaks



Slew ring grease nipples located on front top machinery deck flange.

H

Open gears

Grease open gears with the recommended compounds avoiding bare metal to metal contact. For best result, apply with brush sparingly to avoid dripping or splattering. Lubrication should be checked weekly.

I

Maintenance / inspection of splined pinion drives

Cranes fitted with splined pinion drives on the luff, main hoist and fly hoist winches must be inspected prior to erection of the crane. This must be repeated every 5,000 working hours, or every two years, whichever occurs first. Failure to do so can result in the premature failure of the winches on the crane. The following is a procedure for inspection of the pinion spline.

I.1 Standard gearbox / pinion arrangement

1. Remove the pinion from each gearbox output shaft.
2. Wash down and clean the male and female splines and inspect for wear.
3. Hand fit the pinion to the shaft and rock the pinion backwards

	and forwards as per normal rotation. Any movement greater than 1 mm at the outer edge of the teeth of the pinion indicates the pinion and/or the gearbox output shaft must be replaced. Any visual signs of significant corrosion or wear also indicates that the pinion and/or gearbox shaft must be replaced. 4. If the pinion and the gearbox shaft wear is within limits, refit the pinion, and ensure oiler is connected and charged with oil 5. Repeat the procedure for each pinion. **ATTENTION** ***Slew drives which incorporate splines should also be inspected at the above frequency.***
J	**Lubrication of splines on pinion drives** See Figure 4-2 Hoist and Luff Drive Maintenance.
K	**Wire ropes** Use compound when necessary to prevent corrosion. Check weekly. Refer also to the sub-section Ropes - General for further information.
L	**Bearings and bushes** Grease every 100 working hours or monthly, which ever occurs first. For individual grease points refer to "Lubrication Diagram".
M	**Unpainted components** Unpainted parts of the crane, such as shafts and pins, should be inspected on a regular basis and preserved with a spray-on coating.

N

Fuel filter/ water separators (if fitted)

The contamination level of the fuel governs how often it is to drain water or to replace the filter element. Drain the collection bowl before contaminants reach the bottom of the turbine or when the water detector (optional) indicates it is time to 'drain water'. Inspect or drain the collection bowl of water daily and replace the element every 500 hours, every other oil change or if a power loss is noticed, whichever comes first.

If a vacuum gauge has been installed on the outlet side of the filter, change the element between 6" (152.4 mm) to 10" (254 mm) of mercury (restriction). Note that the actual measurement varies in different fuel systems. Always carry an extra filter element as one tank-full of excessively contaminated fuel can a filter.

To drain water:

Open the self-venting drain to evacuate contaminants. If necessary, remove the lid and prime the unit by filling with clean fuel. Replace the lid and tighten the T-handle snugly by hand ONLY.

To replace the filter element:

Only use genuine filter elements.
A convenient moulded handle on the top of the element simplifies removal. Remove the lid and then remove the element by slowly pulling upward on the moulded handle with a turning motion. Replace the lid gasket with the one supplied with the new element. Apply a coating of clean fuel to the seal prior to reassembly. Fill the bowl with clean fuel, then replace the lid and tighten the T-handle snugly by hand ONLY. Start the engine and check for leaks. Correct any leaks with the engine off.

The spare parts drawing for the fuel / water separator is shown in Figure 4-5 Filter.

O

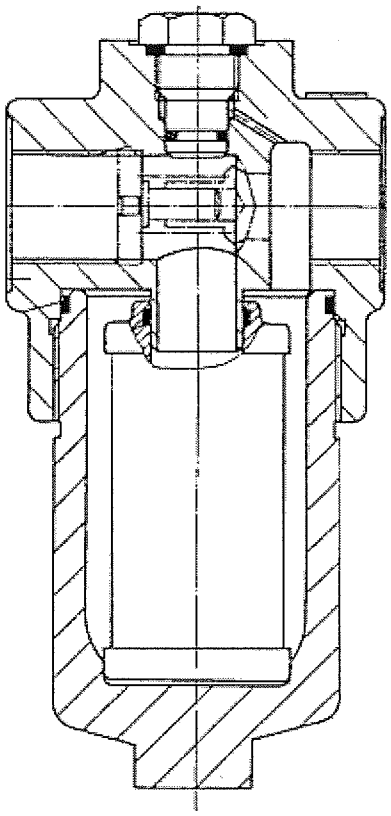
Replacing filter element

O1. Element removal and cleaning

1. Ensure that the oil supply lines to the filter are closed and the line decompressed to atmosphere.
2. Drain the filter of oil by removing the bowl, which is threaded into the housing. Unscrew by applying the correct spanner to the base hexagon.
3. Lower the bowl vertically to clear the element assembly, which will remain in the housing.
4. Dislodge the element from the housing. Remove carefully.
5. Paper elements cannot be cleaned, and must be replaced. Cranes fitted with washable elements should be cleaned appropriately before replacing the element.

O2. Fitting the clean element

1. Before replacing the element, thoroughly clean the interior of the bowl and the accessible areas of the housing. Replace element, wire only, 'O' ring seal and lubricate.
2. Push the element spigot into the housing until it holds in place.
3. Replace bowl rim seal and lubricate housing and bowl before refitting bowl.
4. Screw the bowl rim seal and lubricate the housing and tighten with the correct spanner.



Hydraulic Oil Filter showing replaceable filter element

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Figure 4-5 Filter

P	**Sheaves (Mast, Bridle, Boom and Hook)** 1. Grease sheave bearings. 2. Check for bearing wear and nilos covers every 250hrs. 3. Check sheave rotation and wobble 4. Check sheave root and root flanges for normal wear.

4.3 Recommended Oils and Greases

4.3.1 Hydraulic System Oil

For optimum performance and service life of hydraulic axial piston pumps and motors, and fixed displacement pumps and motors, the viscosity is to be 30 centistokes (30cst) at 60°C.

Favelle Favco Cranes Pty. Ltd. recommends using hydraulic oil with an ISO viscosity class "VG68" or a diesel engine oil with SAE grade of 20W-20.

Both types of fluid with a viscosity index of minimum 95 are suitable for tropical conditions or for areas with high ambient temperatures.

For areas where the ambient temperature falls below zero or day time ambient temperature is between 0°C to maximum of +20°C, a thinner oil as ISO - VG 46 or 32 must be used. Refer also to table on next page.

NOTE ***Oil should be exchanged and stored in clean drums for future use before ambient temperatures fall below 0°C and the allowable viscosity of the oil in the system rises above 1000 cst.***

ATTENTION ***For cranes in low temperature (0°C to -10°C) condition only: Position to fit low wattage heaters into hydraulic oil tank must be made, but the warm oil will only benefit the pumps when started, while the control, brake and safety system oil remains in freezing environment and will operate sluggishly and could lead to a dangerous condition.***

In any case, oil must be warmed up to a minimum temperature as shown on following table before full pressure operation can commence.

They are :

* Mobil	-	DTE	26
Shell	-	Tellus	68
Esso	-	Nuto H	68
Ampol	-	Tecoma	68
Castrol	-	Hystin AWH	68

* Shows factory recommended and first fill.

Approx. Ambient Day Time Temperature		Below 0°C	0°- +20°C	+10°-+35°C
Hydraulic Oil : ISO Class		VG 32	VG 46	VG 68
Diesel Engine Oil : SAE Grade			10W - 20	20W -20
	Viscosity	**Oil Temperature**		
Oil must be heated to reach minimum temp. of	1000cst	-10°C	-5°C	0°C
Preferred minimum starting temperature	600cst	-5°C	0°C	+5°C
Minimum full pressure working temperature	100cst	+20°C	+27°C	+33°C
Optimum working temperature	30cst	+40°C	+50°C	+60°C
Maximum working temperature	20cst	+50°C	+60°C	+70°C
Short time peak temperature (critical)	15cst	+60°C	+70°C	+80°C

Table 4-1 Minimum Warming Up Temperature

~~Pump Drive Gearbox (if applicable)~~

Gearbox manufacturer's recommendation:
SAE 90 with EP additives.

Alternative oils are:

Ampol	:	Gearlube SP220
Esso	:	Spartan EP220
* Mobil	:	Mobilgear 630
Shell	:	Omala Oil 220

4.3.2 Planetary Gearboxes (motion drives)

Gearbox manufacturer's recommendation :
ISO viscosity. Class : VG150 (V.I. 95 min.)

Alternative oils are

Ampol	:	Gearlube SP150
Castrol	:	Alpha SP150
Esso	:	Spartan EP150
* Mobil	:	Mobilgear 629
Shell	:	Omala Oil 150

4.3.3 Disc Brakes (part of planetary transmission gearboxes)

Manufacturer's recommendations: Hydraulic Oils, ISO class: VG32.

Mineral oils with enhanced heat and aging resistance and viscosity ISO VG 32, with a viscosity index greater than or equal to 95

Alternative Oil: Auto transmission fluid, SAE Grade: 10W

* Mobil	:	ATF 220
Esso	:	ATF Dexron II

4.3.4 Grease Points (nipples provided)

Grease must contain an effective corrosion prevention additive and must be consistent after extreme periods of service. Recommended Lithium based EP 2 grease to be used in slew bearing. If the slewring bearing grease contains **MOLYBDENUM DISULPHIDE** then the molybdenum content must not be greater than 3%.

Use of example

Castrol	:	EPL2
Esso	:	Beacon EP2
* Mobil	:	Mobilux EP2

4.3.5 Open Gear Teeth

This compound is highly water resistant and of an adhesive nature.

Use for example

* Castrol	:	Molub-Alloy 936
Esso	:	Surett Fluid 4K'
Mobil	:	Mobiltac 375NC
Shell	:	Cardium Fluid C

4.3.6 Sheaves

The sheaves are fitted with grease nipples or greased through sheave pin.

Castrol	:	EPL2
Esso	:	Beacon EP2
* Mobil	:	Mobilux EP2

The root of the sheave can be lubricated with rope lubricant.

4.3.7 Ropes

The type of lubricant and frequency of application varies with rope construction, the operating conditions and its functional application. The lubricant must provide protection, against wear, corrosion and minimise internal friction between wires and strands while the rope is in service.

The rope must be cleaned of moisture, residual lubricant and contaminants before clean lubrication is applied.

Recommended rope lubricants:

* Rocol	:	RD105

4.3.8 Engine Lubrication Oil

For recommendation refer to separate 'Engine Operators Handbook'.

4.3.9 Engine Radiator

Engine cooling system should have radiator preservatives added. Use antifreeze conditioner if required.

4.3.10 Engine Diesel Fuel

If ambient temperature falls below +5°C, a winter fuel or equivalent should be used to prevent fuel waxing which can the filter. Otherwise a fuel heating attachment is to be considered.

4.4 Ropes - General

Also see Rope Specification chart and Reeving diagram in Section 6.

4.4.1 Recommended Storage and Handling of Ropes

When unreeling or uncoiling rope, attention should be given to avoid the introduction of kinks or twists into the rope. This type of damage is permanent and places weak spots in the rope. Mount the reel on a vertical or horizontal axle and rotate the reel as the rope is pulled off.

When pulling rope out of a coil, the coil should be rolled on the ground to allow it to uncoil. It should be treated the same as if it were being uncoiled from a spool.
Other points to note in the storage and handling of ropes include:

- The stored rope shall be covered in a well ventilated area and away from excessive heat. If covered storage is not available, the rope and reel shall be covered with hemp material. This prevents humidity built up which would result in corrosion of the rope.
- For long periods of storage, apply a lubricant coating to the outside layer of the rope on the reel, and cover the rope and reel with hemp material.
- Care shall be taken during shipping and handling of the reel and rope to prevent damage to the rope. The loose end of the rope on the reel shall be secured properly to the reel. Do not drive a nail through the centre of the wire rope.

4.4.2 Fitting a New Rope

When anchoring a new rope on the drum, make sure that the entire cross section of the rope is held solid, otherwise the inner strands may draw from the attachment, leaving only the outer strands anchored. This can result in core protrusion.

The end of the rope should be brazed or tightly served to ensure no movement between the inner and outer layers of strand can occur.

When winding the new rope on from a reel, always wind from the top of the reel to the top of the drum or from the bottom of the reel to the bottom of the drum. Failure to do this will put a reverse bend in the rope and shorten its life. Check with reeving diagram to ensure correct winding. Figure 4-6 illustrates this concept.

The first layer on the drum must be wound on tight and true. Open or wavy winding will cause serious damage to multiple layers.

Adjacent turns should be tapped against each other with a wooden mallet, when drum is not grooved.

The whole rope should be wound on the drum tightly and correctly. A poor start will mean poor winding and short life. Never allow ropes to become slack. This can cause incorrect coiling on the drum which may allow the rope to jump off the drum or sheaves. If the rope has become slack, check the coiling on the drum before continuing.

WARNING ***Limits must be reset when new ropes are fitted.***

4.4.3 Correct Reeving

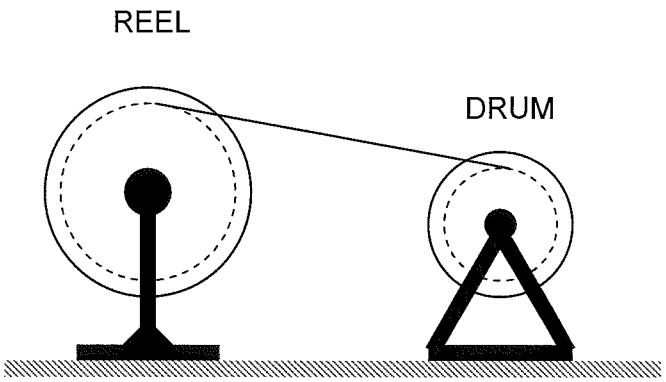
Reeving of hoist or luff ropes must always conform to the reeving diagram.

After installing, run the rope through its operating cycle several times with a light load and at reduced speed.
This is to ensure that the new rope

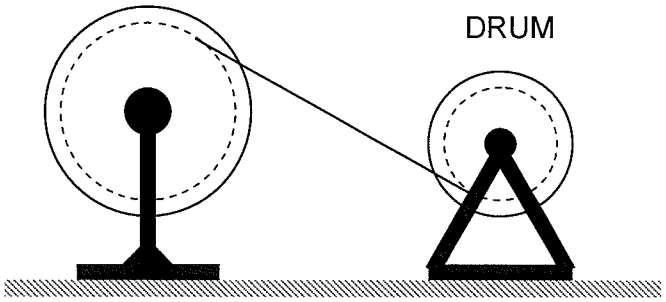
- Adjusts itself gradually to working conditions,
- Strands to become seated,
- Some stretch to occur and
- Diameter to reduce slightly as the strands and core are compacted.

By following the procedure above to condition the rope. A longer working life of the rope can be achieved.

WARNING ***Always observe the first spooling onto the drum of a new rope.***



CORRECT METHOD



INCORRECT METHOD

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Figure 4-6 Correct Method for Reeving Ropes

4.4.4 Rope Inspection

All running ropes in continuous service should be visually inspected once every working day. A thorough inspection of all ropes in use should be made at least once a month. Any rope damage should be noted and the cause be determined and fixed before loading the rope.

No precise rules can be given to determine the exact time for replacements of ropes, since many variable factors are involved. Safety in this respect depends largely upon the use of good judgment by an appointed or authorised person. Conditions such as the following should be sufficient reason for questioning rope safety and for consideration of replacement.

A Broken wires

For non rotation-resistant ropes used in the main hoist fly hoist and/or the luff

In running ropes, six (6) randomly distributed broken wires within one (1)lay length or three (3) broken wires in one strand within one (1) lay length.

For rotation-resistant ropes used in the main hoist

In running ropes, four (4) randomly distributed broken wires within one (1) lay length or two (2) broken wires in one strand within one (1) lay length.

For standing ropes such as boom pendants:

In running ropes, three (3) broken wires within one (1) lay length or two (2) broken wires at the end connection.

B Wire rope wear

Wear of more than one-third of the original diameter of the outside wires of the strand are worn.

C Wire rope deterioration

Kinking, crushing, bird-caging, or any other damage resulting in the distortion of the rope construction.

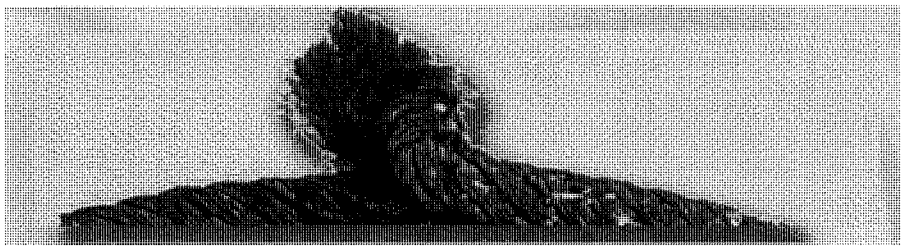
D Heat damage to wire rope

There is evidence of any heat damage from any source. Heat can be generated by passing a rope over a frozen or non-turning sheave, contact with structural members of the crane, improperly grounded welding leads or lightning strikes.

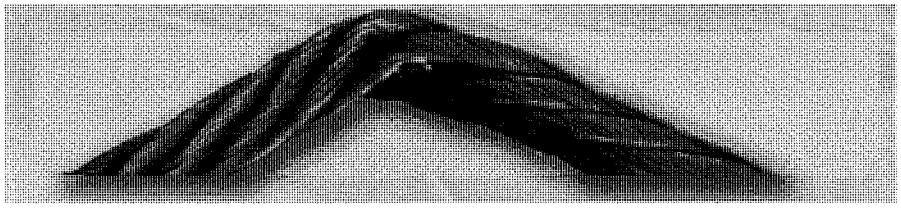
E Valley break to wire rope

If one (1) valley break is observed, this may indicate internal rope damage requiring close inspection of this section of the rope. See Figure 4-9. When

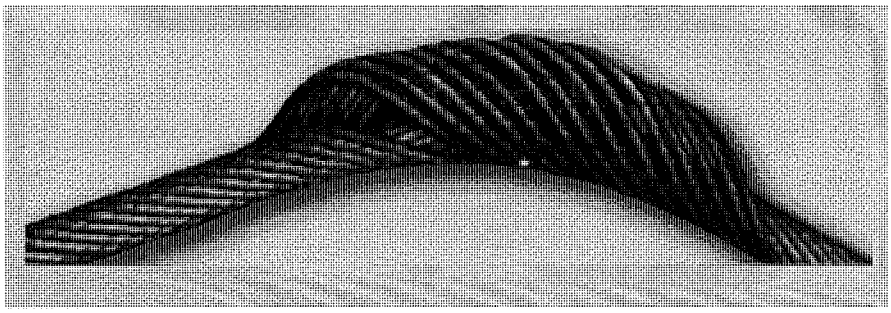
two (2) or more valley breaks are found in one (1) lay length the rope should be discarded.



Kinks

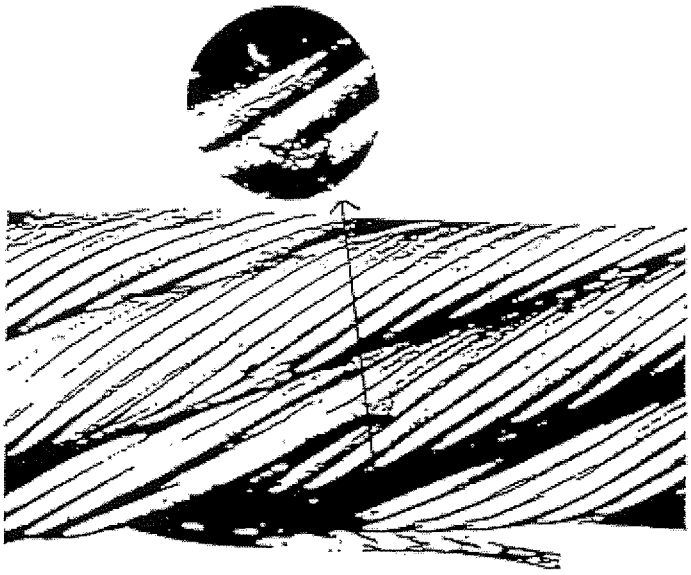


Crush



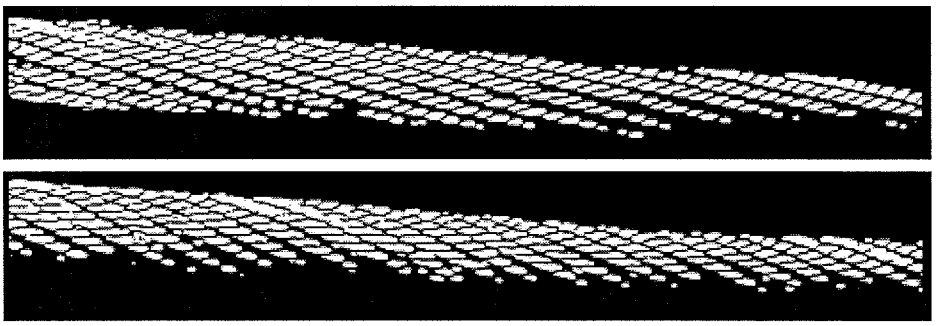
Birdcage

Figure 4-7 Types of Rope Damage



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Figure 4-8 Valley Break



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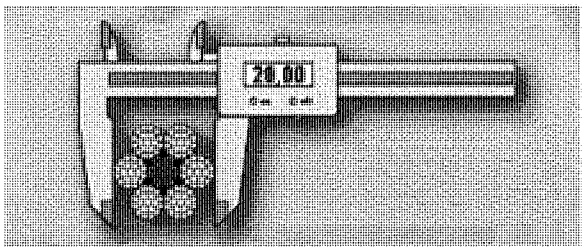
Figure 4-9 Core Failure in Rotation Resistant Wire Ropes

Wire rope diameter

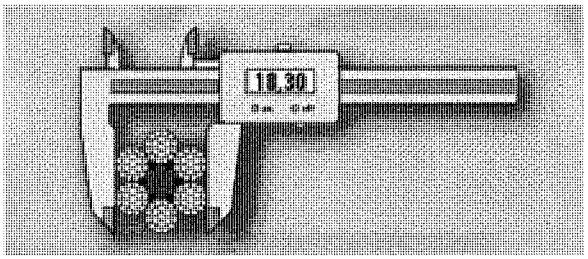
Reductions from rope diameter in a non-working area (an area away from the sheaves) compared to the lowest diameter of rope measured in three (3) working areas (areas where the rope regularly goes over a sheave) of more than the following is observed:

- 1.19mm (3/64 inch) for diameters up to and including 19.05mm (3/4 inch).
- 1.59mm (1.16 inch) for diameters of 22.22mm (7/8 inch) through 28.58 mm (1 1/8 inch).
- 2.36mm (3/32 inch) for diameters of 31.75mm (1 1/4 inch) through 38.1 mm (1 1/2 inch).

See below for proper method of measuring rope diameters.



Correct Method



Incorrect Method

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Figure 4-10 Proper method of measuring rope diameters

F **Wire rope length**

There is an observation of the increase in the length of an individual rope lay. This increase in lay length and accompanying reduction in diameter can be caused by failure of the core. This usually occurs more readily in ropes of rotation-resistant construction. See Figure 4-9 for core failures in rotation-resistant wire rope.

G **Wire rope corrosion**

Extensive external and/or internal permanent corrosion is cause for rope replacement.

In the case of rotation resistant ropes which consist of a number of strand layers, internal corrosion may not be readily detectable. During inspection, outer strands must be separated to assess internal rope condition.

Wires in the rope which are corrosively pitted have greatly reduce flexibility and will break much earlier as a result of rope bending over sheaves.

4.4.5 Rope Lubrication

A wire rope is made up of hundreds of wires which move relative to each other when the rope runs over sheaves. When a rope is manufactured it is completely filled with lubricant; firstly, to minimise frictional wear; and secondly, to keep out moisture and resulting corrosion.

It is vital that this lubrication be preserved to get the maximum life from the rope. An external coating of lubricant must be applied to the rope regularly to prevent the escape of the internal lubricant and also reduce friction on the sheaves.

Lubricating the rope is as important as greasing any other part of the crane. Any of the following methods can be used to lubricate the rope:

- Pouring of lubricant onto rope as it passes over a sheave. Wipe off excess.
- Swab the rope when not in motion with lubricant soaked rags.
- Brush or spray with lubricant.
- Pressure lubrication.

Points to Remember

- Never overload.
- Do not shock load Take up any slack carefully and apply the power smoothly and steadily.
- Protect ropes from sharp edges.
- Avoid dragging ropes from under loads.
- Avoid rolling loads with ropes.
- Avoid dropping ropes from heights.

WARNING ***Never use rope that has been cut, kinked or crushed.***

Prevent loops in slack lines from being pulled tight and kinking. A weak spot will always remain no matter how well the kink seems to have straightened out. If a loop forms do not pull it out, unfold it. Avoid reverse bends.

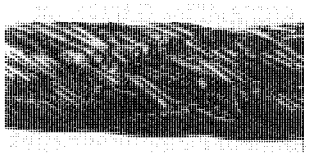
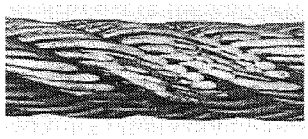
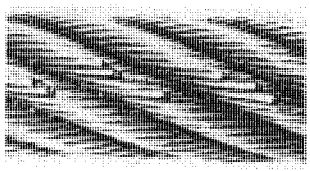
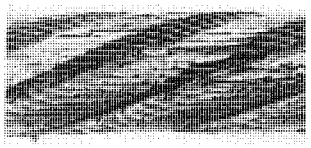
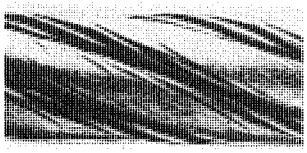
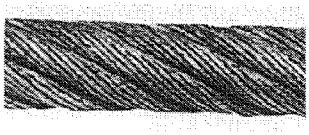
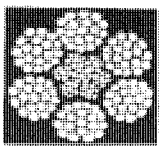
Never wind more that the proper amount of rope on to any drum.

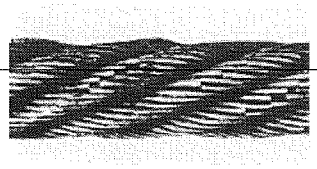
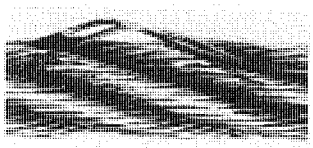
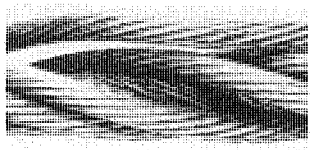
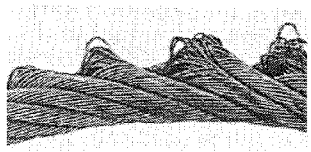
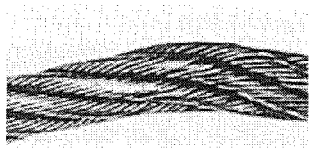
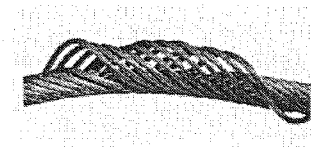
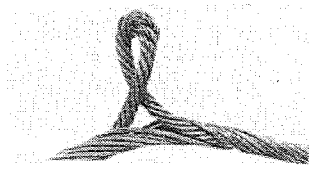
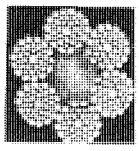
Ensure that the rope ends are properly seized.

Ensure that the ropes do not bind in the sheaves.

Watch for local wear. Premature wear at one spot is common. Uneven wear can be minimised by moving the rope so that different sections are at critical wear points. The wear can be distributed by cutting a few meters of rope from the drum and re-anchoring it.

Maintain the equipment over which the rope runs. Worn grooves, poor alignment of sheaves and worn bearings can result in shock loads and excessive vibration.

Rope Damage	Description
	Mechanical damage due to rope movement over sharp edge whilst under load
	Localised wear due to abrasion on supporting structure
	Narrow path of wear resulting in fatigue fractures, caused by working in a grossly oversized groove, or over small support rollers
	Two parallel paths of broken wires indicative of bending through an undersize groove in the sheave
	Severe wear associated with high tread pressure
	Severe wear in Langs Lay, caused by abrasion
	Severe corrosion
	Internal corrosion whilst external surface shows little evidence of deterioration

	Typical wire fractures as a result of bend fatigue
	Wire fractures at the strand, or core interface, as distinct from crown fractures
	Break up of IWRC resulting from high stress
	Looped wire as a result of torsional imbalance and/or shock loading
	Typical example of localised wear and deformation
	Multi strand rope bird caged to torsional imbalance
	Protrusion of rope centre resulting from build up of turn
	Substantial wear and severe internal corrosion

4.5 Checking Of Slew Ring & Tower Bolts

4.5.1 Tightness

1. After 100 hours first use of the crane. 100% of the bolts should be retightened to specified torque.

2. Every 3-month there after 25% of the tower bolts should be hand checked for tightness. If any are found loose, all should be retightened. When hand checking with no load on crane, and boom at shorts radius, ensure that check is carried out with Counterweight over the bolt/corner. 10% of slew bolts should be checked for adequate torque and if any found loose all should be brought up to tension.

3. If bolts are found loose check that the correct hardened washes are in place as this is a common cause of looseness, and check the seatings are flat.

4.5.2 Fatigue Cracking

Before every installation 10% of the bolts should be checked with Non Destructive Testing Methods (Magnetic Particle Inspection) for cracking. The main area of concern is at or near the head and at or near the transition between the tread and shank. If any bolts are found cracked all bolts should be removed and tested. The defectives ones should be replaced.

ATTENTION ***All inspection, testing and analysis of specimens are to be carried out by/under a certified authority or under instructions of the manufacturer.***

4.6 Sheave Inspection

A Sheave Location

Boom Sheaves

Refer to Boom Assembly drawing A1.4000.183

- Deflector sheaves on boom
- Boom head sheaves main hoist
- Boom head luff sheaves

Mast

Mast sheaves are located on the mast head. Refer to Mast Assembly drawing A1.3000.140

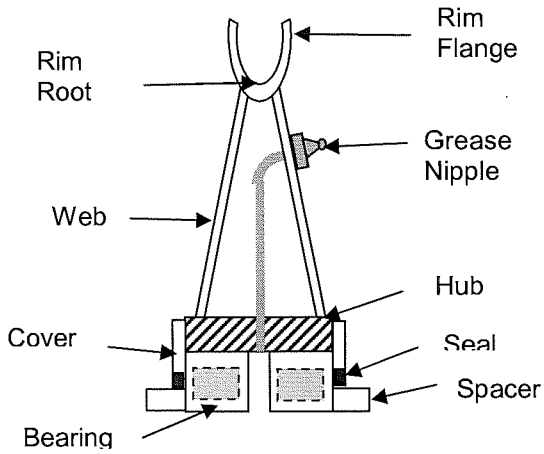
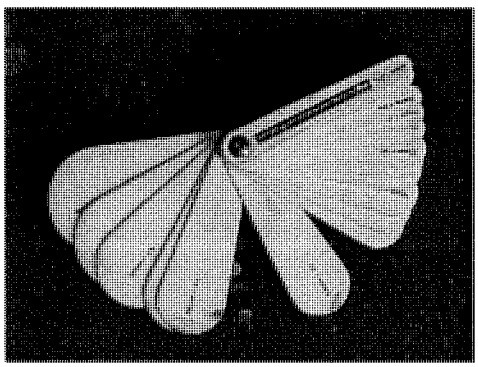


Figure 4-11 Parts of a sheave

B Root

The root area is the inner concave area of the sheave rim, where the rope sits on. Check for excessive wear, corrosion and deformations which could damage the rope.



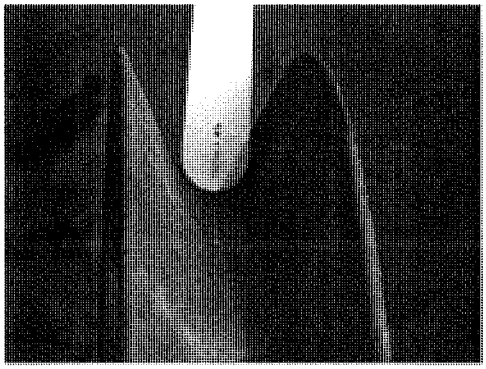


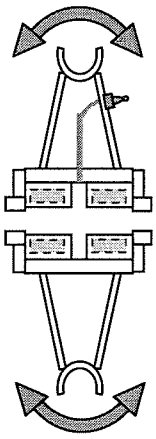
Figure 4-12 Sheave root gauge checking for wear.

C Flange Wear

The flanges are the sidewalls of the rim. Check for excessive wear and deformations which can damage the rope.

D Lateral Wobble

Rock the sides of the sheave and check for excessive play. Check bearings, seals, spacers and pins for wear.



E Cracks in Web, hubs or flange

Check the welded joints for signs of cracks or corrosion. Check the web for straightness and alignment to the centre.

F Sample Inspection Table

Sheave Location, No.	Root Wear	Flange Wear	Lateral Wobble	Cracks in Web, Hubs of Flange	Comments

4.7 Service and Repair of Structural and Mechanical Components

4.7.1 Arc Welding

Due to the materials used and the forces imposed on the structural components of this crane, repair or modifications, and in particular arc welding, should only be carried out in accordance with Favelle Favco Cranes Pty. Ltd. recommended procedures. These are available on written request.

WARNING

In the event that repairs or modifications to the steelwork above the slew ring require electric arc welding, the welding ground cable MUST BE GROUNDED ABOVE THE SLEWING RING.

Failure to observe this precaution could result in damage to the slew ring.

4.7.2 Shaft and Pins

All shafts and pins are fabricated from high tensile steel and must never be replaced with any material other than as specified by Favelle Favco Cranes Pty. Ltd.

4.7.3 Fasteners

Care should be exercised when replacing bolts or cap screws to ensure that the correct thread and bolt grade is selected and the correct tightening torque is applied.

In general, metric thread fasteners are fitted, but other threads such as UNC and UNF may be used on pumps and various other proprietary components.

Where grade and torque of a bolt is critical, the requirements are shown on the relevant drawing.

The following is offered as a guide:

ISO Grade 8.8 bolts are used throughout the crane, for cover plates, brackets, handrails etc., and other non primary structural components. Bolts less than 12mm are of stainless steel type (SS316).

Grade 8.8 or 10.9 bolts are used mainly on winches, slew drives, slew ring, power pack, slip ring assembly (if applicable), winch frame, bridle and mast.

Recommended tightening torques, refer to Figure 2-2 Crane Fastener Torques at the end of Section 2.

4.7.4 Reinstatement of Coatings

Washing down to remove all grease and other foreign matter is essential before any coating repairs are carried out.

If the top coats are mechanically damaged and require repair, feather back rough edges and re-apply paint to the recommended thickness.

Refer to Customer's specification for paint to be used.

If damage has affected the primer, reprime and re-coat after spot blasting or mechanical scrubbing to clean metal.

4.8 Service and Repair of Fluid and Electrical Components

4.8.1 Hydraulic

Concentration should be given to preventive maintenance of hydraulic components rather than complete overhaul, which requires highly specialised repair equipment and skills. The wear rate of pumps and motors is negligible as long as ample boost pressure is provided and the oil is kept free from impurities and operated in a manner that the temperature in the hydraulic circuit does not exceed 70°C.

Although this crane manual contains exploded and sectional views which would assist in stripping and rebuilding of hydraulic components, it is recommended that under normal circumstances such work should be carried out by Favelle Favco Cranes Pty. Ltd. or the component distributor. It is however recognised that circumstances may arise where it is necessary for the user to strip and rebuild hydraulic units.

Claims under guarantee however, cannot normally be entertained especially when pumps or motors have been stripped by untrained personnel.

It is therefore recommended that arrangements be made for the stocking of exchange units with additional minor parts eg. Seals, O-Ring, etc.

Faulty units should be returned to the manufacturer directly through the nearest Favelle Favco Cranes Pty. Ltd. agent for reconditioning.

CAUTION

1. ***Before removing any unit from the installation, clean areas adjacent to ports and drains. Remove pipes or hoses and cover these and component ports to prevent the ingress of dirt.***

2. ***Dismantle and rebuild any hydraulic components only under the cleanest conditions.***

4.8.2 Pressure override on variable displacement motor

Control Description: Motors fitted with option allow remote control of the motor displacement until system pressure reaches the pressure setting of the pressure override (POR) valve. When this occurs, displacement adjusts automatically towards maximum, until the product of displacement and set (system) pressure satisfies the output torque demand put on the motor.

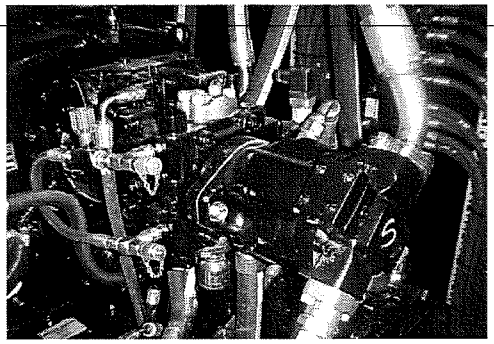
System pressure greater than the set pressure of the POR valve will keep the motor at maximum displacement, even if the HD, EP, or EZ control signal is set to send the motor to minimum displacement.

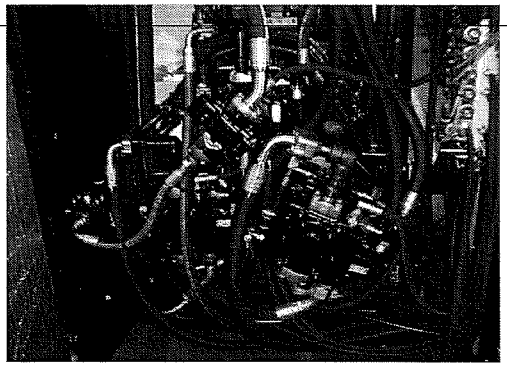
The integral POR valve has the capability of a high low pressure setting. This allows the system pressure at which the override functions to be preset at two different pressure levels.

High range is selected by supplying a pressure signal from "G" port to the "G2" port of the POR valve. Adjustment screw "A" is used to set the high POR setting.

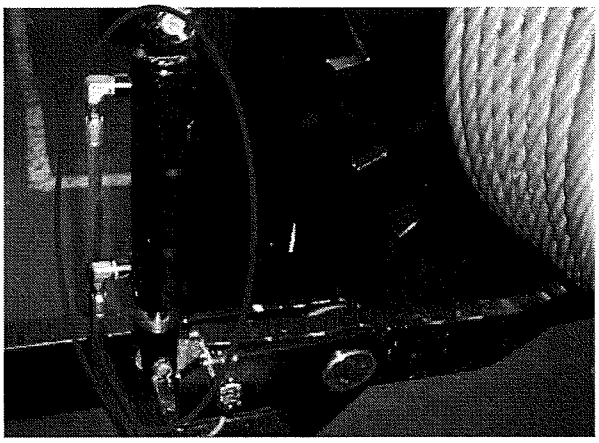
Low range is selected by blocking the pressure supply from the "G" port and connecting the "G2" port of the POR to tank. Adjustment screw "B" is used for the low POR setting.

If a single POR setting is required for an application, adjustment screw "B" should be turned in (clockwise) until firm resistance is encountered, ports "G2" and "G" are plugged. Adjustment screw "A" is then used to set the override pressure.
or pressure setting, refer to the hydraulic circuit relevant to this crane.

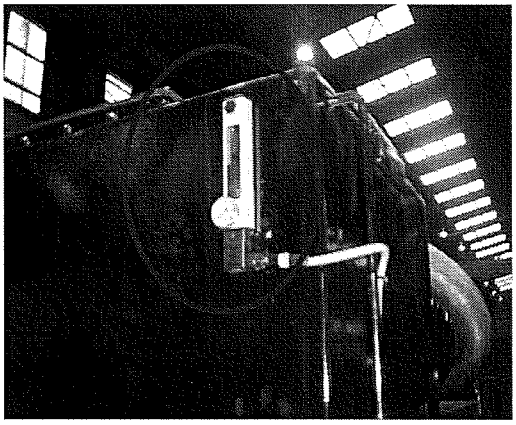




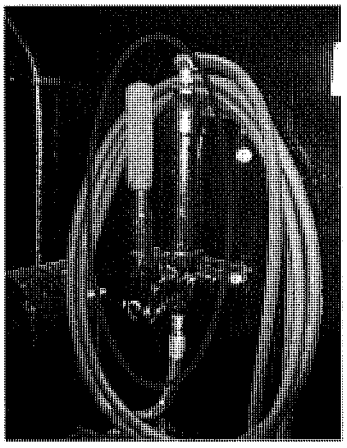
Pump Gearbox with Hydraulic Pump



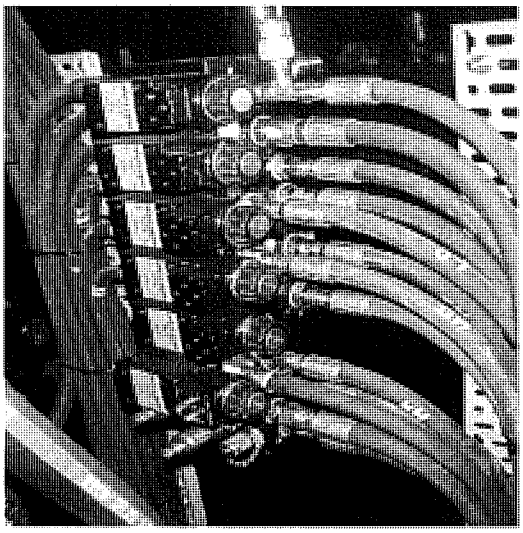
Luff Ratchet Cylinder



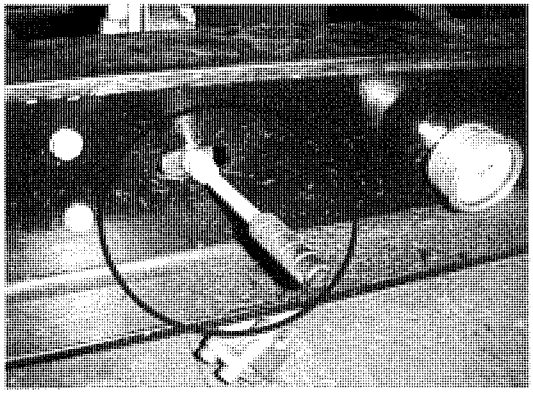
Hydraulic Tank and Tank Level Gauge with Temperature gauge



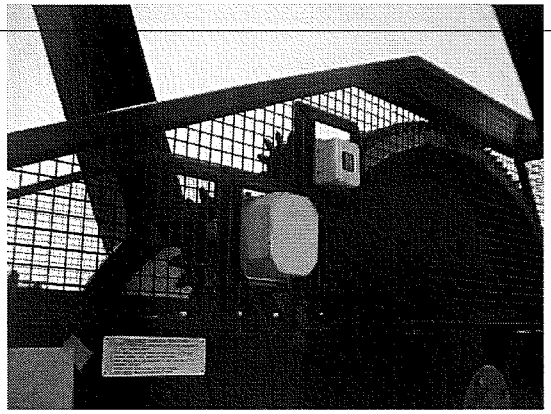
Emergency Brake Release Hand Pump



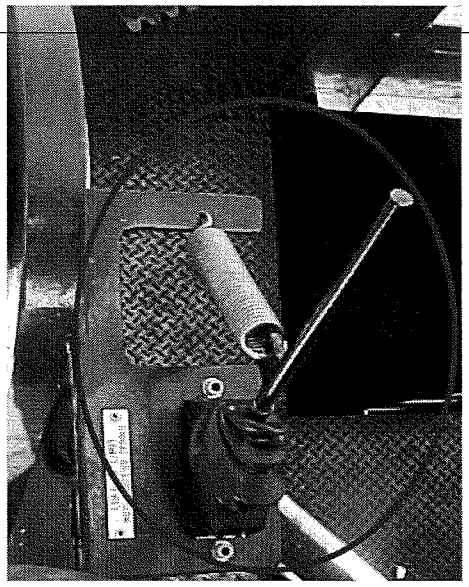
Hydraulic Manifold



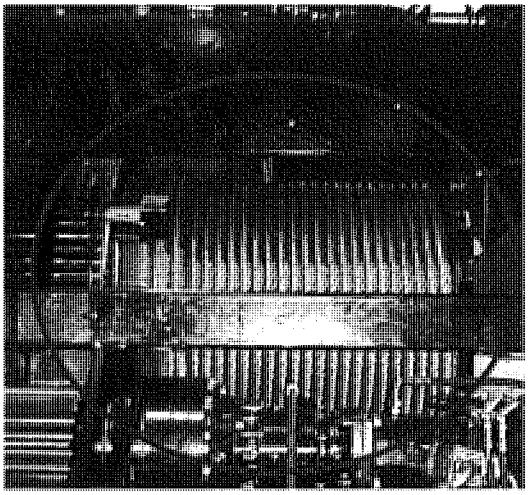
Crane Climbing Lever



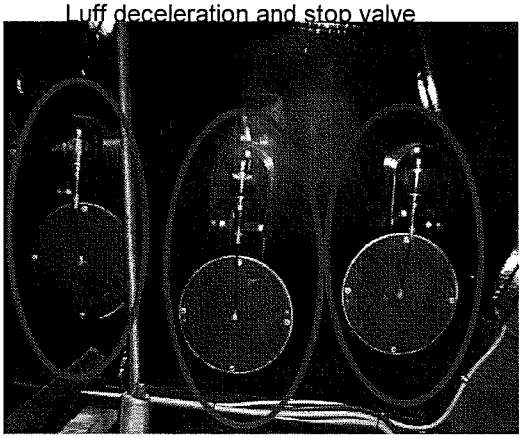
Gear limit switch and rope counter encoder



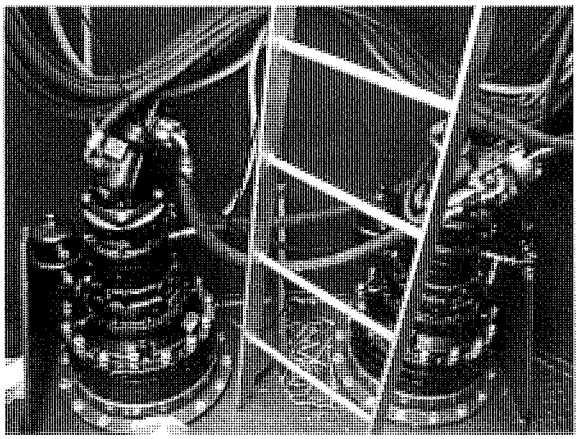
Luff deceleration and stop valve



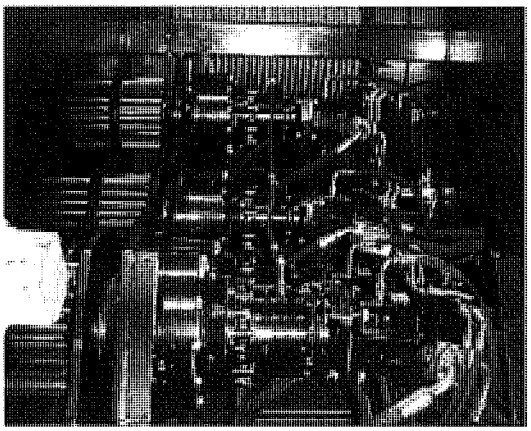
Luff drum



Hoist Spline Lubrication Oil Bottles



Slew Drive



Hoist drum drives

4.8.3 Electric

Electrical components within this crane are serviceable by a competent electrician, the exception being any electronic items.

As previously mentioned, it is recommended to have exchange units for the most important parts stocked for fast replacement.

WARNING ***All sources of electricity supply to the boom must be shut off before any piece of electrical apparatus is serviced.***

4.9 Maintenance Log

(This is a general maintenance sheet and items not applicable are to be deleted).

Refer also to sections

3.4 : Check lists
4.2 : Maintenance – detailed Lubrication Diagram

DAILY MAINTENANCE/CHECKS

ITEM	(WHERE APPLICABLE) MARK S OR MARK U.S CRITERIA: SATISFACTORY/UNSATISFACTORY							OPERATORS NAME & CERT NO& SIGNATURE
	Mon	Tue	Wed	Thur	Fri	Sat	Sun	
TIME								
OVERALL INSPECTION								
CHECK ENGINE OIL LEVEL								
CHECK RADIATOR WATER LEVEL								
CHECK DIESEL FUEL LEVEL								
CHECK PUMP DRIVE OIL LEVEL								
CHECK HYDRAULIC OIL LEVEL								
CHECK ENGINE AIR CLEANER								
CHECK HOIST ROPE LAY								
CHECK THE CONTROL PANEL TO ENSURE THE VISUAL AND AUDIBLE ALARMS ARE WORKING								
CHECK THE HOIST UP LIMIT								
CHECK THE HOIST DOWN LIMIT								
CHECK THE LUFF IN LIMIT								

CHECK THE LUFF OUT LIMIT								
CHECK THE ENGINE/ CRANE BATTERY (IF APPLICABLE)								
CHECK POWERPACK HOLDING DOWN BOLTS/PINS								
CHECK THE EMERGENCY STOP FUNCTION								
CHECK THE SLEW LIMITS								
Remarks								

MAINTENANCE LOG	WEEKLY OR EVERY 40 WORKING HOURS							
DATE								
TIME								
OVERALL INSPECTION INCLUDING VISUALLY CHECKING FOR OIL LEAKAGE AROUND THE POWERPACK AND THE WINCH.								
CHECK ENAGEMENT OF LUFF RATCHET WHEN CRANE SHUTDOWN								
CHECK THE HOIST ROPE FOR DEFECTS AND/OR FAILURE								
CHECK THE LUFF ROPE FOR DEFECTS AND /OR FAILURE								
GREASE SLEW RING BEARING								
INSPECT & GREASE THE HOIST DRUM GEAR								
INSPECT & GREASE THE LUFF DRUM GEAR								
INSPECT & GREASE THE SLEW RING GEAR								
GREASE THE BOOM HEEL BUSHES								
Remarks								

MAINTENANCE LOG	MONTHLY OR EVERY 100 WORKING HOURS							
DATE								
TIME								
CHECK THE ENGINE OIL LEVEL								
CHECK THE RADIATOR WATER LEVEL								
CHECK THE PUMP DRIVE OIL LEVEL								
CHECK THE HOIST BRAKE AND FLUID CONDITION								
CHECK THE LUFF BRAKE AND FLUID CONDITION								
CHECK THE HOIST BRAKE AND FLUID CONDITION								
INSPECT & GREASE THE SHEAVE BEARINGS OF MAST, BRIDLE, BOOM AND HOOK SHEAVES ASSEMBLIES								
INSPECT & GREASE HOIST DRUM BEARINGS								
INSPECT & GREASE LUFF DRUM BEARINGS								
INSPECT & LUBRICATE HOIST DRUM DRIVE BEARINGS AND GEARBOX								
INSPECT & LUBRICATE LUFF DRUM DRIVE BEARINGS AND GEARBOX								
INSPECT & LUBRICATE SLEW DRIVE BEARINGS AND GEARBOX								
INSPECT THE HYDRAULIC OIL TANK								
Remarks								

MAINTENANCE LOG	EVERY THREE MONTHS OR 250 WORKING HOURS							
DATE								
TIME								
INSPECT & GREASE HOIST DRUM BEARINGS								
INSPECT & GREASE LUFF DRUM BEARINGS								
INSPECT & LUBRICATE HOIST DRUM DRIVE BEARINGS								
INSPECT & LUBRICATE LUFF DRUM DRIVE BEARINGS								
INSPECT & LUBRICATE SLEW DRIVE BEARINGS								
INSPECT LIMIT SWITCH DRIVES								
INSPECT THE HYDRAULIC OIL TANK								
Remarks								

MAINTENANCE LOG	EVERY 5000 WORKING HOURS							
DATE								
INSPECT THE SLEW DRIVE SPLINED PINIONS								
INSPECT THE LUFF DRIVE SPLINED PINIONS								
INSPECT THE HOIST DRIVE SPLINED PINIONS								
INSPECT CRANE STRUCTURAL MEMBERS AND WELDS								
Remarks								

5 TROUBLE SHOOTING

5.1 General Trouble Shooting List 5-2
5.2 Planetary Drives 5-7
5.3 Ropes 5-8

5.1 General Trouble Shooting List

The following table will be very useful for finding and solving causes of break-downs and common problems that occur during crane operation. Needless to say this table is not exhaustive, as it is impossible to set down all the causes and their associated solutions.

PROBLEM	PROBABLE CAUSE	REMEDY
A **No boost pressure (or very low) (with engine running) engine should cut out [motion]**	1. Faulty pressure gauge. 2. Damaged/blocked boost pump suction hose(s). 3. Damage drive coupling /between engine and gearbox. 4. Boost pressure setting too low. 5. (Faulty) anti-cavitation switch or setting incorrect.	1. Replace. 2. Stop immediately - call FFC. 3. Stop immediately - call FFC.(replace) 4. Check reason. Boost pressure relief valve should match circuit. Consult FFC. 5. Adjust or replace as necessary.
B **No motions (with engine running)**	1. Lines between cabin & winch frame connected incorrectly. 2. No boost pressure (or very low boost pressure). 3. Limits are tripped or malfunctioning. 4. Cabin control levers not functioning correctly. 5. (Faulty) anti-cavitation switch or setting incorrect. 6. Faulty relay. 7. Faulty/jammed main oil solenoid.	1. Check lines. If in doubt, consult FFC. 2. Stop immediately - call FFC. 3. Reset or replace as necessary - Consult FFC. 4. Replace levers. 5. Adjust or replace as necessary. 6. Check wiring. 7. Check solenoid and spool movement. Repair/replace as necessary.

C **No hoist up** **(other motions OK)**	1. Hoist winch is overloaded. 2. S.L.I. not calibrated correctly -showing overload. 3. Brake not releasing. 4. Pump relief valves set incorrectly. 5. Pump controller not functioning correctly. 6. Emergency lowering bypass valve open or leaking. 7. Winch drives damaged. 8. Hoist up limit is tripped. 9. Leakage or block in hoist up control line from lever.	1. Reduce load to comply with load chart. 2. Recalibration necessary. Temporary bypass may be done only by qualified personnel. 3. Check brake valve & check cabin control lever functioning. 4. Qualified personnel can adjust. Check reason. 5. Replace controller. Qualified personnel to inspect/repair. 6. Close or replace. 7. Consult FFC. 8. Qualified personnel can bypass or reset as necessary if at top hoist down. 9. Fix leak or replace hose as necessary.
D **No hoist down** **(other motions OK)**	1. Hoist down limit is tripped (if fitted). 2. Brake not releasing. 3. Pump controller not functioning correctly. 4. Leakage or block in hoist down control line from lever.	1. Qualified personnel can bypass or reset as necessary. 2. Check brake valve & check cabin control lever functioning. 3. Replace controller. Qualified personnel to inspect/repair. 4. Fix leak or replace hose as necessary.

E **Loaded hook drops slightly before lifting**	1. Brake releasing too early. 2. Pump not correctly in neutral. 3. Excessive leakage in pump or motor.	1. Qualified personnel to adjust. 2. Qualified personnel to adjust. 3. Consult FFC.
F **Empty hook (or light load) initially jumps up when hoisting.**	1. Brake releasing too late. 2. Pump not correctly in neutral.	1. Qualified personnel to adjust. 2. Qualified personnel to adjust.
G **No luff up (other motions OK)**	1. Luff up limit tripped (if fitted). 2. Luff in deceleration valve tripped or malfunctioning. 3. Luff ratchet not releasing. 4. Luff winch is overloaded. 5. Brake not releasing. 6. Pump relief valves set incorrectly. 7. Pump controller not functioning correctly. 8. Winch drives damaged. 9. Leakage or block in luff control line from lever.	1. Qualified personnel can bypass or reset as necessary. 2. Qualified personnel to adjust and check. 3. Check cylinder. 4. Reduce load to comply with load chart. 5. Check brake valve & check cabin control lever functioning. 6. Qualified personnel can adjust - check reason. 7. Replace controller. Qualified personnel to inspect/repair. 8. Consult FFC. 9. Fix leak or replace hose as necessary.

H **Luff ratchet not releasing**	1. Brake valve shuttle (if applicable) problem. 2. Luff ratchet solenoid (if applicable) problem. 3. Ratchet cylinder not functioning properly. 4. Brake valve release pressure set incorrectly (if applicable). 5. Damaged/leaking cylinder line.	1. Replace if necessary. 2. Replace coil or valve as necessary - fault trace if signal not coil. 3. Check cylinder. 4. Qualified personnel can adjust as necessary. Check reason. 5. Replace/repair if as required.
I **No luff down (other motions OK)**	1. Luff down limit is tripped. 2. Motion cut activated on S.L.I. due to overload. 3. S.L.I. not calibrated correctly -showing overload. 4. Luff ratchet not releasing. 5. Brake not releasing. 6. Pump controller not functioning correctly. 7. Leakage or block in luff down control line from lever.	1. Qualified personnel can bypass or reset as necessary. 2. Check load against S.W.L. luff up or hoist down only permissible. 3. Recalibrate if necessary. Temporary bypass may be done only by qualified personnel. 4. Qualified personnel can adjust as necessary. Check reason. 5. Check brake valve - check cabin control lever functioning. 6. Replace controller. Qualified personnel to inspect/repair. 7. Fix leak or replace hose as necessary.

J **Crane will not slew (other motions OK)**	1. Slew brake is on. 2. Slew limit is tripped (if fitted) 3. Brake not releasing. 4. Pump controller not functioning correctly. 5. Cabin control lever not functioning correctly. 6. Slew drive damaged. 7. Pump relief valves set incorrectly.	1. Move slew brake lever to 'off' position. 2. Slew in opposite direction. Qualified personnel. can bypass or reset as necessary. 3. Check brake valve in cabin. 4. Replace controller Qualified personnel. to inspect/repair. 5. Replace lever. Qualified personnel to inspect/repair. 6. Consult FFC. 7. Qualified personnel. can adjust - check reason.
K **Engine will not start**	1. Batteries are flat. 2. No diesel fuel. 3. Fuel filters or air cleaner is blocked. 4. Starter motor damaged. 5. Hydraulic oil is too thick (especially in cold climate) 6. Fuel is contaminated (eg. water) or waxed (ie. incorrect fuel for cold climate) 7. Ultimate limit(s) tripped.	1. Check correct voltage from electric circuit. Charge or replace as necessary. 2. Check level and fill as required. 3. Check and replace as required. 4. Check starter motor and pinion. Replace as required. 5. Replace with lower viscosity oil. 6. Check fuel, filters and water separator (where applicable). 7. Check limits. Qualified personnel can bypass if necessary.

5.2 Planetary Drives

Problem	Cause	Solution
With motor running the shaft output doesn't turn	Incorrect motor assembly	Check coupling between gear unit and motor
	Internal malfunction	Contact FFC or service Center
	Brake blocked	Check hydraulic circuit
Oil leak from breather during operation	Level too high	Lower oil level
	Incorrect breather position	Check breather position
	Possible wear of multidisk seals or hydraulic motor	Contact FFC or service Center
Oil leak from seal	Clogging breather plug	Unscrew and thoroughly clean the lug
	Stiffening of seals due to prolonged storage	Clean the area and check for leakage again after a few days
	Damaged or worn seals	Contact FFC or service Center
Excessive noise	Internal malfunctions	Contact FFC or service Center
Disk brake does not release	Residual pressure in hydraulic circuit	Check hydraulic circuit
Excessive vibrations	Gear unit incorrectly installed	Check the connection and inline configuration
	Coupling structure weak	Strengthen the structure
	Internal malfunction	Contact FFC or service Center
Excessive heating	No ventilation	Removing fairing
	High thermal pressure	Insert oil circulation
Multi-disk brake does not release	No pressure to the brake	Check connections to hydraulic circuit
	Internal malfunction	Contact FFC or service Center
	No pressure in the circuit	Check hydraulic circuit
Multi-disk brake does not brake	Pressure delivered to brake	Check hydraulic circuit
	Worn disks	Contact FFC or service Center
Disk brake does not brake	No pressure to the brake	Check hydraulic circuit
	Worn brake Pads	Replace brake pads

5.3 Ropes

Problem	Cause/Action
Mechanical damaged caused by the rope contacting the structure of the crane on which it is operating or an external structure – usually of a localised nature.	• Generally results from operational conditions. • Check sheave guards and supports/guides sheave to ensure that the rope has not jumped out of the intended reeving system. • Review operating conditions.
Opening of strands in rotation resistant, low rotation and parallel closed ropes – in extreme circumstances the rope may develop a birdcage distortion or protrusion of inner strands	• Check sheave and drum groove radii using sheave gauge to ensure that they are no smaller than nominal rope radius +5% • Repair or replace drum/ sheaves • Check feet angles in the reeving system • Check installation method – turn induced during installation causes excessive rope rotation resulting in distortion • Check if the rope has been cut on site prior to installation or cut to remove a damaged section. If so, was the correct cutting method used. Incorrect cutting of rotation resistant, low rotation and parallel closed ropes can cause distortion in operation • Rope may have experienced a shock load •
Broken wires or crushed or flattened rope on lower layers at crossover points in multi-layer coiling situations. Wire breaks usually resulting from crushing or abrasion.	• Check tension on underlying layers. • Review wire ope construction • Do not used more than necessary • Check drum diameter. Insufficient bending ratio increases tread pressure.
Wire looping from strands	• Insufficient service dressing. • Consider alternative rope construction • If wires are looping out of the rope underneath a crossover point, there may be insufficient tension on the lower wraps on the drum • Check areas for rope crushing or distortion
Pigtail or severe spiralling in rope	• Check that the sheave and drum diameter is large enough •

	• Indicates that the rope has run over a small radius or sharp edge • Check to see if the rope has jumped off a sheave and has over a shaft
Two single axial lines of broken wires running along the length of the rope approximately 120 degrees apart indicating that the rope is being nipped in a tight sheave.	• Check sheave and drum groove radii using sheave gauge to ensure that they are no smaller than nominal rope radius +5% • Repair or replace drum/ sheave if necessary
One line of broken wires running along the length of the rope indicating insufficient support for the rope, generally caused by oversize sheave or drum grooving.	• Check to see if the groove diameter is no greater than 15% the nominal rope diameter. • Repair or replace drum/sheaves is necessary • Check for contact damage
Short rope life resulting from evenly/randomly distributed bend fatigue wire breaks caused by bending through the reeving system. Fatigue induced wire breaks are characterised by flats ends on the broken wires.	• Bending fatigue is accelerated as the load increases and as the bending radius decreases. Consider improving factor. • Check wire rope construction
Short rope life resulting from localised bend fatigue wire breaks. Fatigue induced wire breaks are characterised by flats ends on the broken wires.	• Bending fatigue is accelerated as the load increases and as the bending radius decreases. Consider improving factor. • Check wire rope construction • Localised fatigue breaks indicate continuous repetitive bends over a short length. Consider whether it is economic to periodically shorten the rope in order to move the rope to the system and progressively expose fresh rope to severe bending zone.
Broken rope – ropes are likely to break when subjected to substantial overload or misuse particularly when a rope has already been subjected to mechanical damage.	• Review operating condition.

Corrosion of rope both internally or externally can also result in a significant loss in metallic area. The rope strength is reduced to a level where it is unable to sustain the normal working load.	
Wave or corkscrew deformations normally associated with multistrand ropes.	• Check sheave and drum radii using sheave gauge to ensure that they are no smaller than nominal rope radius +5% • Repair drum or sheaves • Check fleet angles in the reeving system • Check the rope has been secured in accordance with manufactures instructions • Check operating conditions for induced turn
Rotation of the load in a single fall system	• Review rope selection • Consider use of rotation resistant or low rotation rope
Rotation of the load in a multi – fall system resulting in cabling of the rope. Possibly due o induced turn installation or operation	• Review rope selection • Consider use of rotation resistant or low rotation rope • Review installation procedure or operating procedures.
Core protrusion or broken cores in a single layer six or eight strand rope.	• Caused by repetitive shock loading – review operating conditions
Rope accumulating or stacking at drum flange – due to insufficient fleet angle	• Review drum design with original equipment manufacturer – consider adding rope kicker, fleeting sheave
Sunken wraps of rope on the drum normally associated with insufficient support from lower layers of rope or grooving	• Check correct rope diameter • If grooved drum check groove pitch • Check tension on underlying layers • Make sure that the correct rope length is being used. Too much rope may aggravate the problem
Shot rope life induced by	• Check fleet angle to drum

excessive wear and abrasion	• Check general alignment of sheaves in the reeving system • Check that all sheaves are a free to rotate • Review rope selection
External corrosion	• Consider selection of galvanised rope • Review level and type of service dressing
Internal corrosion	• Consider selection of galvanised rope • Review frequency amount and type of service dressing • Consider selection plastic impregnated wire rope

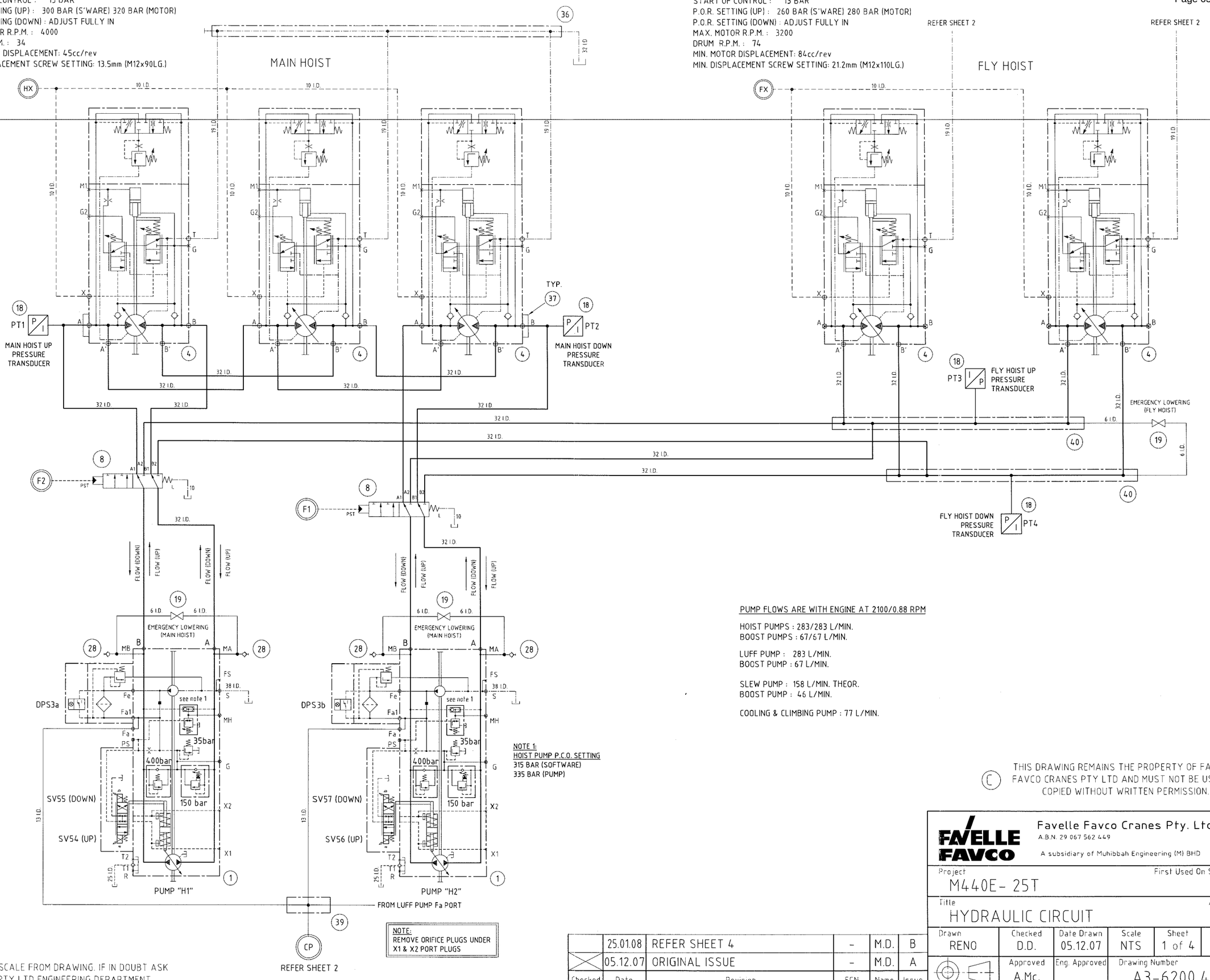
6 DRAWINGS

CRANE DETAILS	DRAWING NUMBER	REV
HYDRAULICS CIRCUIT	A3.6200.443MDO	B
ELECTRICAL CIRCUIT	A3.6100.466	A
MACHINERY DECK		
Machinery Deck Assembly	A3.2000.241	B
WINCH		
Hoist Winch Assembly	A2.2300.306	B
Hoist Drum Assembly	A3.2320.128	B
Luff Drum Assembly	A3.2320.297	A
Hoist Drum Drive Assembly	A3.2390.327MDO	A
Luff Drum Drive Assembly	A3.2390.325MDO	B
Fly Winch Assembly	A3.2300.302	A
Fly Drum Assembly	A3.2320.294	A
Fly Drum Drive Assembly	A3.2390.323MDO	A
LUFF RATCHET		
Luff Ratchet Assembly	A3.2350.025	A
POWERPACK ASSEMBLY	A1.2400.206	A
Engine to Gearbox Coupling Assembly	A4.2436.033MDO	B
Engine Specification	A4.2430.097	A
Gearbox Specification	A4.2450.126	A
CABIN		
Cabin Assembly	A3.2100.175	C
Rope Specification Plate	A3.2175.294	A
Load Chart - Main Hoist	A3.2170.564	C
Load Chart – Fly Hoist	A3.2170.565	A
MAST ASSEMBLY	A3.3000.140	A
Boom Buffer Assembly	A3.3100.112	A
BOOM		
Boom Assembly	A1.4000.183	E

SLEW		
Slew Drive Assembly	A3.2500.098MDO	B
Slew Ring Assembly	A3.2600.044	A
REEVING DIAGRAM	A3.5000.301	A
HOOK		
10T Hook Assembly	A3.5300.235	B
25tT Hook Assembly	A3.5300.225	A
BRIDLE ASSEMBLY	A3.5200.126	B

HOIST MOTOR PRESSURE SETTINGS
START OF CONTROL : 13 BAR
P.O.R. SETTING (UP) : 300 BAR (S'WARE) 320 BAR (MOTOR)
P.O.R. SETTING (DOWN) : ADJUST FULLY IN
MAX. MOTOR R.P.M. : 4000
DRUM R.P.M. : 34
MIN. MOTOR DISPLACEMENT: 45cc/rev
MIN. DISPLACEMENT SCREW SETTING: 13.5mm (M12x90LG.)

FLY MOTOR PRESSURE SETTINGS
START OF CONTROL : 13 BAR
P.O.R. SETTING (UP) : 260 BAR (S'WARE) 280 BAR (MOTOR)
P.O.R. SETTING (DOWN) : ADJUST FULLY IN
MAX. MOTOR R.P.M. : 3200
DRUM R.P.M. : 74
MIN. MOTOR DISPLACEMENT: 84cc/rev
MIN. DISPLACEMENT SCREW SETTING: 21.2mm (M12x110LG.)



NOTE 1:
HOIST PUMP P.C.O. SETTING
315 BAR (SOFTWARE)
335 BAR (PUMP)

NOTE:
REMOVE ORIFICE PLUGS UNDER X1 & X2 PORT PLUGS

PUMP FLOWS ARE WITH ENGINE AT 2100/0.88 RPM

HOIST PUMPS : 283/283 L/MIN.
BOOST PUMPS : 67/67 L/MIN.

LUFF PUMP : 283 L/MIN.
BOOST PUMP : 67 L/MIN.

SLEW PUMP : 158 L/MIN. THEOR.
BOOST PUMP : 46 L/MIN.

COOLING & CLIMBING PUMP : 77 L/MIN.

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Checked	Date	Revision	ECN	Name	Issue
	25.01.08	REFER SHEET 4	-	M.D.	B
	05.12.07	ORIGINAL ISSUE	-	M.D.	A

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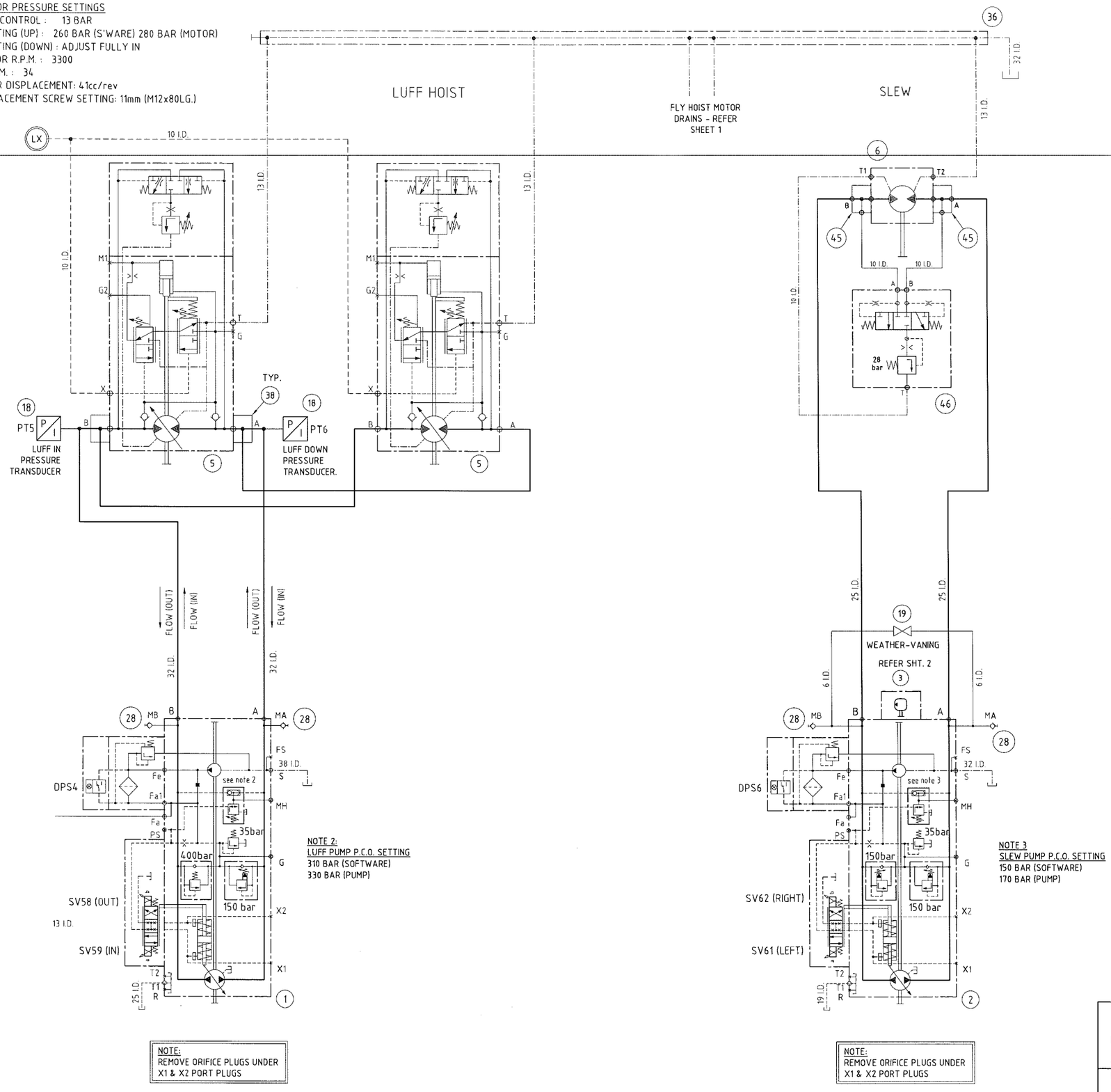
Project: M440E- 25T
First Used On S/No. 1475
Title: HYDRAULIC CIRCUIT
Activity No. 240

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RENO	D.D.	05.12.07	NTS	1 of 4	-	B
	Approved	Eng. Approved	Drawing Number			
	A.Mc.		A3-6200.443.MDO			

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FORM:F04.22.01

LUFF MOTOR PRESSURE SETTINGS
START OF CONTROL : 13 BAR
P.O.R. SETTING (UP) : 260 BAR (S'WARE) 280 BAR (MOTOR)
P.O.R. SETTING (DOWN) : ADJUST FULLY IN
MAX. MOTOR R.P.M. : 3300
DRUM R.P.M. : 34
MIN. MOTOR DISPLACEMENT: 41cc/rev
MIN. DISPLACEMENT SCREW SETTING: 11mm (M12x80LG.)



Checked	Date	Revision	ECN	Name	Issue
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	05.12.07	ORIGINAL ISSUE	-	M.D.	A

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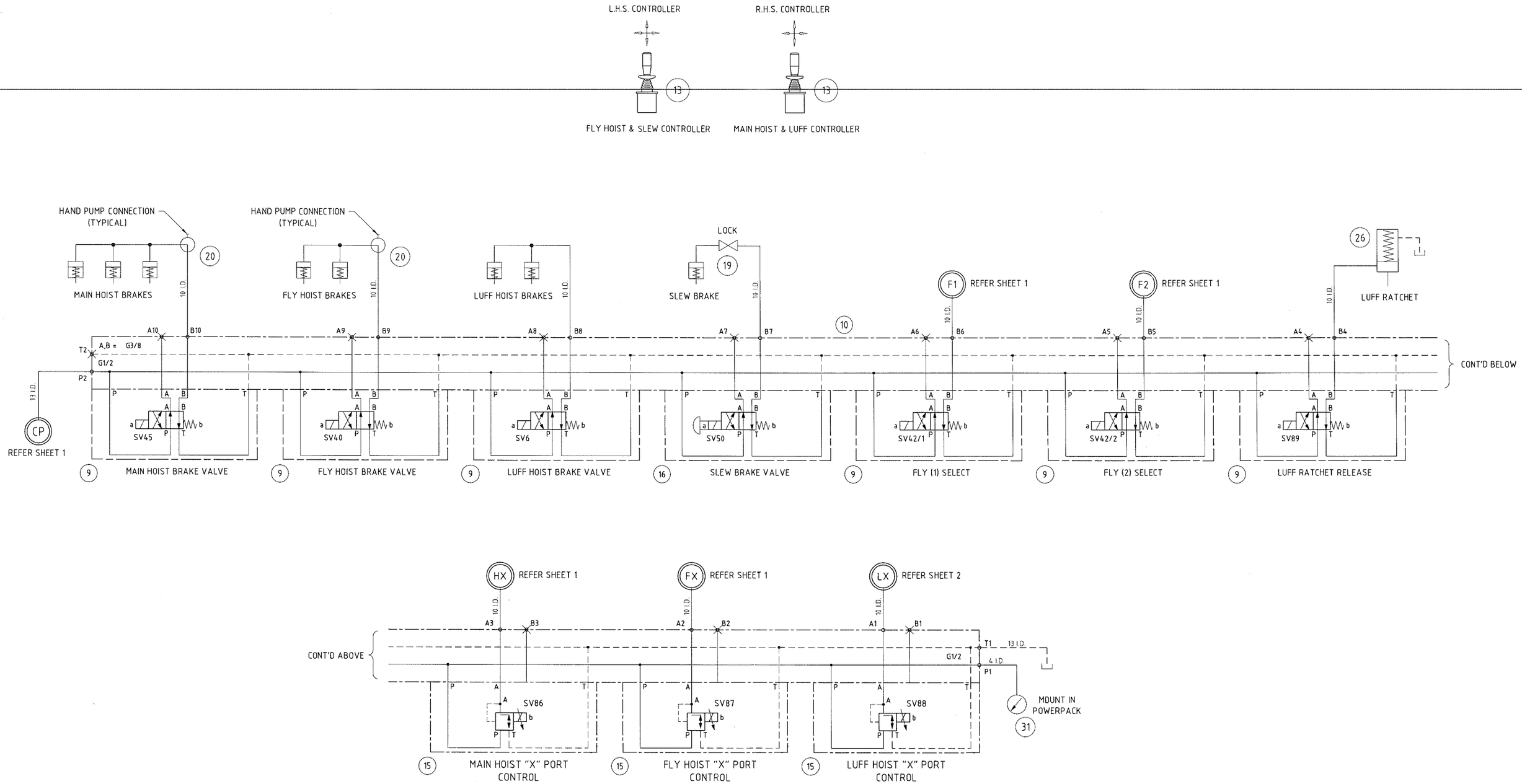
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CONTROL CIRCUIT

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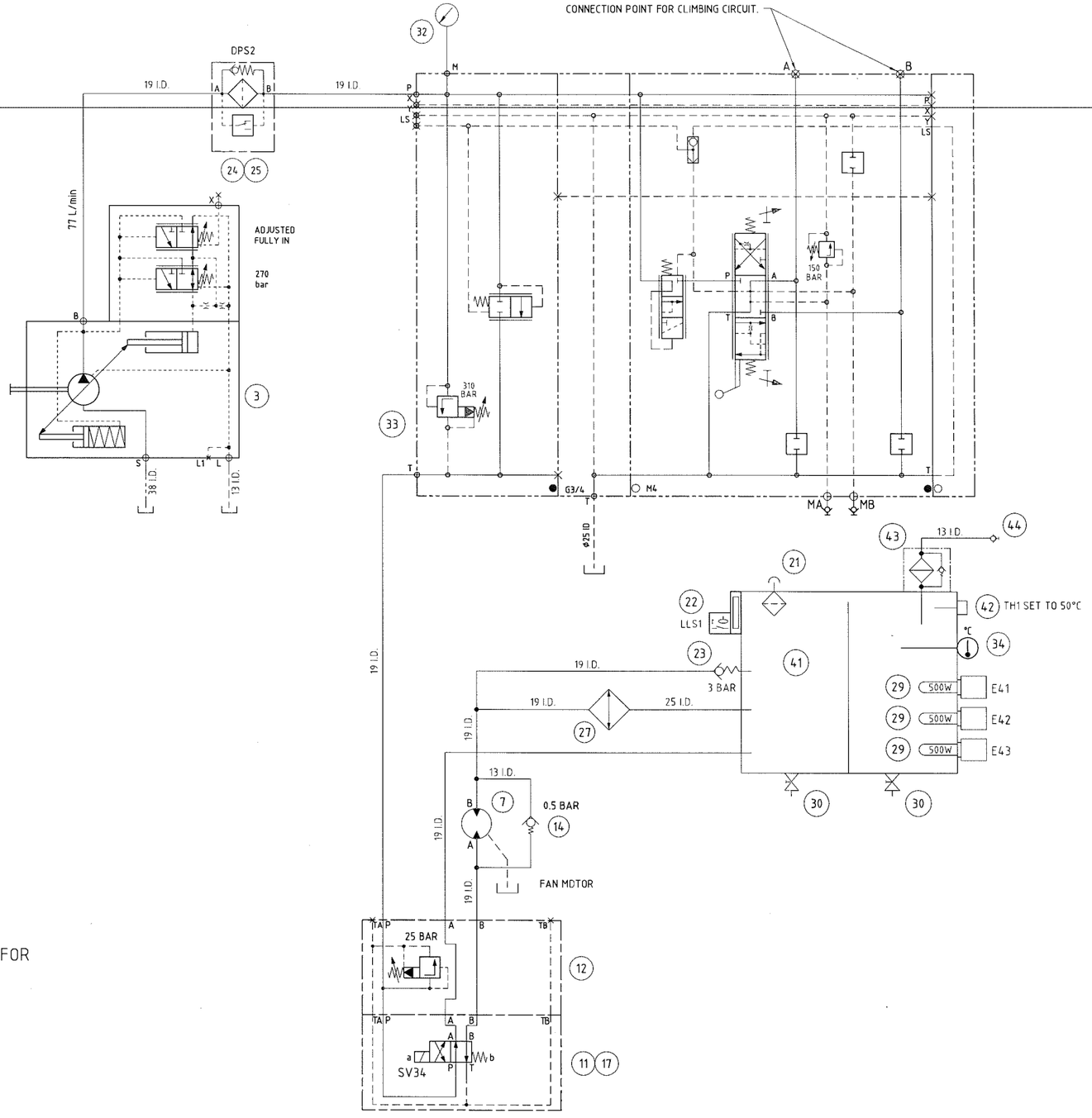
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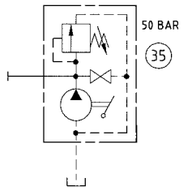
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TO BE LIMITED TO 34cc/rev MAX.

Material List				
Item	Description	Supplier	FFC Part No.	Qty
1	PUMP			3
2	PUMP			1
3	PUMP			1
4	MOTOR			5
5	MOTOR			2
6	MOTOR			1
7	MOTOR			1
8	CONTROL VALVE			2
9	CONTROL VALVE			REF
10	VALVE MANIFOLD - 10 STATION			1
11	CONTROL VALVE			1
12	RELIEF VALVE			1
13	CAN BUS JOYSTICK - 4 AXES			REF
14	CHECK VALVE - 0.5 BAR			1
15	CONTROL VALVE			REF
16	CONTROL VALVE			3
17	SUBPLATE			1
18	PRESSURE TRANSDUCER 0-400 BAR			6
19	NEEDLE VALVE			5
20	BALL VALVE			2
21	FILLER BREATHER			1
22	LEVEL GAUGE			1
23	CHECK VALVE			1
24	FILTER			1
25	FILTER SUPPORT			REF
26	S.A. CYLINDER			1
27	OIL COOLER			1
28	TEST POINT			8
29	HEATER			1
30	DRAIN VALVE			2
31	PRESS.GAUGE			1
32	PRESS.GAUGE			1
33	CONTROL VALVE			1
34	DIAL THERMOMETER - 75mm 0-150°C 1/2" BSP			1
35	HANDPUMP			1
36	DRAIN MANIFOLD 1/2" - 1"			REF
37	SAE TEE - 1.1/4" CODE 62			REF
38	MOTOR ADAPTOR			REF
39	BOOST MANIFOLD 1/2" - 1"			REF
40	FLOW DIVIDER 1.1/4" - 1.1/4"			REF
41	HYDRAULIC RESERVOIR			REF
42	THERMOSTAT			1
43	FILTER			1
44	QUICK CONNECT COUPLING 1/2" F/M with protective cap & plug			1
45	SIDE PORTED SPACER - 1" CODE 62 x 1/2" BSPP			2
46	FLUSHING VALVE			1





EMERGENCY HANDPUMP FOR BRAKE RELEASE

COOLING & CLIMBING CIRCUIT

HYDRAULIC OIL RECOMMENDATION:
REFER TO TABLE 4.1 IN MANUAL FOR SUGGESTED OIL GRADE DEPENDING ON AMBIENT TEMPERATURE. USE HEATERS TO HEAT OIL TO AT LEAST MIN. TEMPERATURE SHOWN IN TABLE PRIOR TO USING CRANE.

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	25.01.08	ITEM 6 WAS SCM-084W/H-14A/FR	-	M.D.	B
	05.12.07	ORIGINAL ISSUE	-	M.D.	A

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Project: M440E - 25T
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Title: HYDRAULIC CIRCUIT
Activity No.: 240

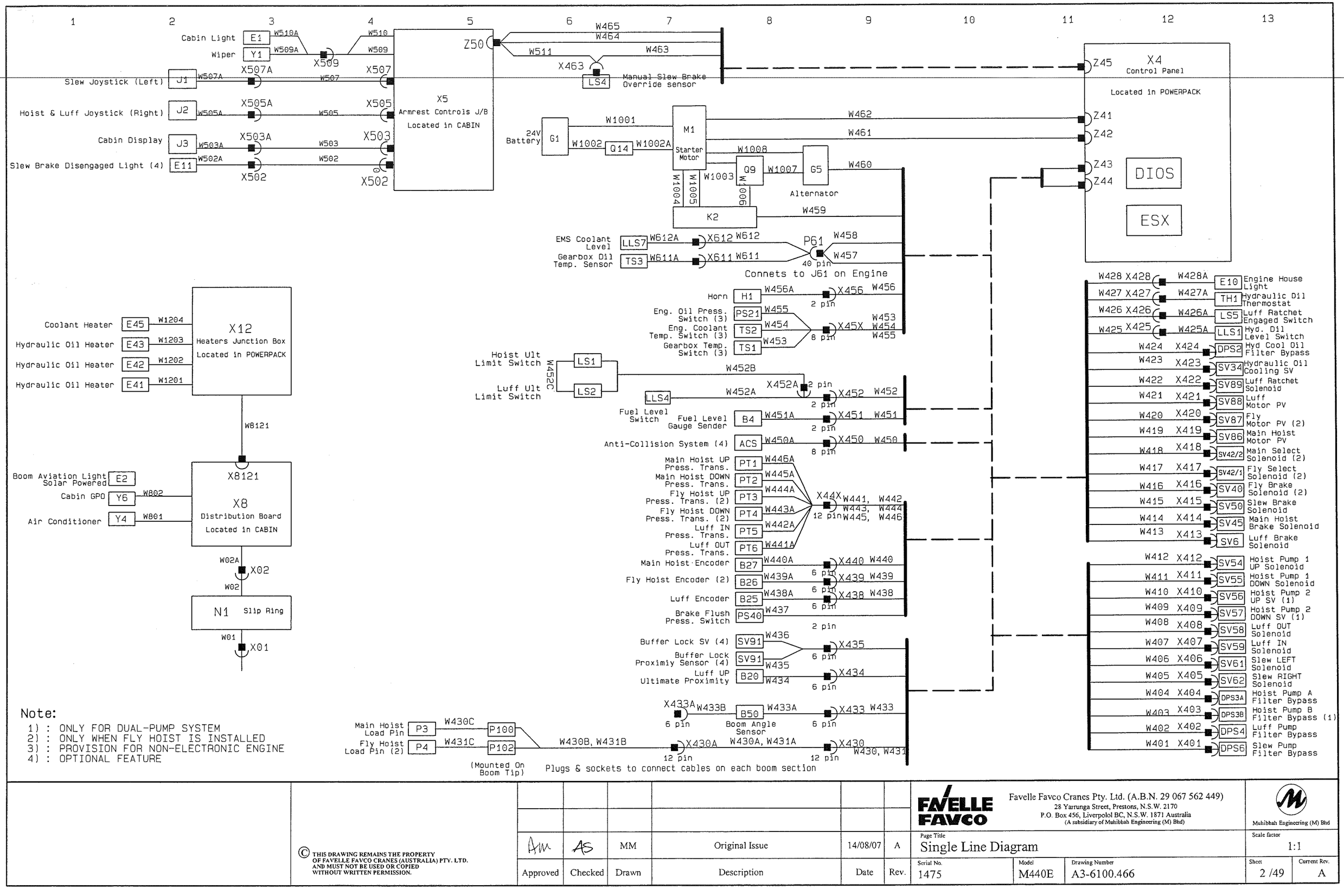
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	Approved	Eng Approved	Drawing Number			
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					FAVELLE FAVCO	Favelle Favco Cranes Pty Ltd (A.B.N. 29 067 562 449) 28 Yarrunga Street, Prestons, N.S.W. 2170 P.O. Box 456, Liverpool BC, N.S.W. 1871 Australia (A subsidiary of Muhibbah Engineering (M) Bhd)			Muhibbah Engineering (M) Bhd
AW	AS	MM	14/08/07	A	Serial No.	Model	Drawing No.	Sheet	Rev
Approved	Checked	Drawn	Date	Rev.	1475	M440E	A3-6100.466	1 /49	A



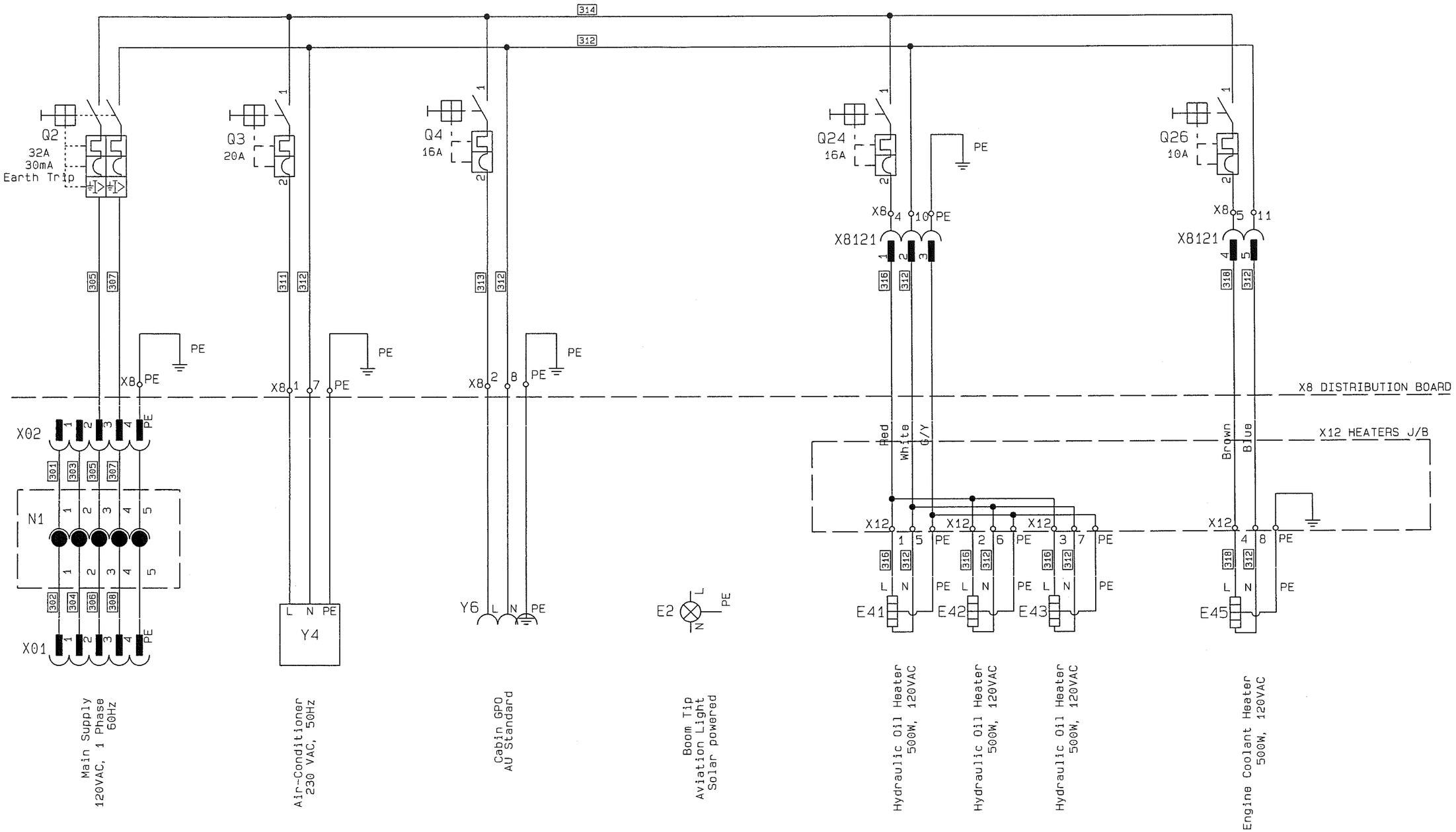
Note:
1) : ONLY FOR DUAL-PUMP SYSTEM
2) : ONLY WHEN FLY HOIST IS INSTALLED
3) : PROVISION FOR NON-ELECTRONIC ENGINE
4) : OPTIONAL FEATURE

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Page Title: Single Line Diagram
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Current Rev.: A



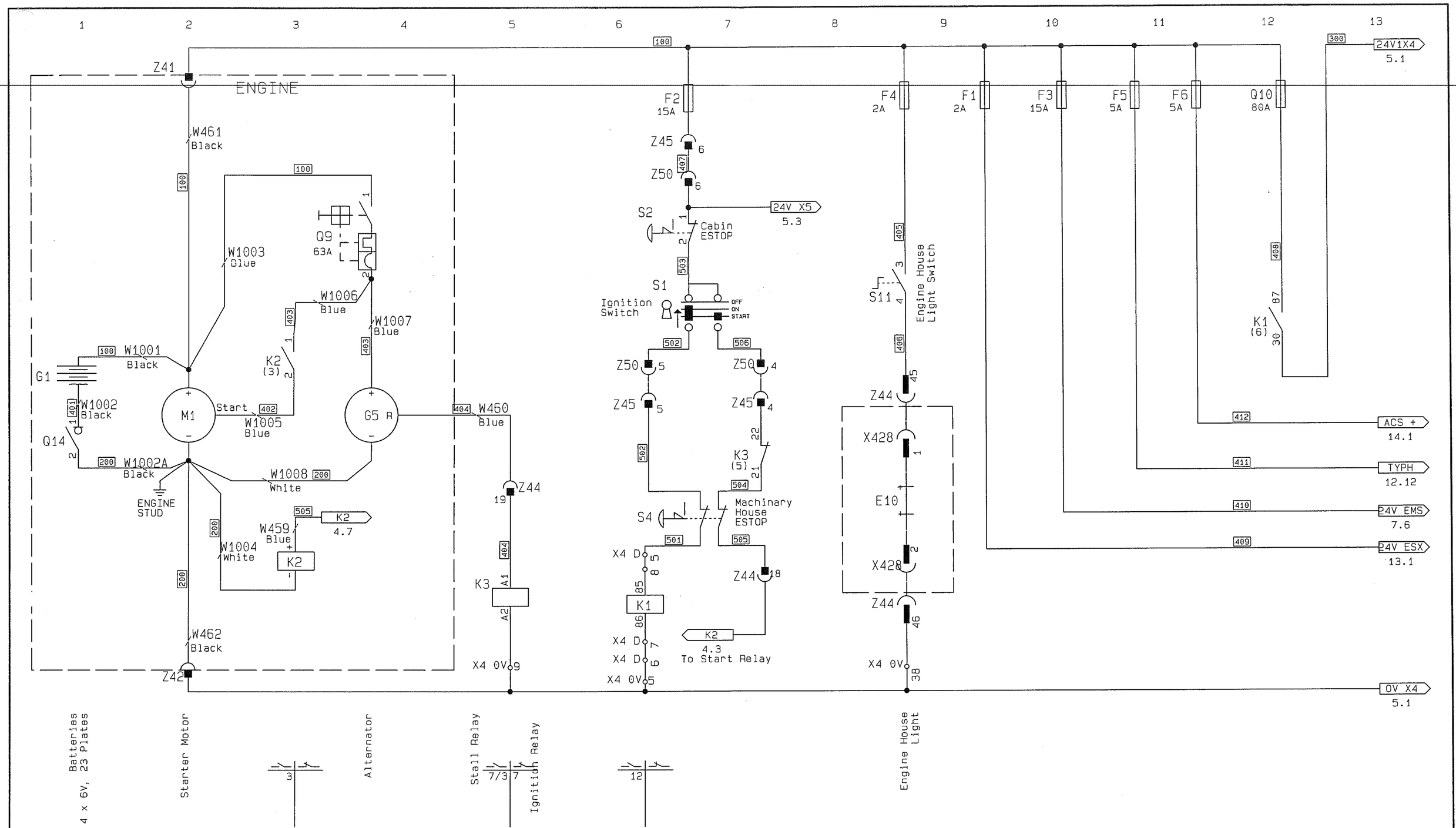
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1475	M440E	A3-6100.466	3 /49	A



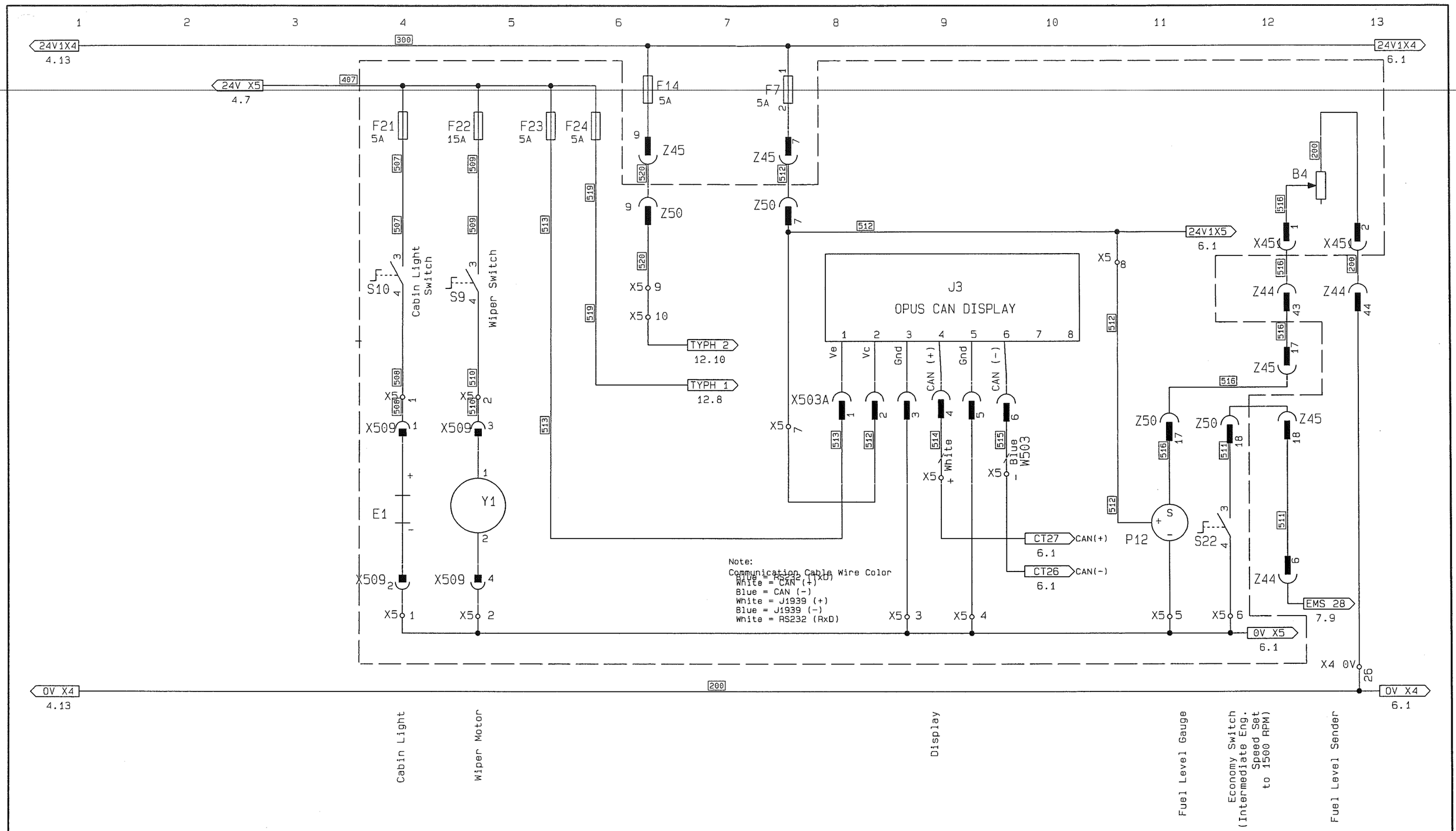
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Model: M440E
Drawing Number: A3-6100.466
Sheet: 5 /49
Current Rev.: A

1 2 3 4 5 6 7 8 9 10 11 12 13

24V1X4 5.13 — 300 — 24V1X4 7.1

24V1X5 5.11 — 512 — 24V1X5 9.10

X5 6

J1
JC600 CAN JOYSTICK
16 2 10 14 15 6 7 8
Gnd | CAN (-) | CAN (+) | Vc
X507
E15 Blue
E14 White
E01 E02 603

J2
JC600 CAN JOYSTICK
16 2 10 14 15 6 7 8
Gnd | CAN (-) | CAN (+) | Vc
X505
515 Blue
514 White
604 605 606

F27 2A
F28 2A

X5 - X5 +

CT27 5.10 — 514 — CT27 11.1

CT26 5.10 — 515 — CT26 11.1

X5 SH 11.1

NOTE: J1 and J2 has 8 pin plug (X507A & X505A) to be connected with the Joystic ends (Not shown in schematic)

Note:
Communication Cable Wire Color
White = CAN (+)
Blue = CAN (-)
White = J1939 (+)
Blue = J1939 (-)
White = RS232 (RxD)
Blue = RS232 (TxD)

200

Z50 1 — Z45 1

X5 7 0V — 0V X5 5.12
X5 8 0V
X5 9 0V — 0V X5 12.12

OV X4 5.13 — 200 — OV X4 7.1

F11 10A 1 2 — 609

X4T2 38

Z43 52 A — X402 DPS4
P 1 2 3 Red Green C

X402 B — X402 C
Z43 54 — Z43 53
608 66

Z43 A — X406
P 1 2 3 Red Green C

X401 B — X401 C
Z43 68 — Z43 67
607

CT13 9.3

X4 0V 43 — X4 0V 42

610

X4T2 6 — 609 — 24V2X4 7.3

Z43 10 A — X424
P 1 2 3 Red Green C — DPS2

X424 B — X424 C
Z43 12 — Z43 11
612

Z43 A — X404
P 1 2 3 Red Green C — DPS3A

X404 B — X404 C
Z43 26 — Z43 25
611

Z43 A — X403B
P 1 2 3 Red Green C

X403 B — X403 C
Z43 40 — Z43 39

X4 0V 46 — X4 0V 45 — X4 0V 41

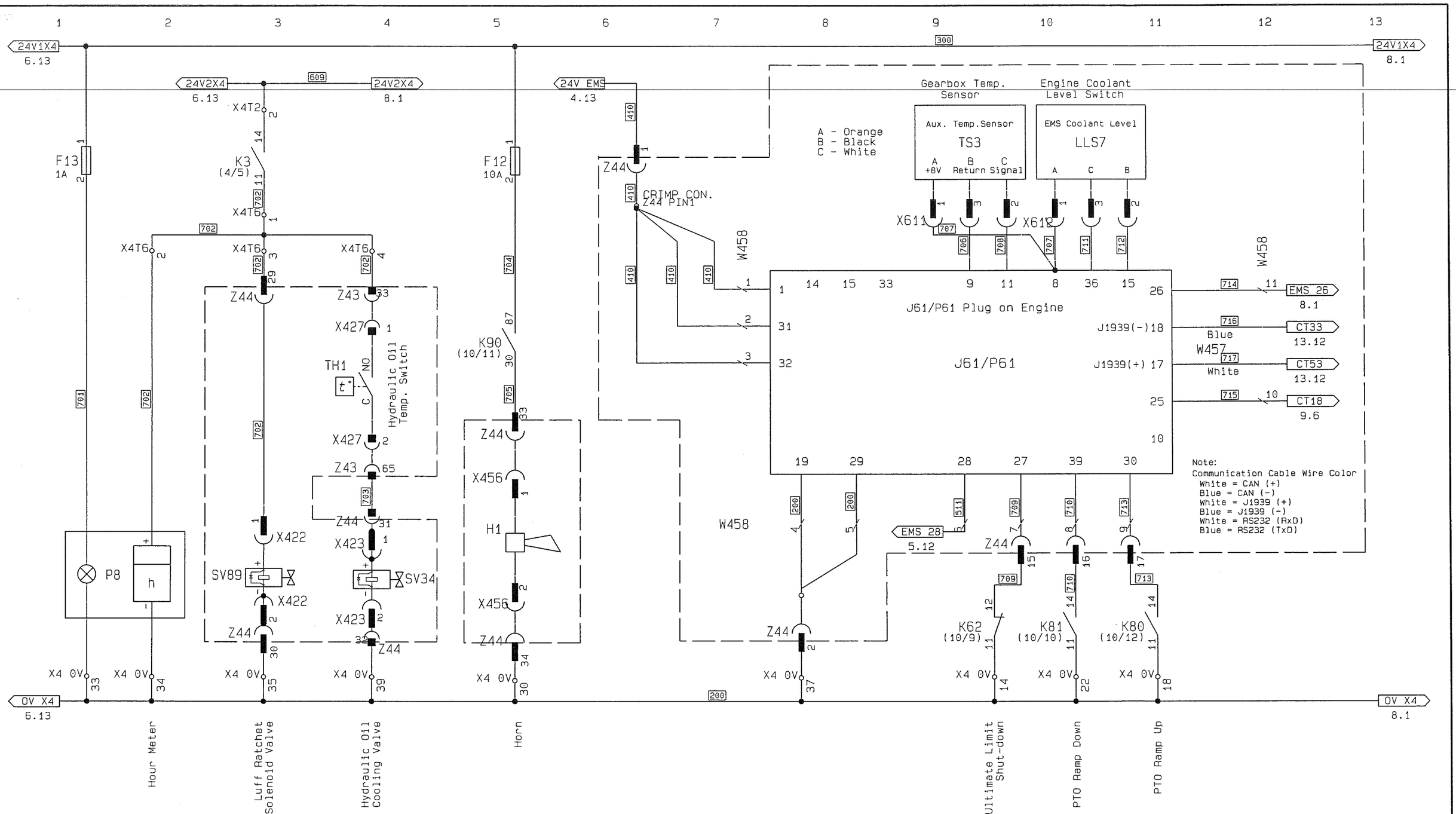
Left Joystick
Right Joystick
Slew Pump Filter Blocked
Luff Pump Filter Blocked
Hoist Pump 2 Filter Blocked
Hoist Pump 1 Filter Blocked
Cooling Pump Filter Blocked

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Page Title: Schematic Diagram
Scale factor: 1:1
Serial No.: 1475
Model: M440E
Drawing Number: A3-6100.466
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Current Rev.: A



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Page Title: Schematic Diagram
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Serial No.	Model	Drawing Number	Sheet	Current Rev.
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1 2 3 4 5 6 7 8 9 10 11 12 13

24V1X4 7.13 — 300 — 24V1X4 9.1

24V2X4 7.4 — 609 — 24V2X4 9.3 — F10 5A — X4T2 19 — X4T1 38 — 801

24V3X4 9.1

Z44 47 — X452 1 — X452A 1

Hoist Uit Limit — LS1 — 1 — 2 — 720

Luff Uit Limit — LS2 — 1 — 2 — 718

X452A 2 — Fuel Level — LLS4 — C — NO

X452 2 — Z44 48 — 714 — DI3 12.3

Z44 7 — EMS 26 7.12

OV X4 7.13

X4T1 23 — Z43 15 — 801 — X438 — 1 — B25 — Red — White — Green — Pink — Grey — Yellow — Brown — Blue

X4T1 27 — Z43 29 — 801 — X439

X4T1 19 — Z43 1 — 801 — X440 — 1 — B27 — Red — White — Green — Pink — Grey — Yellow — Brown — Blue

X438 6 5 4 2 — 803 804 200 — Z43 17 18 16 — X4T1 24

X439 6 5 4 2 — 807 805 200 — Z43 31 32 30 — X4T1 28

X440 6 5 4 2 — 808 809 200 — Z43 3 4 2 — X4T1 20

803 — CT35 9.8

807 — CT34 9.7

808 — CT12 9.2

52	10	50	51	45	11
2/5	2/6	2/3	2/4	2/1	2/2

ESX_BABY_IN

200 — OV X4 9.1

X4T1 3 — Z43 43 — 801 — X44X 12 — PT1 — P I — 4 — X44X 1 — 810 — Z43 57 — 810

X4T1 11 — Z43 45 — 801 — X44X 10 — 4 — X44X 3 — 811 — Z43 59 — 811

X4T1 6 — Z43 47 — 801 — X44X 8 — PT5 — P I — 4 — X44X 5 — 812 — Z43 61 — 812

X4T1 7 — Z43 44 — 801 — X44X 11 — PT2 — P I — 4 — X44X 2 — 814 — Z43 58 — CT09 11.4 — 813 — 814

X4T1 2 — Z43 46 — 801 — X44X 9 — 4 — X44X 4 — 815 — Z43 60 — 815

X4T1 10 — Z43 48 — 801 — X44X 7 — PT6 — P I — 4 — X44X 6 — 816 — Z43 62 — CT32 11.4 — 816 — 817

REMARK FOR PRESS. TRANS.
PIN 1 : +Ub (BROWN)
PIN 4 : OUTPUT (BLACK)

6	7	8	9	29	30	31	32

ESX_ANA_IN

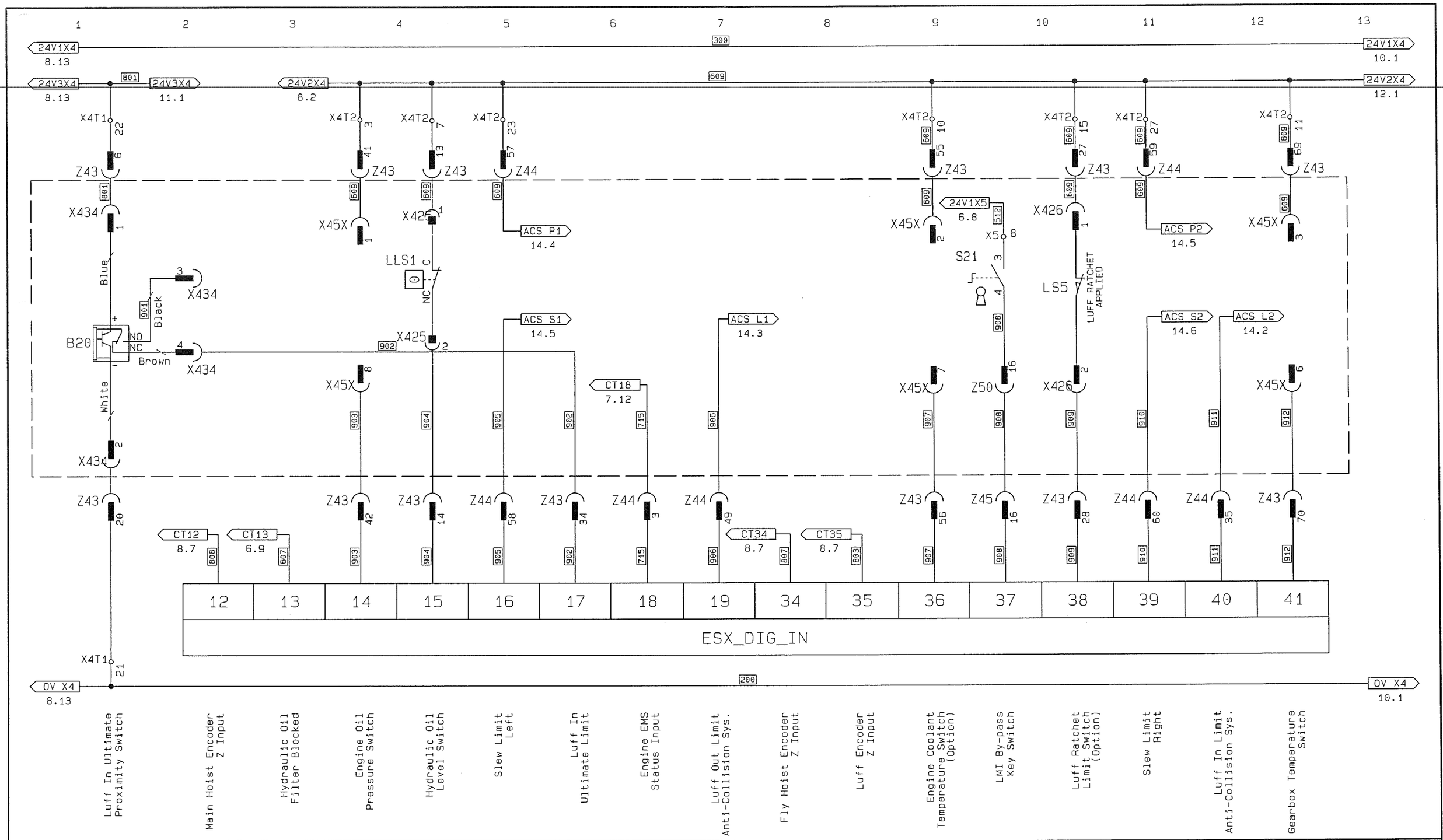
Fuel Level Switch
Luff Encoder Phase A Input
Luff Encoder Phase B Input
Fly Hoist Encoder Phase A Input Option
Fly Hoist Encoder Phase B Input Option
Main Hoist Encoder Phase A Input
Main Hoist Encoder Phase B Input
Main Hoist Up Pressure Transducer
Fly Hoist Up Pressure Transducer Option
Luff In Pressure Transducer
Fly Hoist Load Pin
Main Hoist Down Pressure Transducer
Fly Hoist Down Pressure Transducer Option
Luff Out Pressure Transducer
Main Hoist Load Pin

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Page Title: Schematic Diagram
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1 2 3 4 5 6 7 8 9 10 11 12 13

24V1X4 9.13 — 300 — 24V1X4 12.1

ESX_PWM_OUT

2	3	24	25	46	47	48	49	61	62	63	64
1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012
Z44 23	Z44 51	Z44 9	Z44 37	Z44 11	Z44 13	Z44 25	Z44 27	Z44 39	Z44 53	Z44 55	Z44 41
SV40 X416	SV50 X415	SV45 X414	SV6 X413	SV54 X412	SV55 X411	SV56 X410	SV57 X409	SV58 X408	SV61 X406	SV62 X405	SV59 X407
X416 2	X415 2	X414 2	X413 2	X412 2	X411 2	X410 2	X409 2	X408 2	X406 2	X405 2	X407 2
Z44 24	Z44 52	Z44 10	Z44 38	Z44 12	Z44 14	Z44 26	Z44 28	Z44 40	Z44 54	Z44 56	Z44 42
X4 0V 3	X4 0V 15	X4 0V 4	X4 0V 16	X4 0V 8	X4 0V 12	X4 0V 7	X4 0V 11	X4 0V 20	X4 0V 19	X4 0V 23	X4 0V 24

OV X4 9.13 — 200 — OV X4 11.1

Fly Hoist Brake Solenoid Valve
Slew Brake Solenoid Valve
Main Hoist Brake Solenoid Valve
Luff Brake Solenoid Valve
Hoist Pump 1 (Up) Prop. Valve
Hoist Pump 1 (Down) Prop. Valve
Hoist Pump 2 (Up) Prop. Valve
Hoist Pump 2 (Down) Prop. Valve
Luff Pump (Out) Prop. Valve
Slew Pump (Left) Prop. Valve
Slew Pump (Right) Prop. Valve
Luff Pump (In) Prop. Valve

ESX_BBA_DIG_OUT

1/2	1/4	1/6	1/1	1/3	1/5
20	21	22	42	43	44
1013	1014	1015	1016	1017	1018
K62 A1	K81 A1	SV42/2	K90 85	K80 A1	SV42/1
A2	A2	Z44 36	86	A2	Z44 8
X4 0V 13	X4 0V 17	1015 X418 1	X4 1016 4 1	X4 0V 21	1018 X417 1
		X418 2	X4 D 3 2		X417 2
		Z44 50			Z44 22
		X4 0V 31	X4 0V 25		X4 0V 27

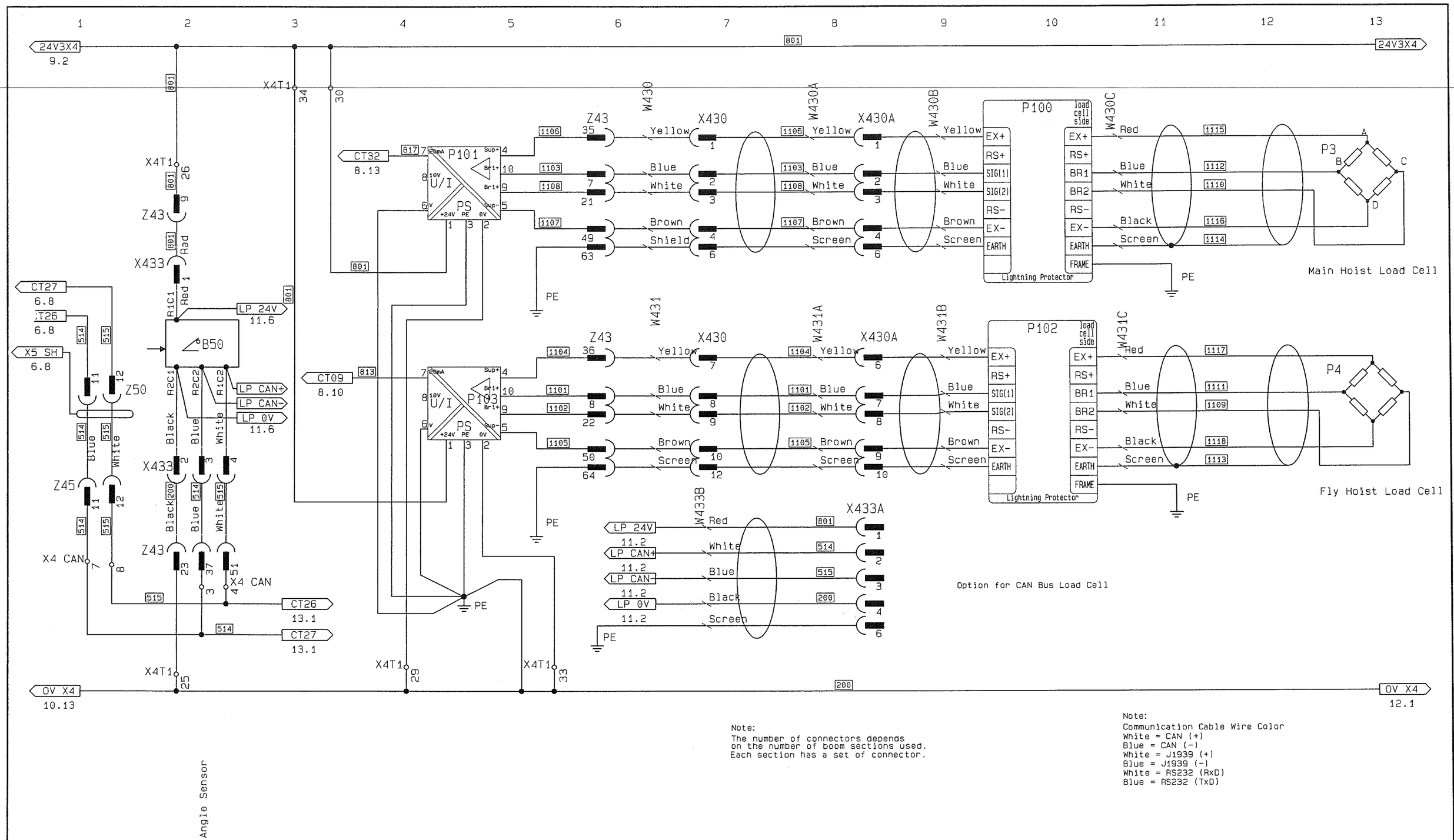
Ultimate Limit Relay
Eng. Throttle Down Relay 7/10 7/10
Main Sel. Changeover Solenoid Valve
LMI Horn/Horn Relay 7/5
Eng. Throttle Up Relay 7/11
Fly Sel. Changeover Solenoid Valve

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1 2 3 4 5 6 7 8 9 10 11 12 13

24V1X4 10.13 — 300 — 24V1X4 13.1

24V2X4 9.13 — 609 — 24V2X4 13.1

DIOS-C_PWM_OUT: 5 6 7 8

DIOS-C_DIG_IN: 13 14 15 16

X4T2 609 61 14 — Z44 — 509 — X437 1 — PS40 NC — P — C — X437 2 — 1201 — Z44 62

X4T2 609 64 18 — Z44 — 609 — X435 3 — X435 2 — 4 — F.SLEW 12.11

1202 — Z50 14 — Z44 63 — DI3 8.2 — 714 — 1202

Z45 14 — 1204

1205 — Z44 65 — 1205 — 1 — X419 — SV86 + − — X419 2 — 200 — Z44 66 — X4 0V 28

1206 — Z44 69 — 1206 — 1 — X420 — SV87 + − — X420 2 — 200 — Z44 70 — X4 0V 36

1207 — Z44 67 — 1207 — 1 — X421 — SV88 + − — X421 2 — 200 — Z44 68 — X4 0V 32

1208 — Z45 13 — Z50 13

TYPH 1 5.7 — 519 — Z50 10 — 519 — X463 1 — X463 2 — 518 — Z45 10 — K91 A1 — A2 — X4 0V 47

TYPH 2 5.7 — 520 — Z50 2 — Z45 2 — 520

520 — K91 (8) 11 12 — X4 D 9 12 — Z43 5 — 1209 — X435 6 — F.SLEW 12.3

X435 5 — Z43 19 — X4 D 10 11 — X4 0V 40

TYPH 4.13 — 411 — K91 (8) 21 24 — 1210 — Z45 3 — 1210 — Z50 3 — X5 3 — X502 1

X502 2 — X5 0V — 0V X5 6.7

200 — 13 12

OV X4 11.13 — OV X4 13.1

Brake Flush Pressure Switch

Buffer Locked Proximity Switch

Fuel Level Switch

Main Hoist Motor Prop. Valve

Fly Hoist Motor Prop. Valve

Luff Motor Prop. Valve

Typhoon Mode Select Relay

Buffer Lock SV (Locked when De-energised)

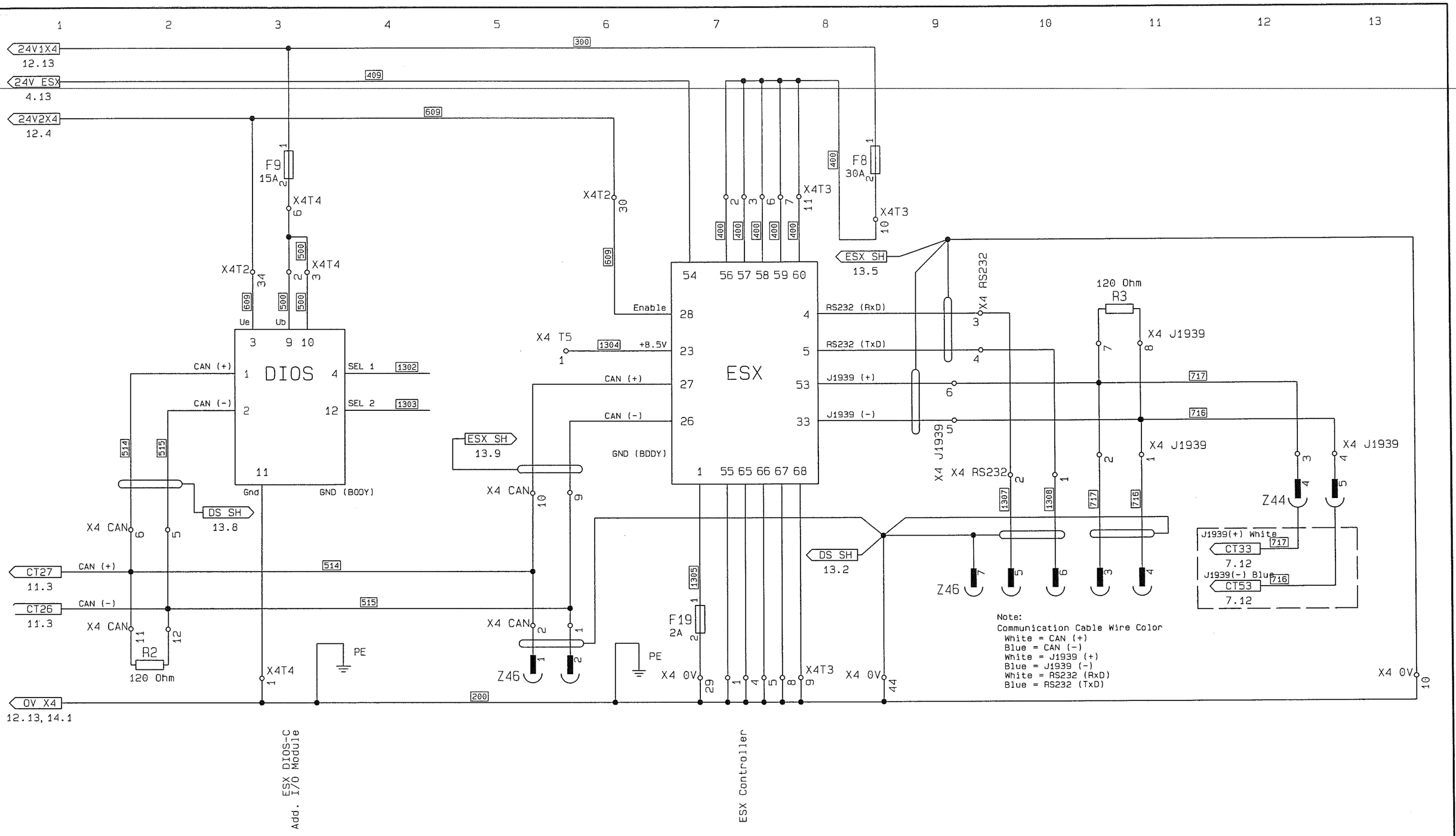
Slew Drive Disengaged Indicator Light

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1 2 3 4 5 6 7 8 9 10 11 12 13

ACS + 412
4.13

Z44 20
412
X450 1

ACS P1
9.5
X450 3

ACS P2
9.11
X450 6

X450 8
911
ACS L2
9.12

X450 2
906
ACS L1
9.7

X450 7
905
ACS S1
9.5

X450 4
910
ACS S2
9.11

Z44 21
0V X4
13.1

Anti-Collision Control Box

Z45 8
1401
Z50 8

Z45 15
1402
Z50 15

Spare Wires To Cabin

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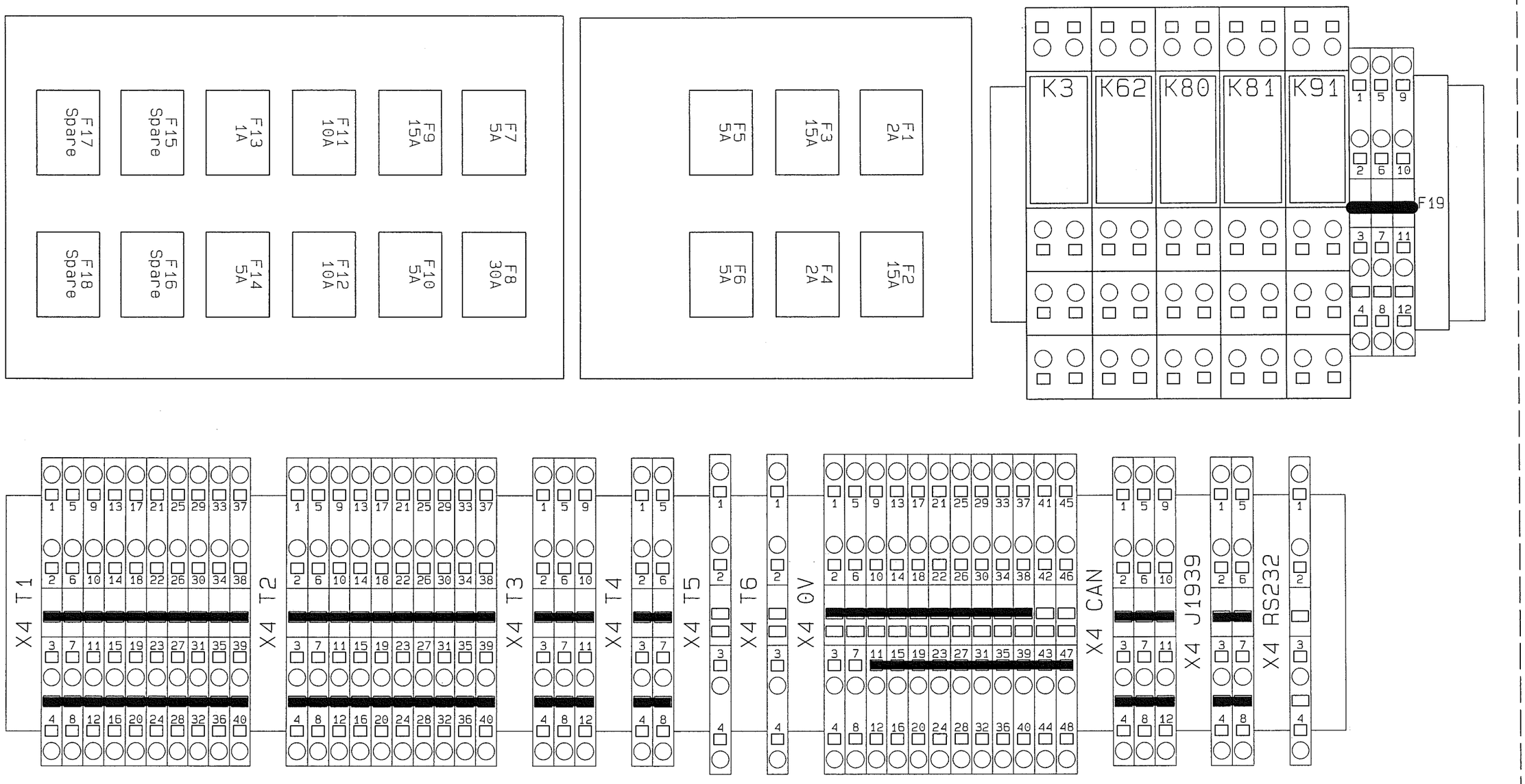
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1 2 3 4 5 6 7 8 9 10 11 12 13

X4 TERMINAL BLOCK ARRANGEMENT



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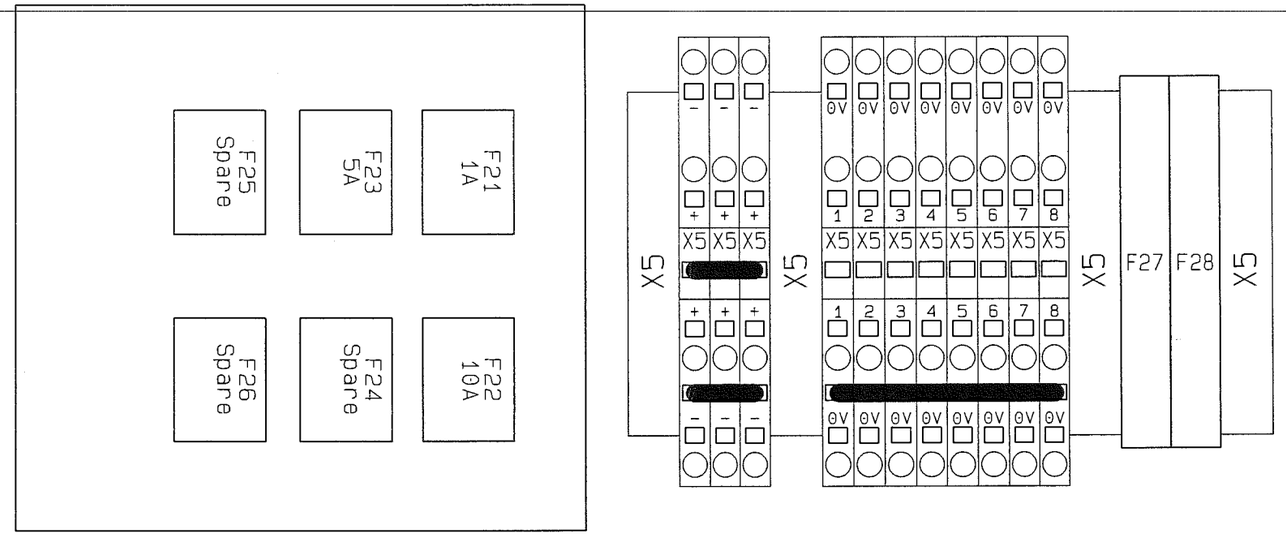
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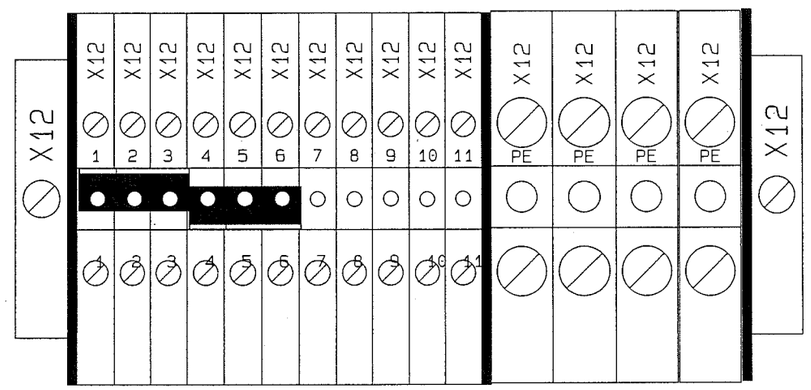
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Page Title: Terminal Blocks Arrangement				Scale factor: 1:1	
Serial No.: 1475	Model: M440E	Drawing Number: A3-6100.466		Sheet: 15 /49	Current Rev.: A

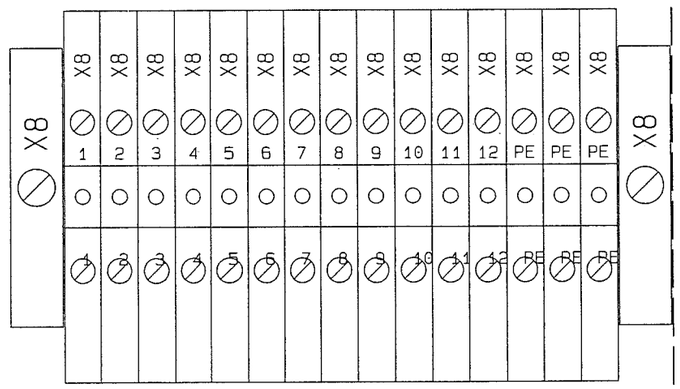
X5 TERMINAL BLOCK ARRANGEMENT



X12 TERMINAL BLOCK ARRANGEMENT



X8 TERMINAL BLOCK ARRANGEMENT



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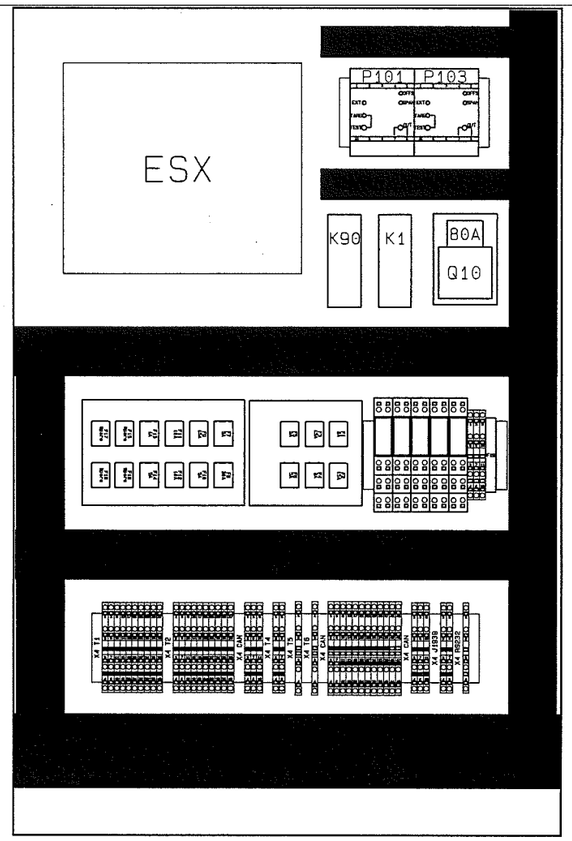
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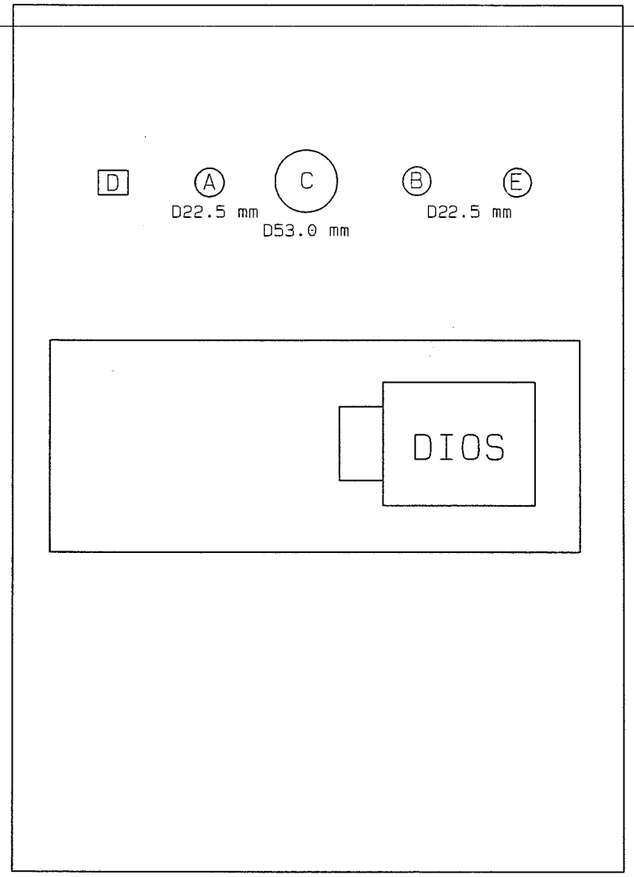
Page Title	Scale factor
Terminal Blocks Arrangement	1:1

Serial No.	Model	Drawing Number	Sheet	Current Rev.
1475	M440E	A3-6100.466	16 /49	A

1 2 3 4 5 6 7 8 9 10 11 12 13

X3 CONTROL PANEL
RITTAL AE1057.500 (H700 x W500 x D250 mm)
IP66
Mounting Plate: H670 W449



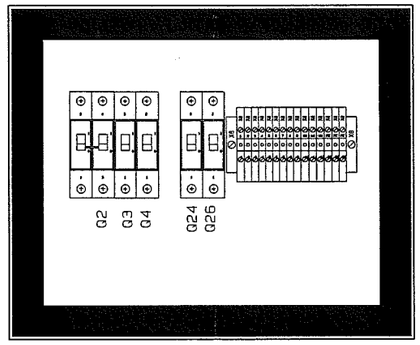


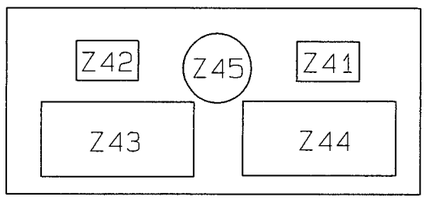
Panel Door
Inside View

NOTE:
A = Emergency Stop Button (S4)
B = Machine House Light Switch (S11)
C = Hour Meter (P8)
D = Diagnostic Plug (Z46)
E = Spare

X8 DISTRIBUTION BOARD
RITTAL AE1030.500 (H300 x W380 x D155 mm)
IP66
Mounting Plate: H275 W334

Located in Cabin





Gland Plate
(Outside View)
Size (W340 X H150)

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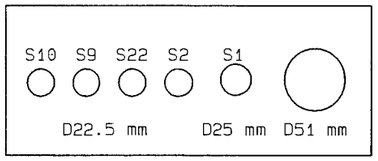
Muhibbah Engineering (M) Bhd

Page Title	Scale factor
X4 Panel Layout	1:5

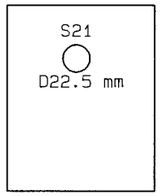
Serial No.	Model	Drawing Number	Sheet	Current Rev.
1475	M440E	A3-6100.466	17 /49	A

1 2 3 4 5 6 7 8 9 10 11 12 13

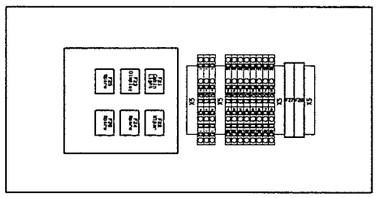
X5 Console Panel Box
Located in Cabin



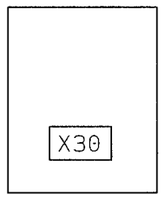
Panel Wall (Top)
Outside View



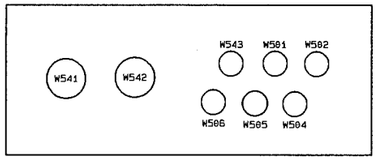
Panel Wall (Left)
Outside View



Front View
(Inside)



Panel Wall (Right)
Outside View

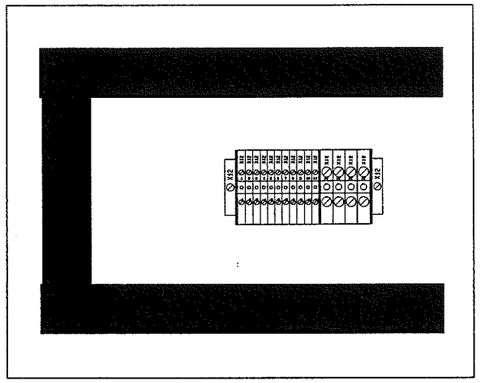


Panel Wall (Bottom)
Outside View

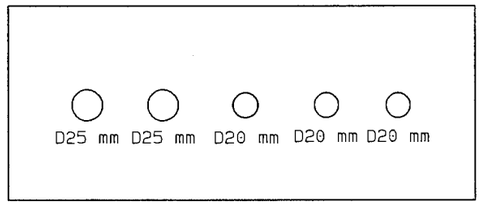
NOTE:

P12 = Fuel Level Gauge
S1 = Ignition/Start Key Switch
S2 = Emergency Stop Mushroom push button
S9 = Windscreen Wiper Switch
S10 = Cabin Light Switch
S21 = Limit Bypass Switch
S22 = Economy Switch

X12 Heaters Junction Box
Located in Powerpack

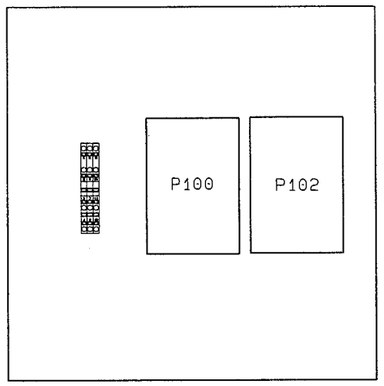


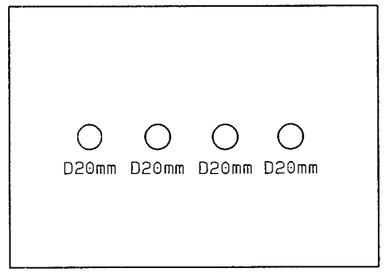
Front View
(Inside)



Bottom View

X14 Load Pin Junction Box
Located at Boom Tip





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FAVELLE FAVCO

Favelle Favco Cranes Pty. Ltd. (A.B.N. 29 067 562 449)
28 Yarrunga Street, Prestons, N.S.W. 2170
P.O. Box 456, Liverpolol BC, N.S.W. 1871 Australia
(A subsidiary of Muhibbah Engineering (M) Bhd)

Muhibbah Engineering (M) Bhd

Page Title: Junction Boxes Layouts
Scale factor: 1:5
Serial No.: 1475
Model: M440E
Drawing Number: A3-6100.466
Sheet: 18 /49
Current Rev.: A

EM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
0	M30 4 Wire PNP NO/NC Inductive Proximity					1
5	Shaft Encoder 64 Puls/Rev 10mm shaft					1
	Shaft Coupling					1
7	Shaft Encoder 64 Puls/Rev 10mm shaft					1
	Shaft Coupling					1
0	CANBus Inclinometer					1
OS	Additional I/Os CANBus Module (4 PWM, 4 DI)					1
	Plug for DIOS - 16 pins					1
S2	Plug for Hydraulic Filter Bypass					1
S3A	Plug for Hydraulic Filter Bypass					1
S3B	Plug for Hydraulic Filter Bypass					1
S4	Plug for Hydraulic Filter Bypass					1
S6	Plug for Hydraulic Filter Bypass					1
	Fluorescent Light 24VDC					1
	Aviation Light Red Solar powered					1
0	Fluorescent Light 24VDC					1
1						1
2						1
3						1
5	Engine Coolant Heater			Part of Engine		1
X	Plug for ESX - 68 pins					1
	ESX with BBA & BBC (6 DO, 3 Enc)					1
	ATC Fuse 2Amp					1
	ATC Fuse 15 Amp					1
	ATC Fuse 15 Amp					1
	ATC Fuse 2Amp					1
	ATC Fuse 5Amp					1
	ATC Fuse 5Amp					1
	ATC Fuse 5Amp					1
	ATC Fuse 30Amp					1

						Title: Electrical Equipment Schedule	
WM	AS	MM	Original Issue	14/08/07	A		
Approved	Checked	Drawn	Description	Date	Rev.	Serial No. 1475 / Model M440E / Drawing Number A3-6100.466	Sheet 19 /49 / Rev. A

EM	DESCRIPTION	MODEL	MANUFACTURER	NOTES	QTY.
	ATC Fuse 15 Amp				1
0	ATC Fuse 5Amp				1
	ATC Fuse 10Amp				1
2	ATC Fuse 10Amp				1
3	ATC Fuse 1Amp				1
4	ATC Fuse 5Amp				1
0	2 Amp Fast Blow Fuse				1
	Fuse terminal				1
	2 Amp Fast Blow Fuse				1
2	ATC Fuse 15 Amp				1
3	ATC Fuse 5Amp				1
4	ATC Fuse 5Amp				1
7	2 Amp Fast Blow Fuse				1
	Fuse terminal				1
8	2 Amp Fast Blow Fuse				1
	Fuse terminal				1
	6 Volt Battery				4
	Alternator				1
	Dual Trumpet Air Horn 24VDC 10A				1
	Opus Display LPW-OPUS1214CAN42(A93)				1
	Automotive Power Relay (24V, 70A)				1
	Engine Start Relay				1
	2CO, DIN Rail Relay				1
2	1CO, DIN Rail Relay				1
0	1CO, DIN Rail Relay				1
1	1CO, DIN Rail Relay				1
0	Automotive Power Relay (24V, 70A)				1
1	2CO, DIN Rail Relay				1
S1	Level Switch (Hydraulic)				1
S4	Level Switch				1

						Title			
						Electrical Equipment Schedule			
KWM	AS	MM	Original Issue	14/08/07	A	Serial No.	Model	Drawing Number	Sheet / Rev.
Approved	Checked	Drawn	Description	Date	Rev.	1475	M440E	A3-6100.466	20 /49 A

EM	DESCRIPTION	MODEL	MANUFACTURER	NOTES	QTY.
57	Engine Coolant Level Sensor			Part of Engine	1
	Limit switch				1
2	Limit switch				1
5	Limit Switch Snap action positive break				1
	Starter Motor			Part of Engine	1
	30 Amp 6 Ring Slip ring				1
	Load Pin				1
	Load Pin				1
	Hours Run Meter				1
2	Sender 10-180 Ohm for fuel Gauge				1
	Fuel Tank Level Gauge				1
1	Plug 40 contacts				1
	Boot for DRC plug 40 contacts				1
00	4 or 6 Wires Protection Loadcell Induced Transients				1
01	Strain Gauge Signal Conditioner			4 Wire, Output 4-20mA	1
02	4 or 6 Wires Protection Loadcell Induced Transients				1
03	Strain Gauge Signal Conditioner			4 Wire, Output 4-20mA	1
1	4-20mA Pressure Transducer				1
	M12 Connector for A08-HT (4m)			Accessory for A08-HT	1
2	4-20mA Pressure Transducer				1
	M12 Connector for A08-HT (4m)			Accessory for A08-HT	1
5	4-20mA Pressure Transducer				1
	M12 Connector for A08-HT (4m)			Accessory for A08-HT	1
6	4-20mA Pressure Transducer				1
	M12 Connector for A08-HT (4m)			Accessory for A08-HT	1
	RCCB 2 Pole 32A Short 30mA Earth Trip				1
	Circuit Breaker 1 Pole 20 Amps C-Curve 6kA			5 - 10 In C - Curve	1
	Circuit Breaker 1 Pole 16 Amps C-Curve 6kA			5 - 10 In C - Curve	1
9	Circuit Breaker 1 Pole 63 Amps C-Curve 6kA			5 - 10 In C - Curve	1
0	Maxi Single Fuse Holder (80Amps)				1

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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
	Maxi Fuse 80 Amps					1
	Battery Disconnect Switch, Single contact					1
4	Circuit Breaker 1 Pole 16 Amps C-Curve 6kA			5 - 10 In C - Curve		1
5	Circuit Breaker 1 Pole 10 Amps C-Curve 6kA			5 - 10 In C - Curve		1
	Resistor 120 Ohm					1
	Resistor 120 Ohm					1
	Ignition/Start Key Switch			Part of Engine		1
	Mushroom pushbutton + 1 NC contact					1
	NC Contact					1
	NC Contact					1
	Emergency Stop 2NC					1
	Mounting Base					1
	Selector switch 2 position stay put + 1 NO					1
	Selector switch 2 position stay put + 1 NO					1
	Selector switch 2 position stay put + 1 NO					1
	Key Switch 2 Position spring return + 1 NO					1
2	Selector switch 2 position stay put + 1 NO					1
1	Hydraulic oil temperature switch					1
3	Auxilary Temperature Sensor			Part of Engine		1
01	4C+E 6mm Olflex-classic-400P					1
02	4C+E 6mm Olflex-classic-400P					1
02A	4C+E 6mm Olflex-classic-400P					1
401	3 Core cable harness, Coloured 1.5mm2	3 COLR CORE HAR				1
402	3 Core cable harness, Coloured 1.5mm2	3 COLR CORE HAR				1
403	3 Core cable harness, Coloured 1.5mm2	3 COLR CORE HAR				1
404	3 Core cable harness, Coloured 1.5mm2	3 COLR CORE HAR				1
405	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR				1
406	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR				1
407	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR				1
408	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR				1

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Serial No.	Model	Drawing Number	Sheet	Rev.
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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES	QTY.
W409	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W410	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W411	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W412	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W413	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W414	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W415	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W416	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W417	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W418	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W419	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W420	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W421	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W422	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W423	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W424	3 Core cable harness, Coloured 1.5mm2	3 COLR CORE HAR			1
W425	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W425A	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W426	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W427	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W427A	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W428	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W428A	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W430	15 & 18 AWG 2 twisted pair cable, TC braid shield	3082A	BELDEN Cable	Insulation: PVC (power) FPE (data)	1
W430A	15 & 18 AWG 2 twisted pair cable, TC braid shield	3082A	BELDEN Cable	Insulation: PVC (power) FPE (data)	1
W430B	15 & 18 AWG 2 twisted pair cable, TC braid shield	3082A	BELDEN Cable	Insulation: PVC (power) FPE (data)	1
W430C	15 & 18 AWG 2 twisted pair cable, TC braid shield	3082A	BELDEN Cable	Insulation: PVC (power) FPE (data)	1
W431	15 & 18 AWG 2 twisted pair cable, TC braid shield	3082A	BELDEN Cable	Insulation: PVC (power) FPE (data)	1
W431A	15 & 18 AWG 2 twisted pair cable, TC braid shield	3082A	BELDEN Cable	Insulation: PVC (power) FPE (data)	1
W431B	15 & 18 AWG 2 twisted pair cable, TC braid shield	3082A	BELDEN Cable	Insulation: PVC (power) FPE (data)	1

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Serial No.	Model	Drawing Number	Sheet	Rev.
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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES	QTY.
W431C	15 & 18 AWG 2 twisted pair cable, TC braid shield	3082A	BELDEN Cable	Insulation: PVC (power) FPE (data)	1
W433	15 & 18 AWG 2 twisted pair cable, TC braid shield	3082A	BELDEN Cable	Insulation: PVC (power) FPE (data)	1
W433A	15 & 18 AWG 2 twisted pair cable, TC braid shield	3082A	BELDEN Cable	Insulation: PVC (power) FPE (data)	1
W433B	15 & 18 AWG 2 twisted pair cable, TC braid shield	3082A	BELDEN Cable	Insulation: PVC (power) FPE (data)	1
W434	4 Core cable harness, Coloured 1.5mm2	4 COLR CORE HAR			1
W437	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W437A	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W438	4 Core cable harness, Coloured 1.5mm2	4 COLR CORE HAR			1
W439	4 Core cable harness, Coloured 1.5mm2	4 COLR CORE HAR			1
W440	4 Core cable harness, Coloured 1.5mm2	4 COLR CORE HAR			1
W441	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W441A	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W442	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W442A	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W443	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W444	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W445	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W445A	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W446	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W446A	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W451	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W451A	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W452	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W452A	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W452B	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W452C	1 Core cable, Coloured 1.5mm2	1 COLR CORE 1.5mm			1
W456	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W456A	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR			1
W457	24 AWG 1 twisted pair cable, TC braid shield	9841	BELDEN Cable		1
W458	12 Core cable harness, numbered 1.5mm2	12 NUM CORE HAR			1

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Electrical Equipment Schedule

Serial No.	Model	Drawing Number	Sheet	Rev.
1475	M440E	A3-6100.466	24 /49	A

ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
W459	1 Core cable, Coloured 1.5mm2	1 COLR CORE 1.5mm				1
W460	1 Core cable, Coloured 1.5mm2	1 COLR CORE 1.5mm				1
W461	1 Core cable, Coloured 6mm2	1 COLR CORE 6mm				1
W462	1 Core cable, Coloured 6mm2	1 COLR CORE 6mm				1
W463	1 Core cable, Coloured 1.5mm2	1 COLR CORE 1.5mm				1
W464	18 Core cable harness, numbered 1.5mm2	18 NUM CORE HAR				1
W465	24 AWG 1 twisted pair cable, TC braid shield	9841	BELDEN Cable			1
W503	24 AWG 1 twisted pair cable, TC braid shield	9841	BELDEN Cable			1
W503A	24 AWG 1 twisted pair cable, TC braid shield	9841	BELDEN Cable			1
W504	5 Core cable harness, numbered 1.5mm2	5 NUM CORE HAR				1
W504A	5 Core cable harness, numbered 1.5mm2	5 NUM CORE HAR				1
W505	24 AWG 1 twisted pair cable, TC braid shield	9841	BELDEN Cable			1
W505A	24 AWG 1 twisted pair cable, TC braid shield	9841	BELDEN Cable			1
W506	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR				1
W506A	6 Core cable harness, numbered 1.5mm2	6 NUM CORE HAR				1
W507	24 AWG 1 twisted pair cable, TC braid shield	9841	BELDEN Cable			1
W507A	24 AWG 1 twisted pair cable, TC braid shield	9841	BELDEN Cable			1
W508	2 Core cable harness, Coloured 1.5mm2	2 COLR CORE HAR				1
W508A	6 Core cable harness, numbered 1.5mm2	6 NUM CORE HAR				1
W509	2C+E 2.5mm Olflex-Classic-110	1119403T	Lapp			1
W509A	2C+E 2.5mm Olflex-Classic-110	1119403T	Lapp			1
W510	2C+E 2.5mm Olflex-Classic-110	1119403T	Lapp			1
W510A	2C+E 2.5mm Olflex-Classic-110	1119403T	Lapp			1
W511	1 Core cable, Coloured 1.5mm2	1 COLR CORE 1.5mm				1
W611	3 Core cable harness, Coloured 1.5mm2	3 COLR CORE HAR				1
W611A	3 Core cable harness, Coloured 1.5mm2	3 COLR CORE HAR				1
W612	3 Core cable harness, Coloured 1.5mm2	3 COLR CORE HAR				1
W612A	3 Core cable harness, Coloured 1.5mm2	3 COLR CORE HAR				1
W801	2C+E 2.5mm Olflex-Classic-110	1119403T	Lapp			1
W802	2C+E 2.5mm Olflex-Classic-110	1119403T	Lapp			1

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Electrical Equipment Schedule

Serial No.	Model	Drawing Number	Sheet	Rev.
1475	M440E	A3-6100.466	25 /49	A

ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
1001	1 Core cable, Black 70mm2	1 COLR CORE 70mm				1
1002	1 Core cable, Black 70mm2	1 COLR CORE 70mm				1
1002A	1 Core cable, Black 70mm2	1 COLR CORE 70mm				1
1003	1 Core cable, Coloured 6mm2	1 COLR CORE 6mm				1
1004	1 Core cable, Coloured 1.5mm2	1 COLR CORE 1.5mm				1
1005	1 Core cable, Coloured 6mm2	1 COLR CORE 6mm				1
1006	1 Core cable, Coloured 6mm2	1 COLR CORE 6mm				1
1007	1 Core cable, Coloured 6mm2	1 COLR CORE 6mm				1
1008	1 Core cable, Coloured 6mm2	1 COLR CORE 6mm				1
1201	2C+E 2.5mm Olflex-Classic-110	1119403T	Lapp			1
1202	2C+E 2.5mm Olflex-Classic-110	1119403T	Lapp			1
1203	2C+E 2.5mm Olflex-Classic-110	1119403T	Lapp			1
1204	2C+E 2.5mm Olflex-Classic-110	1119403T	Lapp			1
8121	4C+E 4mm Olflex-Classic-400P	1312505T	Lapp			1
4	6 Circuit ATC/ATO Fuse Block	5028	Blue Sea Systems			1
	12 Circuit ATC/ATO Fuse Block	5029	Blue Sea Systems			1
	Compact Enclosure Sheet Steel W500*H700*D250	AE1057.500	Rittal	IP66		1
	End Backet Marker	EM8/30 1806120000	Weidmuller			16
	End Stopper with Group Marking	ZEW 35/2	Weidmuller			16
	2.5mm 2 pin Cross-connector	ZQV2.5/2 1608860000	Weidmuller			4
	2.5mm 3 pin Cross-connector	ZQV2.5/3 1608870000	Weidmuller			5
	2.5mm 10 pin Cross-connector	ZQV2.5/10 1608940000	Weidmuller			4
	4mm 10 pin Cross-connector	ZQV4/10 GE 1609030000	Weidmuller			2
4 0V	4mm 4 Common Feed Through Terminal Block	ZDU 1806980000	Weidmuller			12
4 CAN	2.5mm 2 Feed Through Terminal Block	ZDK 1790990000	Weidmuller			3
4 D	Diode Terminal	ZDK2.5/D/1 1690020000	Weidmuller			4
	Diode Terminal	ZDK2.5/D/1 1690020000	Weidmuller			3
4 J1939	2.5mm 2 Feed Through Terminal Block	ZDK 1790990000	Weidmuller			2
4 RS232	2.5mm 2 Feed Through Terminal Block	ZDK 1790990000	Weidmuller			1
4T1	2.5mm 2 Feed Through Terminal Block	ZDK 1790990000	Weidmuller			10

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Serial No.	Model	Drawing Number	Sheet	Rev.
1475	M440E	A3-6100.466	26 /49	A

ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
4T2	2.5mm 2 Feed Through Terminal Block	ZDK 1790990000	Weidmuller			10
4T3	2.5mm 2 Feed Through Terminal Block	ZDK 1790990000	Weidmuller			3
4T4	2.5mm 2 Feed Through Terminal Block	ZDK 1790990000	Weidmuller			2
4T5	4mm 4 Common Feed Through Terminal Block	ZDU 1806980000	Weidmuller			1
4T6	4mm 4 Common Feed Through Terminal Block	ZDU 1806980000	Weidmuller			1
5	6 Circuit ATC/ATO Fuse Block	5028	Blue Sea Systems			1
	Compact Enclosure Sheet Steel W380*H300*D155	AE1030.500	Rittal			1
	End Backet Marker	EM8/30 1806120000	Weidmuller			4
	2.5mm 2 Feed Through Terminal Block	ZDK 1790990000	Weidmuller			11
	End Stopper with Group Marking	ZEW 35/2	Weidmuller			4
8	Compact Enclosure Sheet Steel W380*H300*D155	AE1030.500	Rittal			1
	End Stopper	EW35	Weidmuller	For TS35 DIN rail		2
	4mm Terminal Spring Loaded Standard	WDU4 SL/EN 9537450000	Weidmuller			12
	4mm Earth Terminal Standard Design	WPE4 1010100000	Weidmuller			3
01		WIP532B+WIP532RB				1
02		WIP532B+WIP532RB				1
12	End Stopper	EW35	Weidmuller	For TS35 DIN rail		2
	Terminal box Sheet Steel W300 H150 D120	KL1503.210	Rittal			1
	End plate 2.5-10 1.5mm Width	WAP2.5-10 1050000000	Weidmuller			3
	4mm Terminal Spring Loaded Standard	WDU4 SL/EN 9537450000	Weidmuller			21
	10mm Earth Terminal Standard Design	WPE10 1010300000	Weidmuller			4
44X	Receptacle 12 pin	DT04-12P	Deutsch Connectors			1
	Backshell for DT Receptacle 12 way straight	DT12PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 12 way straight	DT12SBS-ST	Deutsch Connectors			1
	Plug 12 Connectors	DT-06-12S	Deutsch Connectors			1
	Receptacle Wedge Lock 12 pin	W12P	Deutsch Connectors			1
	Plug Wedge Lock 12 pin	W12S	Deutsch Connectors			1
45X	Backshell for DT Receptacle 8 way straight	DT8PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 8 way straight	DT8SBS-ST	Deutsch Connectors			1
	Receptacle 8 pin	DT04-8P	Deutsch Connectors			1

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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
45X	Plug 8 Connectors	DT-06-8S	Deutsch Connectors			1
	Receptacle Wedge Lock 8 pin	W8P	Deutsch Connectors			1
	Plug Wedge Lock 8 pin	W8S	Deutsch Connectors			1
401	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			10
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			10
	Plug 3 Connectors	DT-06-3S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			10
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
402	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			10
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			10
	Plug 3 Connectors	DT-06-3S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			10
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
403	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			10
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			10
	Plug 3 Connectors	DT-06-3S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			10

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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
X403	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
X404	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			10
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			10
	Plug 3 Connectors	DT-06-3S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			10
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
X405	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
X406	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
X407	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
X408	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1

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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
408	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
409	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
410	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
411	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
412	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
413	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
414	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1

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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
414	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
415	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
416	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
417	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
418	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
419	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			2
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
420	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			2
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
421	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2

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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
421	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			2
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
422	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
423	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			2
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			2
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
424	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			10
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			10
	Plug 3 Connectors	DT-06-3S	Deutsch Connectors			3
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			10
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
425	Backshell for DT Receptacle 2 way straight	DT2PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Receptacle 2 pin	DT04-2P	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			1
	Receptacle Wedge Lock 2 pin	W2P	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
426	Backshell for DT Receptacle 2 way straight	DT2PBS-ST	Deutsch Connectors			1
	Receptacle 2 pin	DT04-2P	Deutsch Connectors			1

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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
426	Receptacle Wedge Lock 2 pin	W2P	Deutsch Connectors			1
427	Backshell for DT Receptacle 2 way straight	DT2PBS-ST	Deutsch Connectors			1
	Receptacle 2 pin	DT04-2P	Deutsch Connectors			1
	Receptacle Wedge Lock 2 pin	W2P	Deutsch Connectors			1
428	Backshell for DT Receptacle 2 way straight	DT2PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Receptacle 2 pin	DT04-2P	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			1
	Receptacle Wedge Lock 2 pin	W2P	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
430	Receptacle 12 pin	DT04-12P	Deutsch Connectors			1
	Backshell for DT Receptacle 12 way straight	DT12PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 12 way straight	DT12SBS-ST	Deutsch Connectors			1
	Plug 12 Connectors	DT-06-12S	Deutsch Connectors			1
	Receptacle Wedge Lock 12 pin	W12P	Deutsch Connectors			1
	Plug Wedge Lock 12 pin	W12S	Deutsch Connectors			1
430A	Receptacle 12 pin	DT04-12P	Deutsch Connectors			1
	Backshell for DT Receptacle 12 way straight	DT12PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 12 way straight	DT12SBS-ST	Deutsch Connectors			1
	Plug 12 Connectors	DT-06-12S	Deutsch Connectors			1
	Receptacle Wedge Lock 12 pin	W12P	Deutsch Connectors			1
	Plug Wedge Lock 12 pin	W12S	Deutsch Connectors			1
433	Backshell for DT Receptacle 6 way straight	DT6PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 6 way straight	DT6SBS-ST	Deutsch Connectors			1
	Receptacle 6 pin	DT04-6P	Deutsch Connectors			1
	Plug 6 Connectors	DT-06-6S	Deutsch Connectors			1
	Receptacle Wedge Lock 6 pin	W6P	Deutsch Connectors			1
	Plug Wedge Lock 6 pin	W6S	Deutsch Connectors			1
433A	Backshell for DT Receptacle 6 way straight	DT6PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 6 way straight	DT6SBS-ST	Deutsch Connectors			1

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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
433A	Receptacle 6 pin	DT04-6P	Deutsch Connectors			1
	Plug 6 Connectors	DT-06-6S	Deutsch Connectors			1
	Receptacle Wedge Lock 6 pin	W6P	Deutsch Connectors			1
	Plug Wedge Lock 6 pin	W6S	Deutsch Connectors			1
434	Backshell for DT Receptacle 6 way straight	DT6PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 6 way straight	DT6SBS-ST	Deutsch Connectors			1
	Receptacle 6 pin	DT04-6P	Deutsch Connectors			1
	Plug 6 Connectors	DT-06-6S	Deutsch Connectors			1
	Receptacle Wedge Lock 6 pin	W6P	Deutsch Connectors			1
	Plug Wedge Lock 6 pin	W6S	Deutsch Connectors			1
435	Backshell for DT Receptacle 6 way straight	DT6PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 6 way straight	DT6SBS-ST	Deutsch Connectors			1
	Receptacle 6 pin	DT04-6P	Deutsch Connectors			1
	Plug 6 Connectors	DT-06-6S	Deutsch Connectors			1
	Receptacle Wedge Lock 6 pin	W6P	Deutsch Connectors			1
	Plug Wedge Lock 6 pin	W6S	Deutsch Connectors			1
437	Backshell for DT Receptacle 2 way straight	DT2PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Receptacle 2 pin	DT04-2P	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			1
	Receptacle Wedge Lock 2 pin	W2P	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
438	Backshell for DT Receptacle 6 way straight	DT6PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 6 way straight	DT6SBS-ST	Deutsch Connectors			1
	Receptacle 6 pin	DT04-6P	Deutsch Connectors			1
	Plug 6 Connectors	DT-06-6S	Deutsch Connectors			1
	Receptacle Wedge Lock 6 pin	W6P	Deutsch Connectors			1
	Plug Wedge Lock 6 pin	W6S	Deutsch Connectors			1
439	Backshell for DT Receptacle 6 way straight	DT6PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 6 way straight	DT6SBS-ST	Deutsch Connectors			1

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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
439	Receptacle 6 pin	DT04-6P	Deutsch Connectors			1
	Plug 6 Connectors	DT-06-6S	Deutsch Connectors			1
	Receptacle Wedge Lock 6 pin	W6P	Deutsch Connectors			1
	Plug Wedge Lock 6 pin	W6S	Deutsch Connectors			1
440	Backshell for DT Receptacle 6 way straight	DT6PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 6 way straight	DT6SBS-ST	Deutsch Connectors			1
	Receptacle 6 pin	DT04-6P	Deutsch Connectors			1
	Plug 6 Connectors	DT-06-6S	Deutsch Connectors			1
	Receptacle Wedge Lock 6 pin	W6P	Deutsch Connectors			1
	Plug Wedge Lock 6 pin	W6S	Deutsch Connectors			1
450	Backshell for DT Receptacle 8 way straight	DT8PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 8 way straight	DT8SBS-ST	Deutsch Connectors			1
	Receptacle 8 pin	DT04-8P	Deutsch Connectors			1
	Plug 8 Connectors	DT-06-8S	Deutsch Connectors			1
	Receptacle Wedge Lock 8 pin	W8P	Deutsch Connectors			1
	Plug Wedge Lock 8 pin	W8S	Deutsch Connectors			1
451	Backshell for DT Receptacle 2 way straight	DT2PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Receptacle 2 pin	DT04-2P	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			1
	Receptacle Wedge Lock 2 pin	W2P	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
452	Backshell for DT Receptacle 2 way straight	DT2PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Receptacle 2 pin	DT04-2P	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			1
	Receptacle Wedge Lock 2 pin	W2P	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
452A	Backshell for DT Receptacle 2 way straight	DT2PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1

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452A	Receptacle 2 pin	DT04-2P	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			1
	Receptacle Wedge Lock 2 pin	W2P	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
456	Backshell for DT Receptacle 2 way straight	DT2PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Receptacle 2 pin	DT04-2P	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			1
	Receptacle Wedge Lock 2 pin	W2P	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
463	Backshell for DT Receptacle 2 way straight	DT2PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Receptacle 2 pin	DT04-2P	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			1
	Receptacle Wedge Lock 2 pin	W2P	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
502	Backshell for DT Receptacle 2 way straight	DT2PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 2 way straight	DT2SBS-ST	Deutsch Connectors			1
	Receptacle 2 pin	DT04-2P	Deutsch Connectors			1
	Plug 2 Connectors	DT-06-2S	Deutsch Connectors			1
	Receptacle Wedge Lock 2 pin	W2P	Deutsch Connectors			1
	Plug Wedge Lock 2 pin	W2S	Deutsch Connectors			1
503	Backshell for DT Receptacle 8 way straight	DT8PBS-ST	Deutsch Connectors			1
	Receptacle 8 pin	DT04-8P	Deutsch Connectors			1
	Receptacle Wedge Lock 8 pin	W8P	Deutsch Connectors			1
505	Backshell for DT Receptacle 8 way straight	DT8PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 8 way straight	DT8SBS-ST	Deutsch Connectors			1
	Receptacle 8 pin	DT04-8P	Deutsch Connectors			1
	Plug 8 Connectors	DT-06-8S	Deutsch Connectors			1
	Receptacle Wedge Lock 8 pin	W8P	Deutsch Connectors			1

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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES		QTY.
505	Plug Wedge Lock 8 pin	W8S	Deutsch Connectors			1
505A	Backshell for DT Plug 8 way straight	DT8SBS-ST	Deutsch Connectors			1
	Plug 8 Connectors	DT-06-8S	Deutsch Connectors			1
	Plug Wedge Lock 8 pin	W8S	Deutsch Connectors			1
507	Backshell for DT Receptacle 8 way straight	DT8PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 8 way straight	DT8SBS-ST	Deutsch Connectors			1
	Receptacle 8 pin	DT04-8P	Deutsch Connectors			1
	Plug 8 Connectors	DT-06-8S	Deutsch Connectors			1
	Receptacle Wedge Lock 8 pin	W8P	Deutsch Connectors			1
	Plug Wedge Lock 8 pin	W8S	Deutsch Connectors			1
507A	Backshell for DT Plug 8 way straight	DT8SBS-ST	Deutsch Connectors			1
	Plug 8 Connectors	DT-06-8S	Deutsch Connectors			1
	Plug Wedge Lock 8 pin	W8S	Deutsch Connectors			1
509	Backshell for DT Receptacle 2 way straight	DT2PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 4 way straight	DT4SBS-ST	Deutsch Connectors			2
	Receptacle 2 pin	DT04-2P	Deutsch Connectors			1
	Plug 4 Connectors	DT-06-4S	Deutsch Connectors			2
	Receptacle Wedge Lock 2 pin	W2P	Deutsch Connectors			1
	Plug Wedge Lock 4 pin	W4S	Deutsch Connectors			2
611	Backshell for DT Receptacle 3 way straight	DT3PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Receptacle 3 pin	DT04-3P	Deutsch Connectors			1
	Plug 3 Connectors	DT-06-3S	Deutsch Connectors			1
	Receptacle Wedge Lock 3 pin	W3P	Deutsch Connectors			1
	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors			1
612	Backshell for DT Receptacle 3 way straight	DT3PBS-ST	Deutsch Connectors			1
	Backshell for DT Plug 3 way straight	DT3SBS-ST	Deutsch Connectors			1
	Receptacle 3 pin	DT04-3P	Deutsch Connectors			1
	Plug 3 Connectors	DT-06-3S	Deutsch Connectors			1
	Receptacle Wedge Lock 3 pin	W3P	Deutsch Connectors			1

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ITEM	DESCRIPTION	MODEL	MANUFACTURER	NOTES	QTY.
512	Plug Wedge Lock 3 pin	W3S	Deutsch Connectors		1
3121	Male 6P+E Screw Connector 24A HE - Size 3	1200000000	Weidmuller	Clamping range 0.5 - 2.5 sqmm	1
	Female 6P+E Screw Connector 24A HE - Size 3	1200200000	Weidmuller	Clamping range 0.5 - 2.5 sqmm	1
	Bulkhead Housing size3	1202500000	Weidmuller	With an integral cover	1
	Cable Gland Brass Nickel plated M25	1778350000	Weidmuller		1
	Housing Hood size3 1xM25 top cable entry	1788110000	Weidmuller	Top Cable entry	1
	Wiper Motor 3" stud 24Vdc 1-Speed Manual park	WWF241730	United Technologies		1
4	Air Conditioner Roughneck Marinised (115V 60HZ)	7433 (115V 60Hz)	Coleman		1
6	Twin 250V 15A Double Pole GPO	25D15	Clipsal		1
	Mounting Box 20mm End Entries	238	Clipsal	to mount 25D15 or 10DLS	1
41	Feed Through Stud (Red)	2204	Blue Sea Systems		1
42	Feed Through Stud (Black)	2203	Blue Sea Systems		1
43	Plug 70 contacts	DRC16-70SA	Deutsch Connectors		1
	Boot for DRC plug 70 contacts	DRC70S-BT	Deutsch Connectors		1
44	Sealing Plug	114017	Deutsch Connectors		50
	Plug 70 contacts	DRC16-70SA	Deutsch Connectors		1
	Boot for DRC plug 70 contacts	DRC70S-BT	Deutsch Connectors		1
45	Receptacle 18 pins, size 24 c/w accessories	HD44-24-18-PN	Deutsch Connectors		1
	Plug 18 sockets, size 24 c/w accessories	HD46-24-18-SN	Deutsch Connectors		1
	Cap for Plug protection, size 24	HDC34-24	Deutsch Connectors		1
	Cap for receptacle protection, size 24	HDC36-24	Deutsch Connectors		1
	Strain Relief size 24 straight	WHDS-24-1	Deutsch Connectors		1
46	Receptacle 8 Pin with Flange Mounting	DT04-08PA-L012	Deutsch Connectors		1
	Receptacle Wedge Lock 8 pin	W8P	Deutsch Connectors		1
50	Receptacle 18 pins, size 24 c/w accessories	HD44-24-18-PN	Deutsch Connectors		1
	Plug 18 sockets, size 24 c/w accessories	HD46-24-18-SN	Deutsch Connectors		1
	Cap for Plug protection, size 24	HDC34-24	Deutsch Connectors		1
	Cap for receptacle protection, size 24	HDC36-24	Deutsch Connectors		1
	Strain Relief size 24 straight	WHDS-24-1	Deutsch Connectors		1

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CABLE	CORE	TERMINAL	POINT A	WIRE	POINT B	TERMINAL		CABLE TYPE
W01	1	X01:1		302		N1:1		1312605T
W01	2	X01:2		304		N1:2		1312605T
W01	3	X01:3		306		N1:3		1312605T
W01	4	X01:4		308		N1:4		1312605T
W01	G/Y	X01:PE				N1:5		1312605T
W02	1	N1:1		301		X02:1		1312605T
W02	2	N1:2		303		X02:2		1312605T
W02	3	N1:3		305		X02:3		1312605T
W02	4	N1:4		307		X02:4		1312605T
W02	G/Y	N1:5				X02:PE		1312605T
W02A	3	X02:3		305	32A	Q2:2		1312605T
W02A	4	X02:4		307	32A	Q2:4		1312605T
W02A	G/Y	X02:PE				X8:PE		1312605T
W401	White	X401:C		200		DPS6:C	3	COLR CORE HAR
W401	Blue	X401:B				X401:B	3	COLR CORE HAR
W401	Brown	X401:A		608		X401:A	3	COLR CORE HAR
W402	Brown	X402:A		610		DPS4:1	3	COLR CORE HAR
W402	Blue	X402:B				DPS4:2	3	COLR CORE HAR
W402	White	X402:C		200		DPS4:C	3	COLR CORE HAR
W403	Blue	X403:B				DPS3B:2	3	COLR CORE HAR
W403	White	X403:C				DPS3B:C	3	COLR CORE HAR
W403	Brown					X403:A	3	COLR CORE HAR
W404	Brown	X404:A		612		DPS3A:1	3	COLR CORE HAR
W404	White	X404:C		200		DPS3A:C	3	COLR CORE HAR
W404	Blue	X404:B		611		X404:B	3	COLR CORE HAR
W405	Blue	Z44:55		1011		X405:1	2	COLR CORE HAR
W405	White	Z44:56		200		X405:2	2	COLR CORE HAR
W406	Blue	Z44:53		1010		X406:1	2	COLR CORE HAR
W406	White	Z44:54		200		X406:2	2	COLR CORE HAR
W407	Blue	Z44:41		1012		X407:1	2	COLR CORE HAR

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CABLE	CORE	TERMINAL	POINT A	WIRE	POINT B	TERMINAL	CABLE TYPE
W407	White	Z44:42		200		X407:2	2 COLR CORE HAR
W408	Blue	Z44:39		1009		X408:1	2 COLR CORE HAR
W408	White	Z44:40		200		X408:2	2 COLR CORE HAR
W409	Blue	Z44:27		1008		X409:1	2 COLR CORE HAR
W409	White	Z44:28		200		X409:2	2 COLR CORE HAR
W410	Blue	Z44:25		1007		X410:1	2 COLR CORE HAR
W410	White	Z44:26		200		X410:2	2 COLR CORE HAR
W411	Blue	Z44:13		1006		X411:1	2 COLR CORE HAR
W411	White	Z44:14		200		X411:2	2 COLR CORE HAR
W412	Blue	Z44:11		1005		X412:1	2 COLR CORE HAR
W412	White	Z44:12		200		X412:2	2 COLR CORE HAR
W413	Blue	Z44:37		1004		X413:1	2 COLR CORE HAR
W413	White	Z44:38		200		X413:2	2 COLR CORE HAR
W414	Blue	Z44:9		1003		X414:1	2 COLR CORE HAR
W414	White	Z44:10		200		X414:2	2 COLR CORE HAR
W415	Blue	Z44:51		1002		X415:1	2 COLR CORE HAR
W415	White	Z44:52		200		X415:2	2 COLR CORE HAR
W416	Blue	Z44:23		1001		X416:1	2 COLR CORE HAR
W416	White	Z44:24		200		X416:2	2 COLR CORE HAR
W417	Blue	X417:1				SV42/1:+	2 COLR CORE HAR
W417	White	X417:2				SV42/1:-	2 COLR CORE HAR
W418	Blue	Z44:36		1015		SV42/2:+	2 COLR CORE HAR
W418	White	X418:2		200		SV42/2:-	2 COLR CORE HAR
W419	Blue	Z44:65		1205		X419:1	2 COLR CORE HAR
W419	White			200		Z44:66	2 COLR CORE HAR
W420	Blue			1206		X420:1	2 COLR CORE HAR
W420	White			200		Z44:70	2 COLR CORE HAR
W421	Blue			1207		X421:1	2 COLR CORE HAR
W421	White			200		Z44:68	2 COLR CORE HAR
W422	Blue	Z44:29		702		X422:1	2 COLR CORE HAR

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CABLE	CORE	TERMINAL	POINT A	WIRE	POINT B	TERMINAL	CABLE TYPE
W422	White			200		Z44:30	2 COLR CORE HAR
W423	Blue			703		X423:1	2 COLR CORE HAR
W423	White			200		Z44:32	2 COLR CORE HAR
W424	White	X424:C		200		DPS2:C	3 COLR CORE HAR
W424	Blue	X424:B		612		X424:B	3 COLR CORE HAR
W424	Brown					X424:A	3 COLR CORE HAR
W425	Blue	Z43:13		609		X425:1	2 COLR CORE HAR
W425	White	Z43:14		904		X425:2	2 COLR CORE HAR
W425A	Blue	X425:1		609		LLS1:C	2 COLR CORE HAR
W425A	White	X425:2		904		LLS1:NC	2 COLR CORE HAR
W426	Blue	Z43:27		609		X426:1	2 COLR CORE HAR
W426	White	Z43:28		909		X426:2	2 COLR CORE HAR
W427	Blue	Z43:33		702		X427:1	2 COLR CORE HAR
W427	White	Z43:65		703		X427:2	2 COLR CORE HAR
W427A	White	X427:2		703		TH1:C	2 COLR CORE HAR
W427A	Blue	X427:1		702		TH1:NO	2 COLR CORE HAR
W428	Blue	Z44:45		406		X428:1	2 COLR CORE HAR
W428	White	Z44:46		200		X428:2	2 COLR CORE HAR
W428A	Blue	X428:1		406		E10:+	2 COLR CORE HAR
W428A	White	X428:2		200		E10:-	2 COLR CORE HAR
W430	Brown	Z43:49		1107		X430:4	3082A
W430	Shield	Z43:63				X430:6	3082A
W430	Blue	Z43:7		1103		X430:2	3082A
W430	White	Z43:21		1108		X430:3	3082A
W430	Yellow	Z43:35		1106		X430:1	3082A
W430A	Yellow	X430:1		1106		X430A:1	3082A
W430A	Blue	X430:2		1103		X430A:2	3082A
W430A	White	X430:3		1108		X430A:3	3082A
W430A	Brown	X430:4		1107		X430A:4	3082A
W430A	Screen	X430:6				X430A:6	3082A

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CABLE	CORE	TERMINAL	POINT A	WIRE	POINT B	TERMINAL	CABLE TYPE
W430B	Screen	X430A:6				P100:EARTH	3082A
W430B	Yellow	X430A:1		1106		P100:EX+	3082A
W430B	Brown	X430A:4		1107		P100:EX-	3082A
W430B	Blue	X430A:2		1103		P100:SIG(1)	3082A
W430B	White	X430A:3		1108		P100:SIG(2)	3082A
W430C	White	P100:BR2		1110		P3:1	3082A
W430C	Black	P100:EX-		1116		P3:2	3082A
W430C	Blue	P100:BR1		1112		P3:3	3082A
W430C	Red	P100:EX+		1115		P3:4	3082A
W430C	Screen	P100:EARTH				SCREEN:	3082A
W431	Yellow	Z43:36		1104		X430:7	3082A
W431	Brown	Z43:50		1105		X430:10	3082A
W431	Screen	Z43:64				X430:12	3082A
W431	Blue	Z43:8		1101		X430:8	3082A
W431	White	Z43:22		1102		X430:9	3082A
W431A	Yellow	X430:7		1104		X430A:6	3082A
W431A	Blue	X430:8		1101		X430A:7	3082A
W431A	White	X430:9		1102		X430A:8	3082A
W431A	Brown	X430:10		1105		X430A:9	3082A
W431A	Screen	X430:12				X430A:10	3082A
W431B	Screen	X430A:10				P102:EARTH	3082A
W431B	Yellow	X430A:6		1104		P102:EX+	3082A
W431B	Brown	X430A:9		1105		P102:EX-	3082A
W431B	Blue	X430A:7		1101		P102:SIG(1)	3082A
W431B	White	X430A:8		1102		P102:SIG(2)	3082A
W431C	White	P102:BR2		1109		P4:1	3082A
W431C	Black	P102:EX-		1118		P4:2	3082A
W431C	Blue	P102:BR1		1111		P4:3	3082A
W431C	Red	P102:EX+		1117		P4:4	3082A
W431C	Screen	P102:EARTH				SCREEN:	3082A

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CABLE	CORE	TERMINAL	POINT A	WIRE	POINT B	TERMINAL	CABLE TYPE
W433	Black	Z43:23		200		X433:2	3082A
W433	Blue	Z43:37		514		X433:3	3082A
W433	White	Z43:51		515		X433:4	3082A
W433	Red	Z43:9		801		X433:1	3082A
W433A	White	X433:4		515		B50:	3082A
W433A	Blue	X433:3		514		B50:	3082A
W433A	Black	X433:2		200		B50:	3082A
W433A	Red	X433:1		801		B50:	3082A
W433B	Red	B50:		801		X433A:1	3082A
W433B	White	B50:		514		X433A:2	3082A
W433B	Blue	B50:		515		X433A:3	3082A
W433B	Black	B50:		200		X433A:4	3082A
W433B	Screen	X8:PE				X433A:6	3082A
W434	Blue	X434:1		801		B20:+	4 COLR CORE HAR
W434	White	X434:2		200		B20:-	4 COLR CORE HAR
W434	Brown	X434:4		902		B20:NC	4 COLR CORE HAR
W434	Black	X434:3		901		B20:NO	4 COLR CORE HAR
W437	Blue	Z44:61		609		X437:1	2 COLR CORE HAR
W437	White	Z44:62		1201		X437:2	2 COLR CORE HAR
W437A	White	X437:2		1201		PS40:C	2 COLR CORE HAR
W437A	Blue	X437:1		609		PS40:NC	2 COLR CORE HAR
W438	Grey	Z43:16		200		X438:2	4 COLR CORE HAR
W438	White	Z43:18		804		X438:4	4 COLR CORE HAR
W438	Blue	Z43:17		803		X438:5	4 COLR CORE HAR
W438	Brown	Z43:15		801		X438:1	4 COLR CORE HAR
W439	Grey	Z43:30		200		X439:2	4 COLR CORE HAR
W439	White	Z43:32		805		X439:4	4 COLR CORE HAR
W439	Blue	Z43:31		807		X439:5	4 COLR CORE HAR
W439	Brown	Z43:29		801		X439:1	4 COLR CORE HAR
W440	Grey	Z43:2		200		X440:2	4 COLR CORE HAR

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CABLE	CORE	TERMINAL	POINT A	WIRE	POINT B	TERMINAL		CABLE TYPE
W440	White	Z43:4		809		X440:4	4	COLR CORE HAR
W440	Blue	Z43:3		808		X440:5	4	COLR CORE HAR
W440	Brown	Z43:1		801		X440:1	4	COLR CORE HAR
W441	White	Z43:62		816		X44X:6	2	COLR CORE HAR
W441	Blue	Z43:48		801		X44X:7	2	COLR CORE HAR
W441A	Blue	X44X:7		801		PT6:1	2	COLR CORE HAR
W441A	White	X44X:6		816		PT6:4	2	COLR CORE HAR
W442	White	Z43:61		812		X44X:5	2	COLR CORE HAR
W442	Blue	Z43:47		801		X44X:8	2	COLR CORE HAR
W442A	Blue	X44X:8		801		PT5:1	2	COLR CORE HAR
W442A	White	X44X:5		812		PT5:4	2	COLR CORE HAR
W443	White	Z43:60		815		X44X:4	2	COLR CORE HAR
W443	Blue	Z43:46		801		X44X:9	2	COLR CORE HAR
W444	White	Z43:59		811		X44X:3	2	COLR CORE HAR
W444	Blue	Z43:45		801		X44X:10	2	COLR CORE HAR
W445	White	Z43:58		814		X44X:2	2	COLR CORE HAR
W445	Blue	Z43:44		801		X44X:11	2	COLR CORE HAR
W445A	Blue	X44X:11		801		PT2:1	2	COLR CORE HAR
W445A	White	X44X:2		814		PT2:4	2	COLR CORE HAR
W446	White	Z43:57		810		X44X:1	2	COLR CORE HAR
W446	Blue	Z43:43		801		X44X:12	2	COLR CORE HAR
W446A	Blue	X44X:12		801		PT1:1	2	COLR CORE HAR
W446A	White	X44X:1		810		PT1:4	2	COLR CORE HAR
W451	Blue	Z44:43		516		X451:1	2	COLR CORE HAR
W451	White	Z44:44		200		X451:2	2	COLR CORE HAR
W451A	Blue	X451:1		516	B4-Fuel Level Sender	B4:2	2	COLR CORE HAR
W451A	White	X451:2		200	B4-Fuel Level Sender	B4:3	2	COLR CORE HAR
W452	Blue	Z44:47		609		X452:1	2	COLR CORE HAR
W452	White	Z44:48		714		X452:2	2	COLR CORE HAR
W452A	Blue	X452A:2		718	Fuel Level	LLS4:C	2	COLR CORE HAR

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CABLE	CORE	TERMINAL	POINT A	WIRE	POINT B	TERMINAL	CABLE TYPE
W452A	White	X452:2		714	Fuel Level	LLS4:NO	2 COLR CORE HAR
W452B	Blue	X452A:1		609	Hoist Ult Limit	LS1:1	2 COLR CORE HAR
W452B	Blue	X452A:2		718	Luff Ult Limit	LS2:2	2 COLR CORE HAR
W452C	Blue	LS1:2	Hoist Ult Limit	720	Luff Ult Limit	LS2:1	1 COLR CORE 1.5mm
W456	Blue	Z44:33		705		X456:1	2 COLR CORE HAR
W456	White	Z44:34		200		X456:2	2 COLR CORE HAR
W456A	Blue	X456:1		705		H1:1	2 COLR CORE HAR
W456A	White	X456:2		200		H1:2	2 COLR CORE HAR
W457	White	J61/P61:18		717		Z44:4	9841
W457	Blue	J61/P61:17		716		Z44:5	9841
W458	1	CRIMP CON.:	Z44 PIN1	410		J61/P61:1	12 NUM CORE HAR
W458	2	CRIMP CON.:	Z44 PIN1	410		J61/P61:31	12 NUM CORE HAR
W458	3	CRIMP CON.:	Z44 PIN1	410		J61/P61:32	12 NUM CORE HAR
W458	4	CRIMP CON.:		200		J61/P61:19	12 NUM CORE HAR
W458	7	Z44:15		709		J61/P61:27	12 NUM CORE HAR
W458	6	Z44:6		511		J61/P61:28	12 NUM CORE HAR
W458	5	CRIMP CON.:		200		J61/P61:29	12 NUM CORE HAR
W458	9	Z44:17		713		J61/P61:30	12 NUM CORE HAR
W458	8	Z44:16		710		J61/P61:39	12 NUM CORE HAR
W458	10	Z44:3		715		J61/P61:25	12 NUM CORE HAR
W458	11	Z44:7		714		J61/P61:26	12 NUM CORE HAR
W459	Blue	Z44:18		505		K2:+	1 COLR CORE 1.5mm
W460	Blue	G5:R		404		Z44:19	1 COLR CORE 1.5mm
W461	Black	M1:+		100		Z41:	1 COLR CORE 6mm
W462	Black	M1:-		200		Z42:	1 COLR CORE 6mm
W463	Blue	Z45:10		518		X463:2	1 COLR CORE 1.5mm
W464	7	F7:2	5A	512		Z45:7	18 NUM CORE HAR
W464	14	Z50:14		1204		Z45:14	18 NUM CORE HAR
W464	18	Z50:18		511		Z45:18	18 NUM CORE HAR
W464	17	Z45:17		516		Z50:17	18 NUM CORE HAR

AW	AS	MM	Original Issue	14/08/07	A
Approved	Checked	Drawn	Description	Date	Rev.

Title

Cable Termination Schedule

Serial No.	Model	Drawing Number	Sheet	Rev.
1475	M440E	A3-6100.466	45 /49	A

CABLE	CORE	TERMINAL	POINT A	WIRE	POINT B	TERMINAL	CABLE TYPE
W464	16	Z45:16		908		Z50:16	18 NUM CORE HAR
W464	13	Z45:13		1208		Z50:13	18 NUM CORE HAR
W464	1	Z45:1		200		Z50:1	18 NUM CORE HAR
W464	2	Z45:2		520		Z50:2	18 NUM CORE HAR
W464	3	Z45:3		1210		Z50:3	18 NUM CORE HAR
W464	8	Z45:8		1401		Z50:8	18 NUM CORE HAR
W464	15	Z45:15		1402		Z50:15	18 NUM CORE HAR
W464	4	Z45:4		506		Z50:4	18 NUM CORE HAR
W464	5	Z45:5		502		Z50:5	18 NUM CORE HAR
W464	6	Z45:6		407		Z50:6	18 NUM CORE HAR
W464	9	Z45:9		520		Z50:9	18 NUM CORE HAR
W465	Blue	Z50:11		514		Z45:11	9841
W465	White	Z50:12		515		Z45:12	9841
W503	White	X5:+		514		X503:4	9841
W503	Blue	X5:-		515		X503:6	9841
W503A	White	X503:4		514		J3:4	9841
W503A	Blue	X503:6		515		J3:6	9841
W504	2	X5:7		512		X503:2	5 NUM CORE HAR
W504	3	X5:3		200		X503:3	5 NUM CORE HAR
W504	5	X5:4		200		X503:5	5 NUM CORE HAR
W504	1	F23:	5A	513		X503:1	5 NUM CORE HAR
W504A	2	J3:2		512		X503:2	5 NUM CORE HAR
W504A	3	J3:3		200		X503:3	5 NUM CORE HAR
W504A	5	J3:5		200		X503:5	5 NUM CORE HAR
W504A	1	J3:1		513		X503:1	5 NUM CORE HAR
W505	Blue	X5:-		515		X505:2	9841
W505	White	X5:+		514		X505:3	9841
W505A	Blue	X505:2		515		J2:2	9841
W505A	White	X505:3		514		J2:10	9841
W506	Blue	X505:8		606	2A	F28:2	2 COLR CORE HAR

Approved	Checked	Drawn	Description	Date	Rev.
	AS	MM	Original Issue	14/08/07	A

Title

Cable Termination Schedule

Serial No.	Model	Drawing Number	Sheet	Rev.
1475	M440E	A3-6100.466	46 /49	A

Page 680

CABLE	CORE	TERMINAL	POINT A	WIRE	POINT B	TERMINAL	CABLE TYPE
W506	White	X505:1		200	8	X5:0V	2 COLR CORE HAR
W506A	4	X505:6		605		J2:6	6 NUM CORE HAR
W506A	5	X505:7		605		J2:7	6 NUM CORE HAR
W506A	6	X505:8		606		J2:8	6 NUM CORE HAR
W506A	2	X505:4		604		J2:14	6 NUM CORE HAR
W506A	3	X505:5		604		J2:15	6 NUM CORE HAR
W506A	1	X505:1		200		J2:16	6 NUM CORE HAR
W507	Blue	X5:-		515		X507:2	9841
W507	White	X5:+		514		X507:3	9841
W507A	Blue	X507:2		515		J1:2	9841
W507A	White	X507:3		514		J1:10	9841
W508	White	X5:7	0V	200		X507:1	2 COLR CORE HAR
W508	Blue	F27:2	2A	603		X507:8	2 COLR CORE HAR
W508A	4	X507:6		602		J1:6	6 NUM CORE HAR
W508A	5	X507:7		602		J1:7	6 NUM CORE HAR
W508A	6	X507:8		603		J1:8	6 NUM CORE HAR
W508A	2	X507:4		601		J1:14	6 NUM CORE HAR
W508A	3	X507:5		601		J1:15	6 NUM CORE HAR
W508A	1	X507:1		200		J1:16	6 NUM CORE HAR
W509	1	X5:2		510		X509:3	1119403T
W509	2	X5:2		200		X509:4	1119403T
W509A	1	X509:3		510		Y1:1	1119403T
W509A	2	X509:4		200		Y1:2	1119403T
W510	1	X5:1		508		X509:1	1119403T
W510	2	X5:1		200		X509:2	1119403T
W510A	1	X509:1		508		E1:+	1119403T
W510A	2	X509:2		200		E1:-	1119403T
W511	Blue	Z50:10		519		X463:1	1 COLR CORE 1.5mm
W611	White	J61/P61:8		707		X611:1	3 COLR CORE HAR
W611	Blue	J61/P61:11		708		X611:2	3 COLR CORE HAR

AW	AS	MM	Original Issue	14/08/07	A
Approved	Checked	Drawn	Description	Date	Rev.

Title

Cable Termination Schedule

Serial No.	Model	Drawing Number	Sheet	Rev.
1475	M440E	A3-6100.466	47 /49	A

CABLE	CORE	TERMINAL	POINT A	WIRE	POINT B	TERMINAL	CABLE TYPE
W611	Brown	J61/P61:9		706		X611:3	3 COLR CORE HAR
W611A	Blue	X611:3		706		TS3:	3 COLR CORE HAR
W611A	White	X611:2		708		TS3:	3 COLR CORE HAR
W611A	Brown	X611:1		707		TS3:	3 COLR CORE HAR
W612	White	J61/P61:8		707		X612:1	3 COLR CORE HAR
W612	Blue	J61/P61:36		711		X612:3	3 COLR CORE HAR
W612	Brown	J61/P61:15		712		X612:2	3 COLR CORE HAR
W612A	Brown	X612:2		712		LLS7:	3 COLR CORE HAR
W612A	White	X612:1		707		LLS7:	3 COLR CORE HAR
W612A	Blue	X612:3		711		LLS7:	3 COLR CORE HAR
W801	1	X8:1		311		Y4:L	1119403T
W801	2	X8:7		312		Y4:N	1119403T
W801	G/Y	X8:PE				Y4:PE	1119403T
W802	G/Y	X8:PE				X8:PE	1119403T
W802	1	X8:2		313		Y6:L	1119403T
W802	2	X8:8		312		Y6:N	1119403T
W1001	Black	G1:2		100		M1:+	1 COLR CORE 70mm
W1002	Black	G1:1		401		Q14:1	1 COLR CORE 70mm
W1002A	Black	Q14:2		200		M1:-	1 COLR CORE 70mm
W1003	Blue	M1:+		100	63A	Q9:1	1 COLR CORE 6mm
W1004	White	M1:-		200		K2:-	1 COLR CORE 1.5mm
W1005	Blue	M1:Start		402		K2:2	1 COLR CORE 6mm
W1006	Blue	K2:1		403	63A	Q9:2	1 COLR CORE 6mm
W1007	Blue	Q9:2	63A	403		G5:+	1 COLR CORE 6mm
W1008	White	M1:-		200		G5:-	1 COLR CORE 6mm
W1201	1	X12:1		316		E41:L	1119403T
W1201	2	X12:5		312		E41:N	1119403T
W1201	G/Y	X12:PE				E41:PE	1119403T
W1202	1	X12:2		316		E42:L	1119403T
W1202	2	X12:6		312		E42:N	1119403T

Approved	Checked	Drawn	Description	Date	Rev.
	AS	MM	Original Issue	14/08/07	A

Title

Cable Termination Schedule

Serial No.	Model	Drawing Number	Sheet	Rev.
1475	M440E	A3-6100.466	48 /49	A

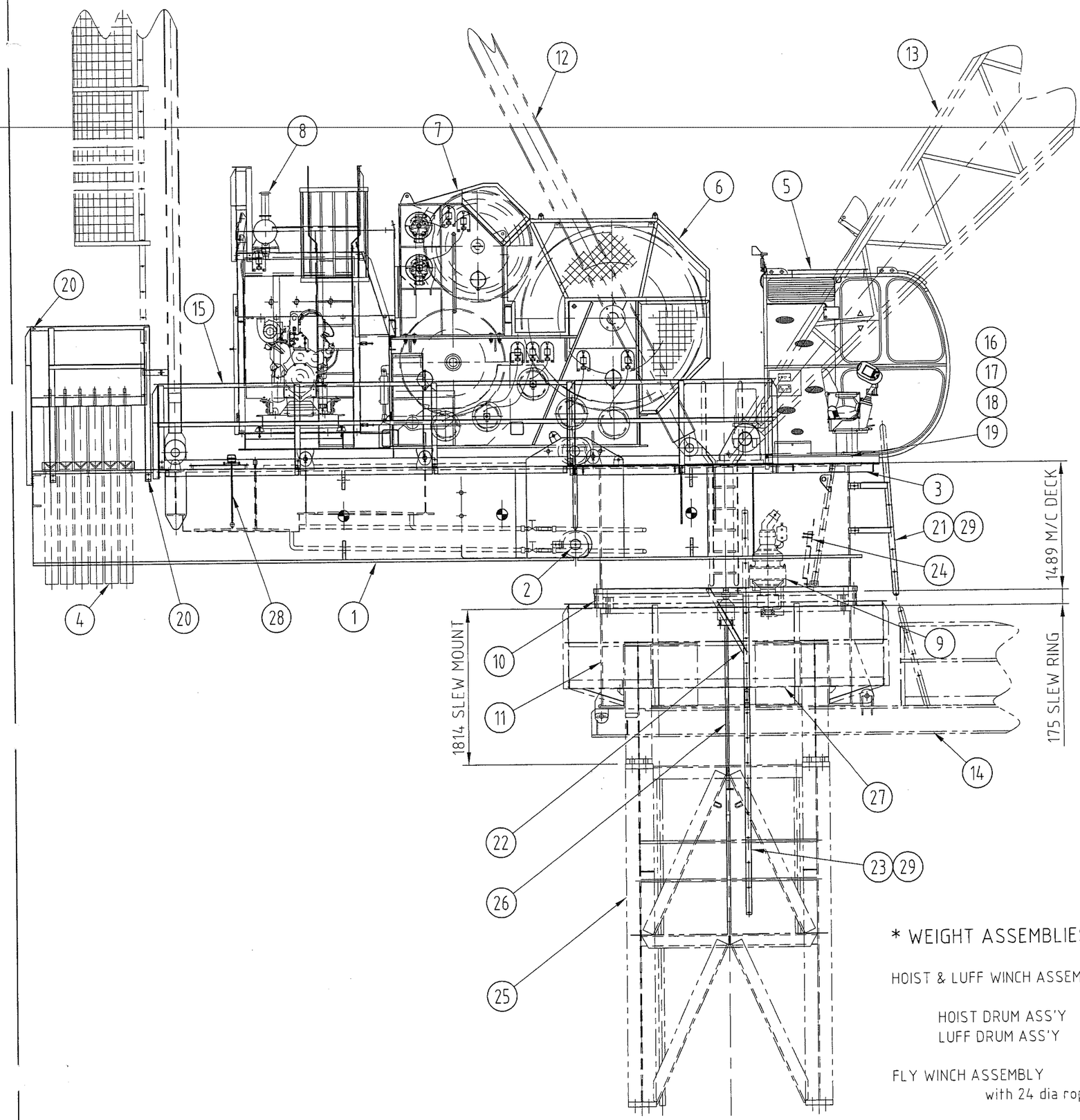
CABLE	CORE	TERMINAL	POINT A	WIRE	POINT B	TERMINAL	CABLE TYPE
W1202	G/Y	X12:PE				E42:PE	1119403T
W1203	1	X12:3		316		E43:L	1119403T
W1203	2	X12:7		312		E43:N	1119403T
W1203	G/Y	X12:PE				E43:PE	1119403T
W1204	1	X12:4		318		E45:L	1119403T
W1204	2	X12:8		312		E45:N	1119403T
W1204	G/Y	X12:PE				E45:PE	1119403T
W8121	Brown	X8121:4		318		X12:4	1312505T
W8121	Blue	X8121:5		312		X12:8	1312505T
W8121	Red	X8121:1		316		X12:3	1312505T
W8121	White	X8121:2		312		X12:7	1312505T
W8121	G/Y	X8121:3				X12:PE	1312505T

Approved	Checked	Drawn	Description	Date	Rev.
	AS	MM	Original Issue	14/08/07	A

Title

Cable Termination Schedule

Serial No.	Model	Drawing Number	Sheet	Rev.
1475	M440E	A3-6100.466	49 /49	A



Material List

Cat.	Item	Qty	Description	Reference	kg
	1	1	MACHINERY SPLIT DECK	A1-2020.206	13837
	2	REF	SPLIT DECK PIN	A1-2020.206/84	-
B	3	1	CABIN SUPPORT PLATFORM & WALKWAYS	A1-2051.164	1136
	4	1	COUNTER WEGHT ASSEMBLY	A1-2024.077	39325
	5	1	~~CABIN ASSEMBLY~~	~~A3-2100.175~~	~~1000~~
*	6	1	HOIST & LUFF WINCH ASSEMBLY	A2-2300.306	10898
*	7	1	FLY WINCH ASSEMBLY	A3-2300.302	2876
*	8	1	POWER PACK ASSEMBLY	A2-2400.206	4355
	9	REF	SLEW DRIVE ASSEMBLY	A3-2500.098	-
	10	1	SLEW RING ASSEMBLY	A3-2600.044	2250
	11	REF	SLEW MOUNT	A1-7460.064	-
	12	REF	MAST ASSEMBLY	A3-3000.140	-
	13	REF	BOOM ASSEMBLY	A1-4000.183	-
	14	REF	EXT. CLIMBING MONORAIL	A1-7452.002	-
B	15	1	MACHINERY DECK HANDRAILS	A1-2032.299	455
	16	3	MACKAY MOUNT M 107-60 (BLACKWOODS)	P/No 09019102	-
	17	2	VPC1 RUBBER PAD (BLACKWOODS)	P/No 00292502	-
			380 x 380 x 10 THICK		
	18	3	M16x75 HEX HD BOLT	GR 8.8	-
	19	3	Φ20 WASHER	GALVANISED	-
B	20	76	M12x40 HEX HD BOLT C/W NUT & WASHER	GR 8.8	-
	21	1	MONORAIL ACCESS LADDER	A3-2033.046	45
	22	1	TOP ACCESS LADDER	A2-2030.039.001	40
	23	1	LOWER ACCESS LADDER	A2-2030.039.003	40
	24	REF	TRAP DOOR	A1-2021.017.001	-
	25	REF	TOWER SECTION TYPE 393T	A1-7150.141	-
	26	1	SLIP RING ASSEMBLY	A2-7300.015	22
	27	REF	SLEW MOUNT PLATFORM	A3-7461.021	-
	28	1	FUEL LOW LEVEL SWITCH	A4-2021.118.002	-
	29	12	M16x45 HEX HD BOLT c/w NUT & WASHER	GR 8.8	-

* WEIGHT ASSEMBLIES:

HOIST & LUFF WINCH ASSEMBLY	empty drums	10.9T
	with ropes	15.0T
HOIST DRUM ASS'Y	(with rope)	8.0T
LUFF DRUM ASS'Y	(with rope)	2.8T
FLY WINCH ASSEMBLY	empty drums	2.9T
with 24 dia rope - 450m Long		4.2T
POWERPACK ASSEMBLY	dry	4.3T
	with oil	5.3T

Checked	Date	Revision	ECN	Name	Issue
~~AC~~	01.07.08	ITEM 3 & 15 DWG No UPDATED &	-	D.F	B
		ITEM 20 QTY WAS 58			
	30.07.07	ORIGINAL ISSUE TAKEN FROM A3-2000.217	-	IZA	A

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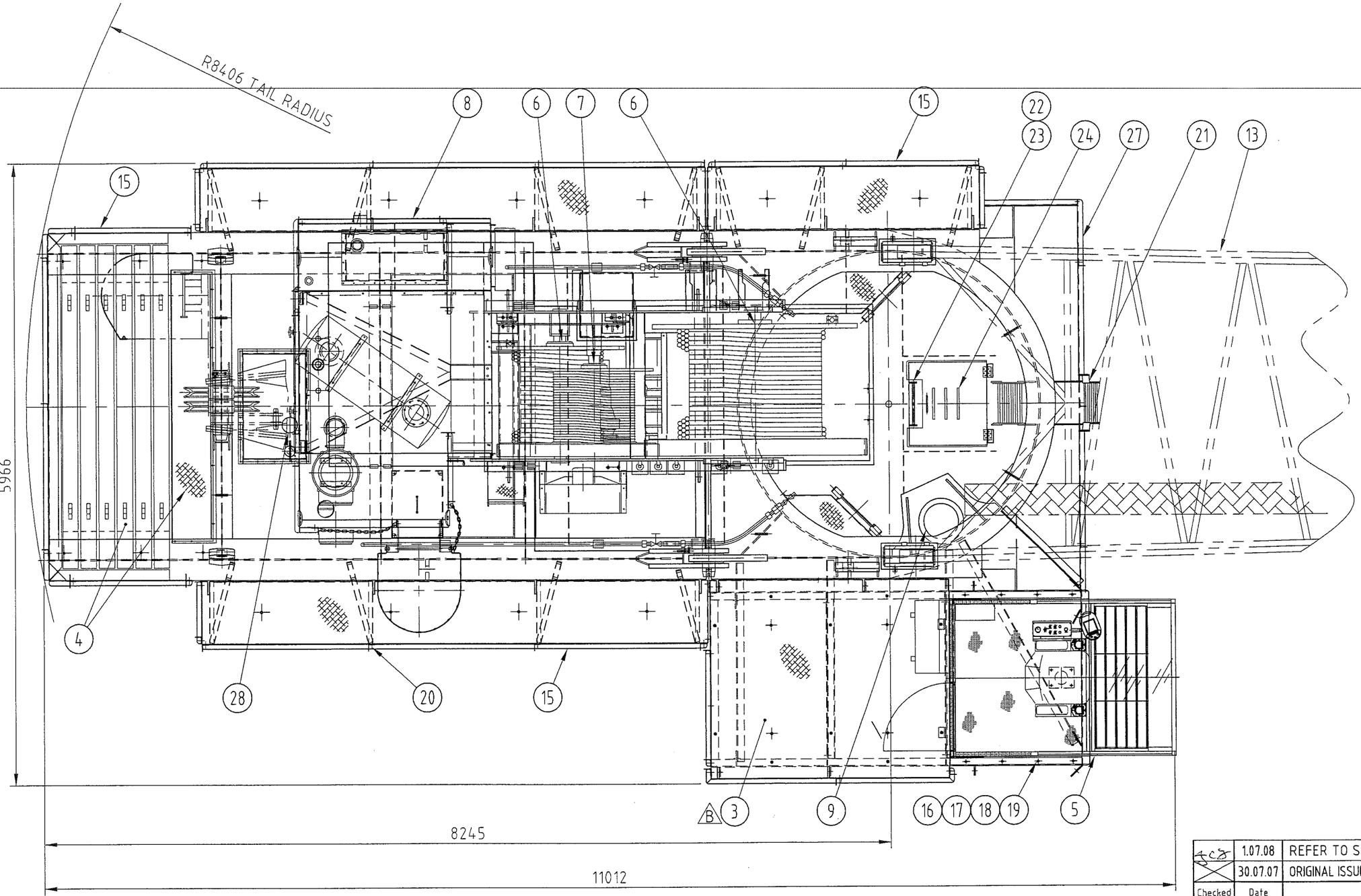
Project: M440E - TOWER CRANE — First Used On S/No. 1475

Title: MACHINERY DECK ASSEMBLY — Activity No. 200

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
ARIZA	U.S	30.07.07	1:50	1 of 2	76227 kg	B
	Approved: A.Mc	Eng. Approved:	Drawing Number: A3-2000.241			

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	1.07.08	REFER TO SHEET 1	-	D.F	B
	30.07.07	ORIGINAL ISSUE TAKEN FROM A3-2000.217	-	IZA	A
Checked	Date	Revision	ECN	Name	Issue

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Project: M440E - TOWER CRANE — First Used On S/No. 1475

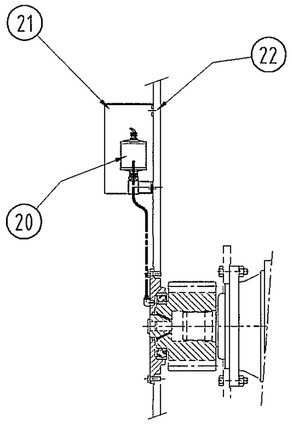
Title: MACHINERY DECK ASSEMBLY — Activity No. 200

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
ARIZA	U.S	30.07.07	1:40	2 of 2	SHT-1	B
	Approved	Eng. Approved	Drawing Number			
	A.Mc		A3-2000.241			

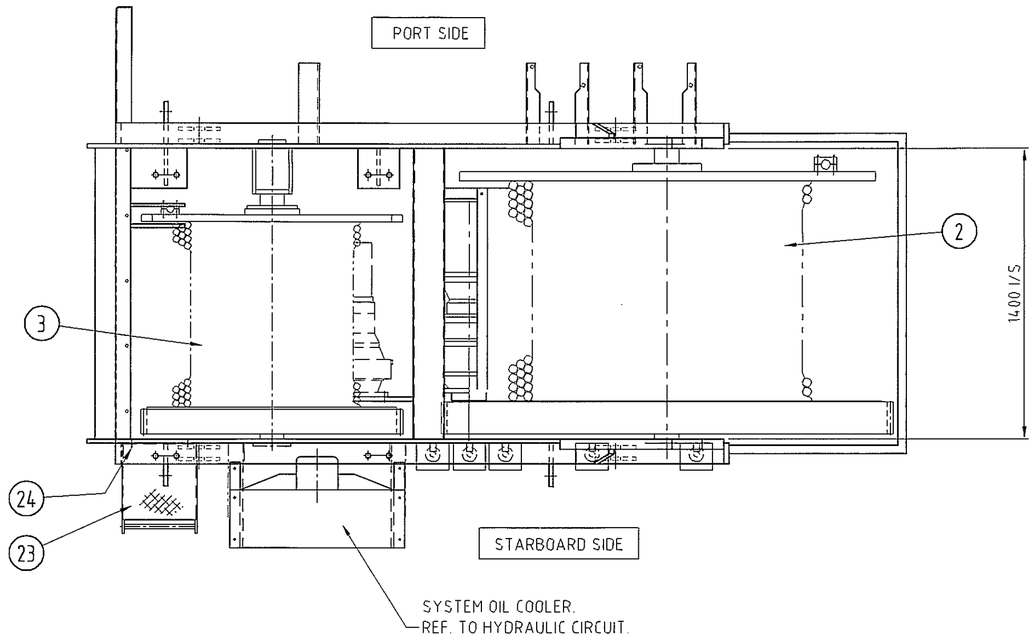
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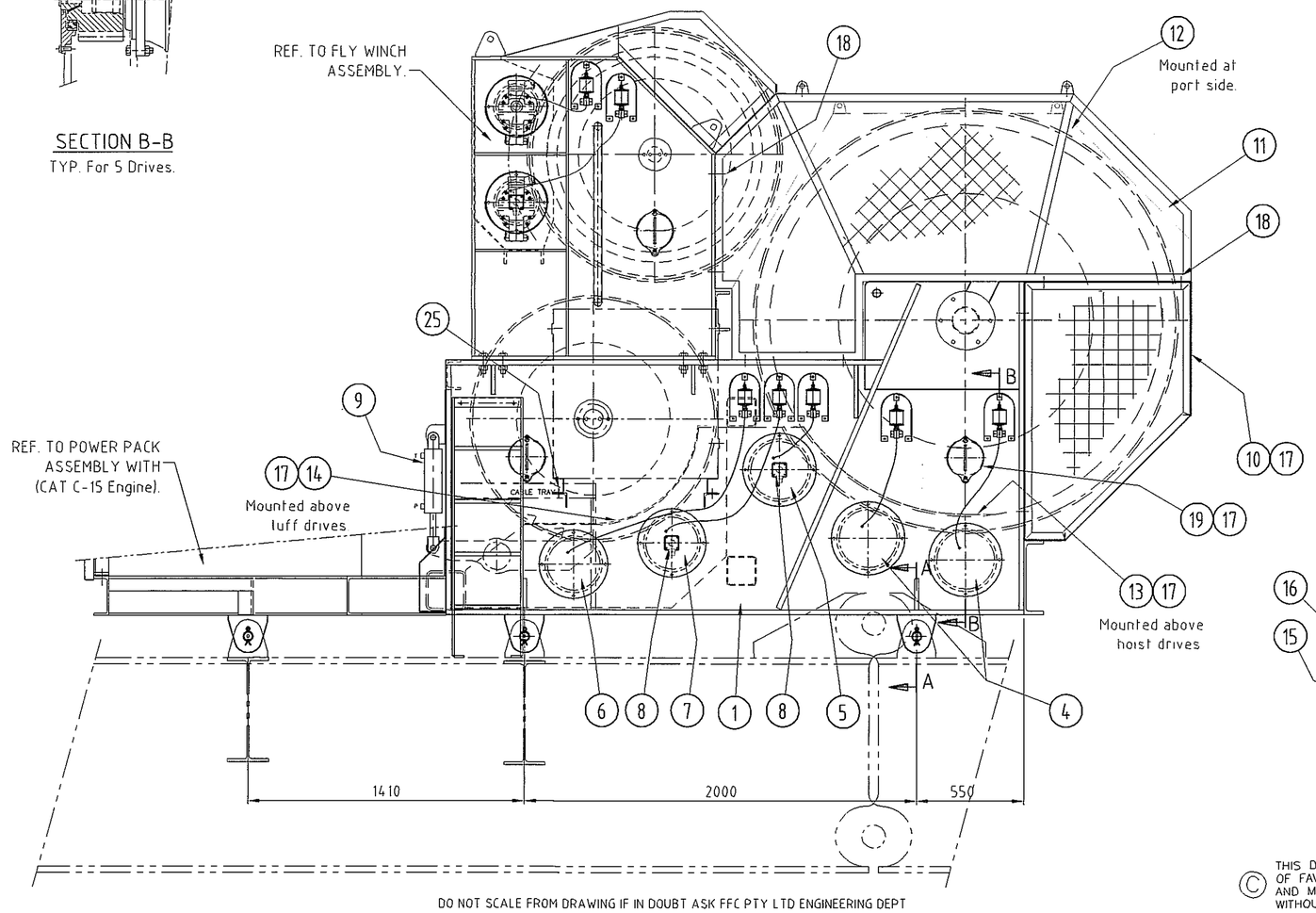
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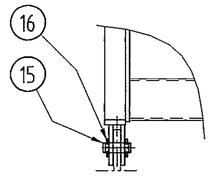
OFFICE USE ONLY·
440-525-25
(HOIST 169/23 TEETH; 12.7M)
(LUFF 97/21 TEETH, 12.7M)



SECTION B-B
TYP. For 5 Drives.







SECTION A-A

Material List						
Cat.	Item	Code	Qty	Description	Reference	kg
	1	REF	1	WINCH FRAME DETAILS	A3-2310.257	2570
	2	REF	1	HOIST DRUM ASS'Y	A3-2320.128	4826
B	3	REF	1	LUFF DRUM ASS'Y	A3-2320.297	1928
	4	REF	2	DRUM DRIVE ASS'Y (Hoist)	A3-2390 326	670
	5	REF	1	DRUM DRIVE ASS'Y (Hoist-Enc drive)	A3-2390.327	335
	6	REF	1	DRUM DRIVE ASS'Y (Luff)	A3-2390.325	257
	7	REF	1	DRUM DRIVE ASS'Y (Luff-Enc. drive)	A3-2390.324	257
	8	REF	2	ENCODER DRIVE ASS'Y (Hoist & Luff)	A3-2370 429	-
	9	REF	1	LUFF RATCHET ASS'Y	A3-2350.025	25
	10	REF	1	HOIST DRUM GUARD	A3-2315.259	48
	11	REF	1	HOIST GEAR GUARD	A2-2315.258/1	40
	12	REF	1	HOIST FLANGE GUARD	A2-2315 258/15	29
	13	REF	1	HOIST DRIVES COVER	A3-2315.052/2	8
	14	REF	1	LUFF DRIVES COVER	A3-2315.052/1	8
×× P	15	REF	6	HOLD DOWN PIN	A4-2311.014	12
	16	SP	12	SPLIT PIN ø10 x 70 L G	ST. STEEL	-
	17	HEX	20	HEX BOLT M10 x 30	ST. STEEL	-
	18	HEX	10	HEX BOLT M10x40 c/w NUT	ST. STEEL	-
	19	REF	4	ACCESS ø180 HOLE COVER	A4-2315 189	1
	20	REF	5	SPLINE MAINTENANCE	A4-2394 010	3
	21	REF	5	OILER COVER	SK-3336	10
	22	HEX	15	HEX BOLT M8 x 25	ST. STEEL	-
	23	REF	1	ACCESS LADDER	A3-2315 257	24
	24	HEX	2	HEX BOLT M12x50 c/w NUT	ST. STEEL	-
	25	HEX	6	HEX BOLT M8 x 25 c/w NUT	ST. STEEL	-

NOTES:

1 U.O.N. ALL BOLTS TIGHTENED TO DWG. A3-9900 214.

2. DRILL (OR DRILL & TAP) HOLES IN WINCH FRAME TO SUIT WINCH GUARDS AND DRIVE COVERS, AT ASSEMBLY.

×× HOLD DOWN PINS ARE CALLED UP FOR POWER PACK MOUNTING

WEIGHT ASS'Y: WINCH ASS'Y (Empty drums) - 10.9 T
TOTAL WINCH ASS'Y (with ropes) - 15.0 T

HOIST DRUM ASS'Y (with rope) - 8.0 T
LUFF DRUM ASS'Y (with rope) - 2.8 T

Checked	Date	Revision	ECN	Name	Issue
	17.03.05	ITEM 3 (LUFF DRUM ASS'Y) WAS A3-2320.228	-	L.Z.	B
	1.02.05	ORIGINAL ISSUE	-	L.Z.	A

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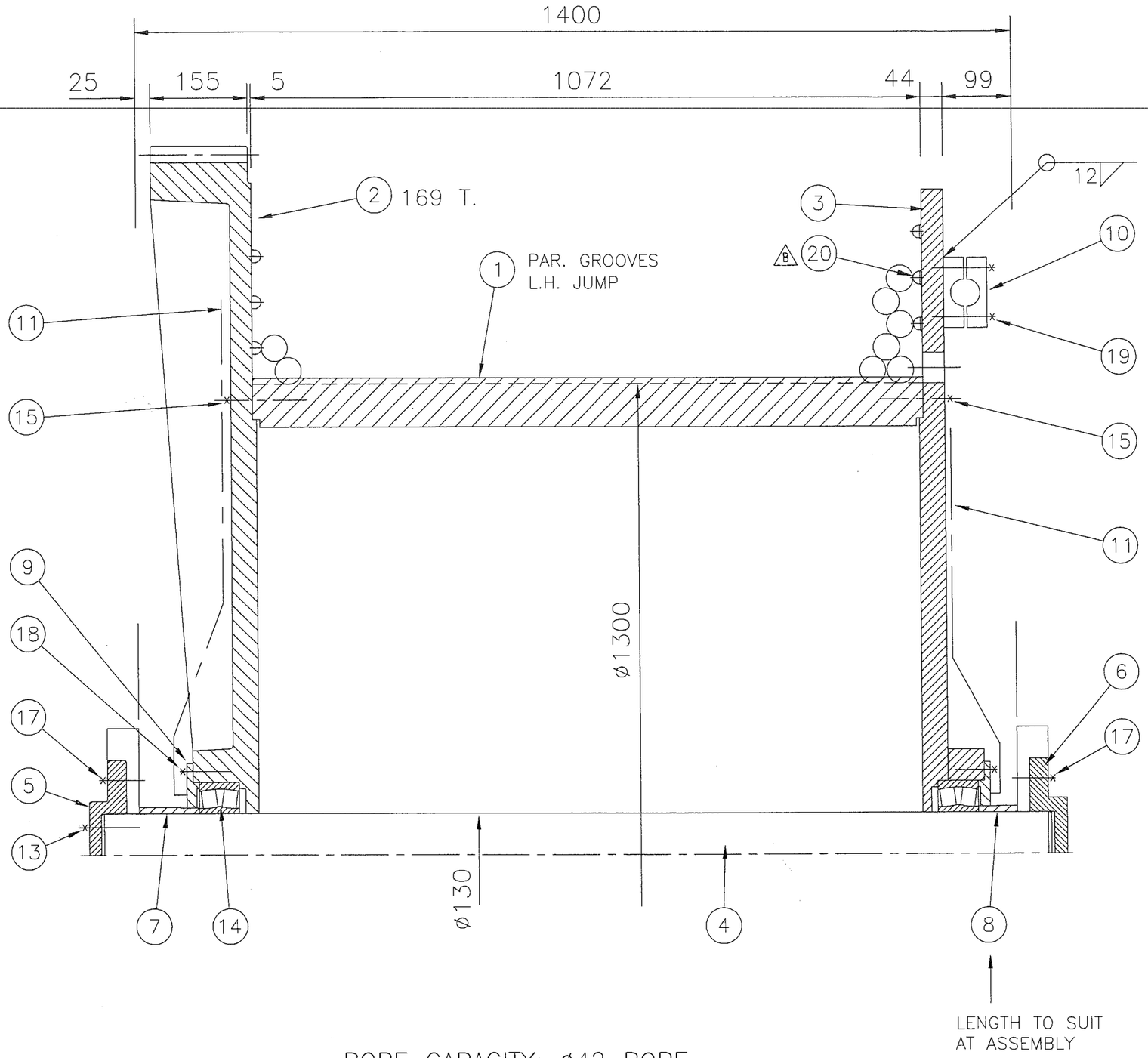
Project: M440D - (525-25-10) — First Used On S/No. 1234

Title: WINCH ASSEMBLY — Activity No. 230

Drawn	Checked	Date Drawn	Sheet	Weight	M/Film	Issue
L.ZUBIC	J.C.F.	1.02.05	1 of 1	10898 kg		B
	Approved	Scale	Drawing Number			
	B.M.	1:20	A2-2300.306			

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MATERIAL LIST

ITEM	DESCRIPTION		QTY
1	DRUM	DWG. A3.2321.042	1
2	GEAR	DWG. A3.2340.047	1
3	FLANGE	DWG. A4.2330.079	1
4	SHAFT	DWG. A4.2345.029	1
5	BEARING PLATE	DWG. A4.2345.019/1	1
6	BEARING PLATE	DWG. A4.2345.019/2	2
7	SPACER	DWG. A4.9901.015.001	1
8	SPACER	DWG. A4.9901.015.002	1
9	BEARING COVER	DWG. A4.2331.127	1
10	ROPE CLAMP	DWG. A4.9230.021.004	2
11	GREASE LINE	DWG. A4.9230.028	2
12			
13	HEX. SCREW	M16 x 40 Gr 8.8	5
14	BEARING	22226 (130/230/64)	2
15	HEX. BOLT	M24 x 100 Gr 8.8	60
16			
17	HEX. SCREW	M16 x 50 Gr 8.8	10
18	HEX. SCREW	M12 x 40 Gr 8.8	12
19	S.H.C. SCREW	M20 x 50	8
B 20	KICKER PLATES LAYOUT	A2-2322.036	—

NOTES:

1. U.O.N. ALL BOLTS TO BE TIGHTENED TO DWG. A3-9900.214

ROPE CAPACITY: ø42 ROPE

1st LAYER, 21 TURNS	: 89m
2nd LAYER, 23 TURNS	: 104m
3rd LAYER, 24 TURNS	: 112m
4th LAYER, 23 TURNS	: 113m
5th LAYER, 24 TURNS	: 123m
6th LAYER, 23 TURNS	: 123m
7th LAYER, 21 TURNS	: 117m
	781m

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DATE	REVISION	NAME	ISSUE
10.8.05	ITEM 20 ADDED, (From M440D-S/No. 1234)	L.Z.	B
29.11.95	ORIGINAL ISSUE	mr	A

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(INCORPORATED IN N.S.W.) A.C.N. 003 689 478
SYDNEY MELBOURNE BRISBANE PERTH

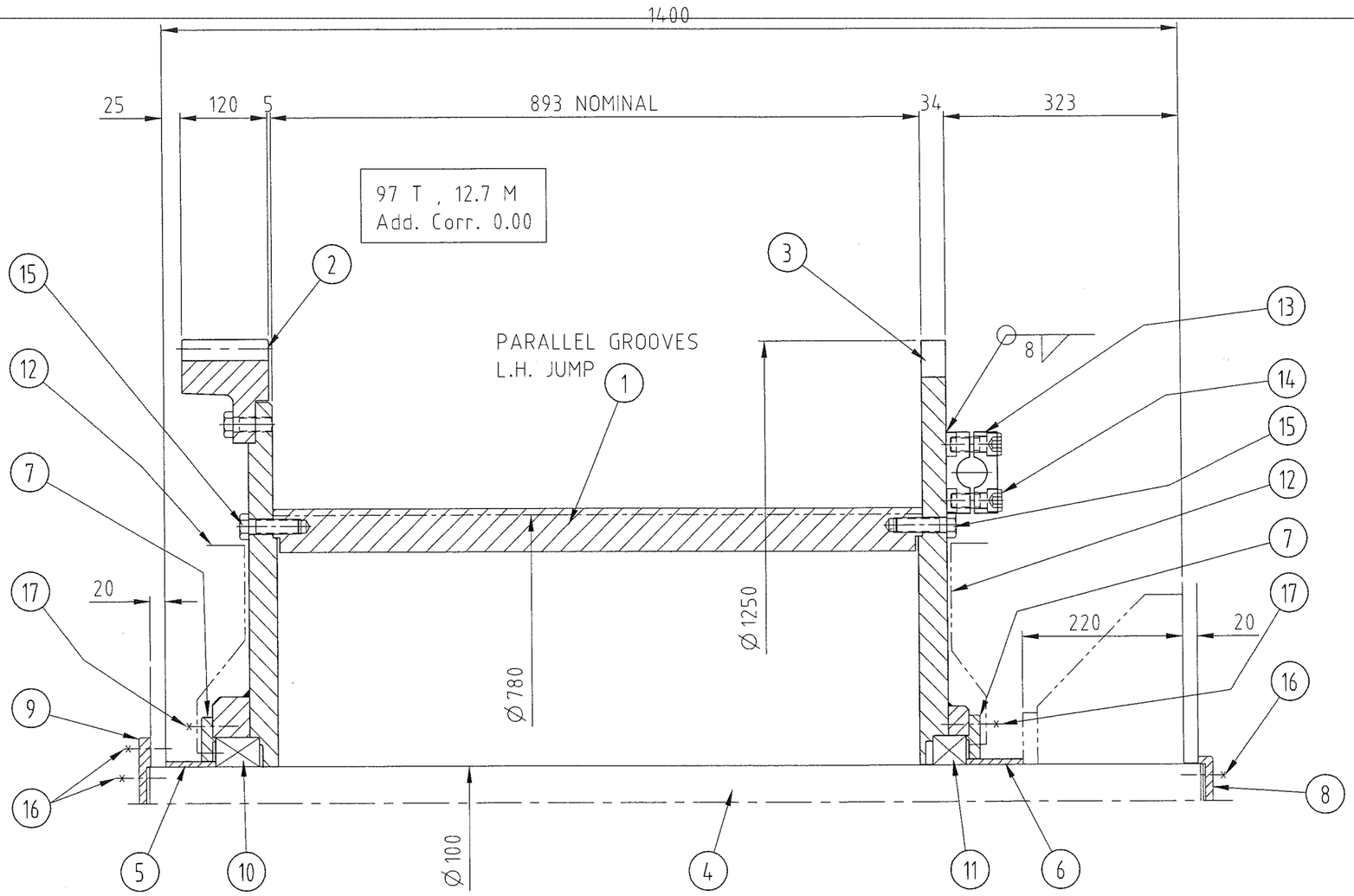
PROJECT: 760/600-XXX-32 (7 layers) — FIRST USED ON S/NO

TITLE: HOIST DRUM ASSEMBLY

DRAWN	CHECKED	DATE DRAWN	SHEET	WEIGHT	ISSUE
mr ROBERTS	P.F.D.	29.11.95	1 OF 1		B
	APPROVED H.F.E.	SCALE NTS	DRAWING No. A3-2320.128		

Material List

Cat.	Item	Code	Qty	Description	Reference	kg
	1	REF	1	DRUM Ø780	A3-2321.035	895
P	2	REF	1	GEAR 97T - ASS'Y	A3-2340.156	563
P	3	REF	1	FLANGE Ø1250	A3-2330.023	350
~~P~~	~~4~~	~~REF~~	~~1~~	~~SHAFT - Ø100~~	~~A4-2345.154~~	~~90~~
	5	REF	1	SPACER (L=69mm); GR.750	A4-9921.001.100	-
	6	REF	1	SPACER (L=79mm); GR.750	A4-9921.001.100	-
	7	REF	2	BEARING COVER	A4-2331.075	1
	8	REF	1	END COVER	A4-2345.024	1
	9	REF	1	END COVER	A4-2345.022	1
	10	BR	1	BEARING (100/180/60.3)	23220	7
	11	BR	1	BEARING (100/180/46)	22220	5
	12	REF	2	GREASE LINE	A4-9230.028	-
	13	REF	2	ROPE CLAMP	A4-9230.021.001	4
	14	SHC	8	SHC SCREW M20x50	GRADE 10.9	1
	15	HEX	40	HEX BOLT M20x70	GRADE 8.8	9
	16	HEX	10	HEX BOLT M16x40	GRADE 8.8	1
	17	HEX	8	HEX BOLT M12x40	ST. STEEL	-



WEIGHT ASSEMBLY:

1. DRUM ASSEMBLY - (Empty drum) - 1.95 T
2. DRUM ASSEMBLY - (With 150m - Ø32 Rope) - 2.8 T

NOTES:

1. U.N.O, ALL BOLTS TIGHTENED TO FFC DWG. A3-9900.214
2. GREASE NIPPLES AT R375 FROM CL OF SHAFT.

ROPE CAPACITY: Ø32 ROPE

1st LAYER, 22 TURNS - : 56.3 m
2nd LAYER, 26 TURNS - : 71.0 m
3rd LAYER, 24 TURNS - : 69.7 m

TOTAL ROPE CAPACITY - : 197 m

	Date	Revision	ECN	Name	Issue
	17.03.05	ORIGINAL ISSUE	-	L.Z.	A

Favelle Favco Cranes Pty. Ltd.
A.C.N. 067 562 449
A subsidiary of Muhibbah Engineering (M) BHD

Project: M440D
First Used On S/No. 1234

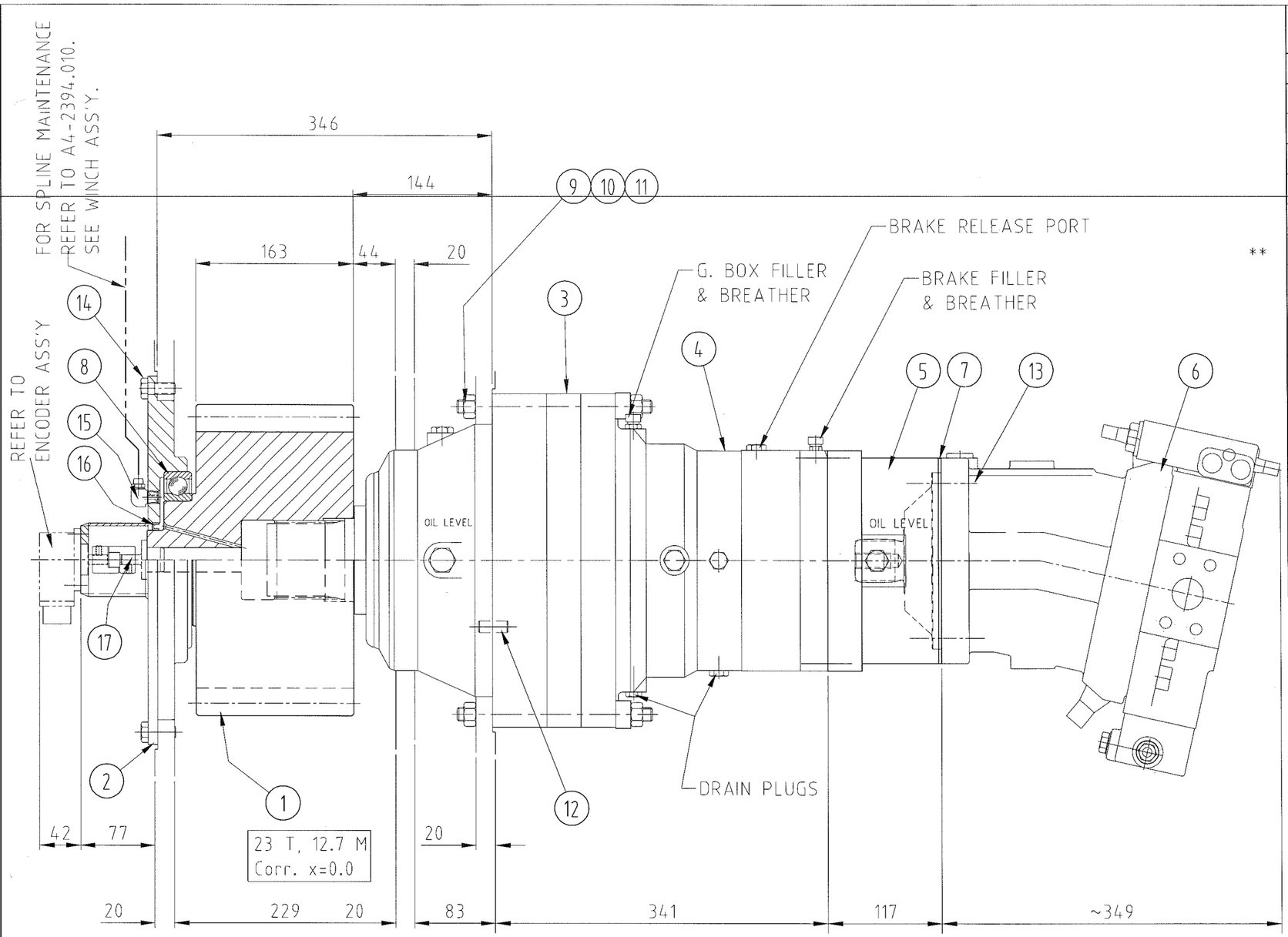
Title: LUFF DRUM ASSEMBLY
Activity No. 230

Drawn	Checked	Date Drawn	Sheet	Weight	M/Film	Issue
L.ZUBIC	ACS	17.03.05	1 of 1	1928 kg		A

Approved	Scale	Drawing Number
AW	1 : 7.5	A3-2320.297

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Material List

Cat.	Item	Code	Qty	Description	Reference	kg
	1	REF	1	DRIVE PINION	A4-2392.184	83
	2	REF	1	BEARING HOUSING	A3-2391.037	17
	3	GBX	1	GEARBOX		123
	4	REF	1	BRAKE		37
	5	ADP	1	MOTOR ADAPTOR SET		3
	6	MTR	REF	HYDRAULIC MOTOR		64
	7	REF	1	MOTOR GASKET	A3-2394.005	-
	8	BR	1	BEARING		2
	9	TB	12	THREADED BAR M14 x 200	GRADE 8.8	3
	10	W	12	WASHER	A4-2393.016.003	1
	11	HEX	24	HEX NUT M14	GRADE 8	1
	12	SPN	3	BISSELL PIN Ø12 x 30	ZINC PLATED	-
	13	HEX	4	HEX BOLT M16 x 50	GRADE 8.8	1
	14	HEX	4	HEX BOLT M12 x 30	ST. STEEL	-
	15	NPL	REF	OIL NIPPLE ELBOW 5/16" OD- 1/4"BSPT	BRASS	-
	16	-	1	SHAFT SEAL-(60/75/8) "CR Seals"	CRW1	-
	17	REF	1	ENCODER DRIVE PIN	A4-2391.034/1	-

ATTENTION: MAINTENANCE PERSONNEL:

1. USE ONLY OIL AS NOMINATED IN CRANE MANUAL, SECTION 4 TO FILL GEARBOX, BRAKE AND MOTOR. DO NOT OVERFILL GEARBOX OR BRAKE.
2. FOR GEARBOX USE SYNTHETIC OIL, AS NOMINATED IN CRANE MANUAL.

NOTES:

1. MATERIAL LIST IS FOR ONE (1) DRIVE ONLY. REFER TO WINCH ASSEMBLY FOR NUMBER OFF REQUIRED.
2. FULLY CLEAN MATING SURFACE OF GEARBOX AND WINCH, AND THEN APPLY "LOCTITE 277" TO PROVIDE FRICTION JOINT.
3. U.N.O. ALL BOLTS ARE TIGHTENED TO DWG. A3-9900.214.

**. TO BE ORDERED WITH SHAFT SEAL REMOVED, AND A LEVEL PLUG ON THE SHAFT CENTRELINE.

	Date	Revision	ECN	Name	Issue
	1.02.05	ORIGINAL ISSUE	-	L.Z.	A

FAVELLE FAVCO

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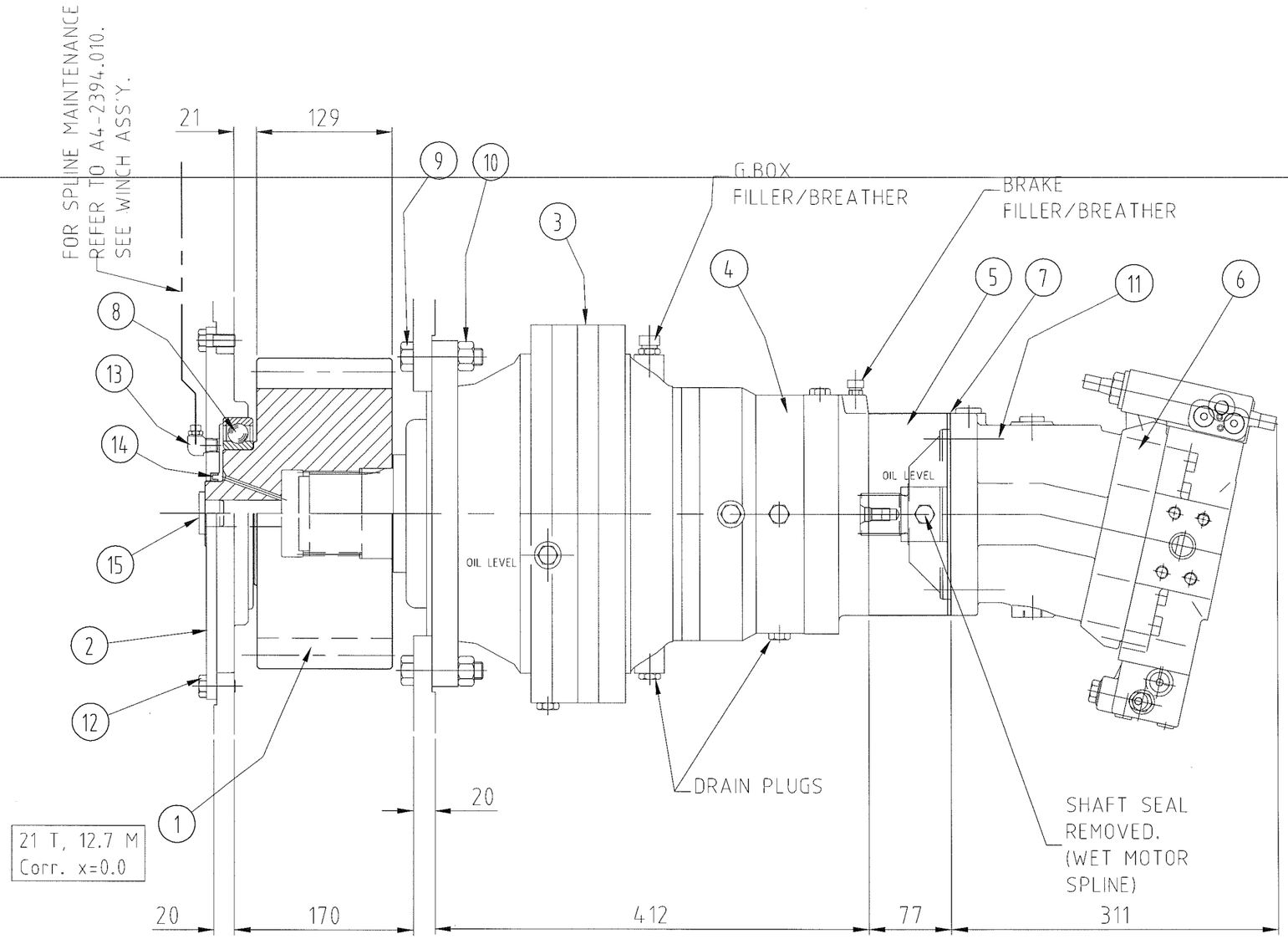
Project: M440D - (525-25-10) — First Used On S/No. 1234

Title: DRUM DRIVE ASSEMBLY - (Hoist - Encoder drive) — Activity No. 230

Drawn	Checked	Date Drawn	Sheet	Weight	M/Film	Issue
L.ZUBIC		1.02.05	1 of 1	335 kg		A
	Approved	Scale	Drawing Number			
		1 : 5	A3-2390.327.MDO			

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Material List

Cat.	Item	Code	Qty	Description	Reference	kg
P	1	REF	1	DRIVE PINION	A4-2392.183	55
	2	REF	1	BEARING HOUSING	A3-2391.036	15
	3	GBX	1	GEARBOX		106
	4	REF	1	BRAKE		29
**	5	ADP	1	MOTOR ADAPTOR SET		2
	6	MTR	REF	HYDRAULIC MOTOR		47
	7	REF	1	MOTOR GASKET	A3-2394.004	-
	8	BR	1	BEARING		2
	9	HEX	10	HEX BOLT M16 x 65	GRADE 8.8	1
	10	HEX	10	HEX NUT M16	GRADE 8	-
	11	HEX	4	HEX BOLT M16 x 55	GRADE 8.8	-
	12	HEX	4	HEX BOLT M12 x 30	ST. STEEL	-
	13	NPL	REF	OIL NIPPLE ELBOW 5/16" OD- 1/4"BSPT	BRASS	-
	14	-	1	SHAFT SEAL-(60/75/8) "CR Seals"	CRW1	-
	15	REF	1	ENCODER DRIVE PIN	A4-2391.034/2	-

NOTES:

1. MATERIAL LIST IS FOR ONE (1) DRIVE ONLY. REFER TO WINCH ASSEMBLY FOR NUMBER OFF REQUIRED.
2. FULLY CLEAN MATING SURFACE OF GEARBOX AND WINCH, AND THEN APPLY "LOCTITE 277" TO PROVIDE FRICTION JOINT.
3. U.N.O. ALL BOLTS ARE TIGHTENED TO DWG. A3-9900.214.

**. TO BE ORDERED WITH SHAFT SEAL REMOVED, AND A LEVEL PLUG ON THE SHAFT CENTRELINE.

ATTENTION: MAINTENANCE PERSONNEL:

1. USE ONLY OIL AS NOMINATED IN CRANE MANUAL, SECTION 4 TO FILL GEARBOX, BRAKE AND MOTOR. DO NOT OVERFILL GEARBOX OR BRAKE.
2. FOR GEARBOX USE SYNTHETIC OIL, AS NOMINATED IN CRANE MANUAL.

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	Date	Revision	ECN	Name	Issue
	18.02.05	TYPE OF GEARBOX WAS ED2090MN MODIF.	-	L.Z.	B
X	4.02.05	ORIGINAL ISSUE	-	L.Z.	A

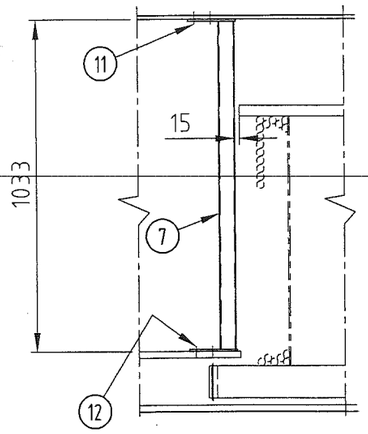
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A.C.N. 067 562 449
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Project: M440D - (525-25-10) — First Used On S/No. 1234

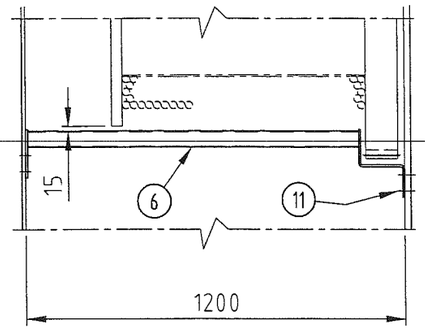
Title: DRUM DRIVE ASSEMBLY (luff) — Activity No. 230

Drawn	Checked	Date Drawn	Sheet	Weight	M/Film	Issue
L.ZUBIC	J.C.F.	4.02.05	1 of 1	257 kg		B

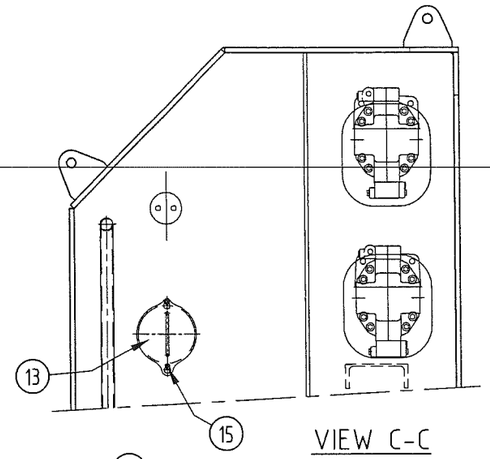
Approved	Scale	Drawing Number
B.M.	1 : 5	A3-2390.325.MDO



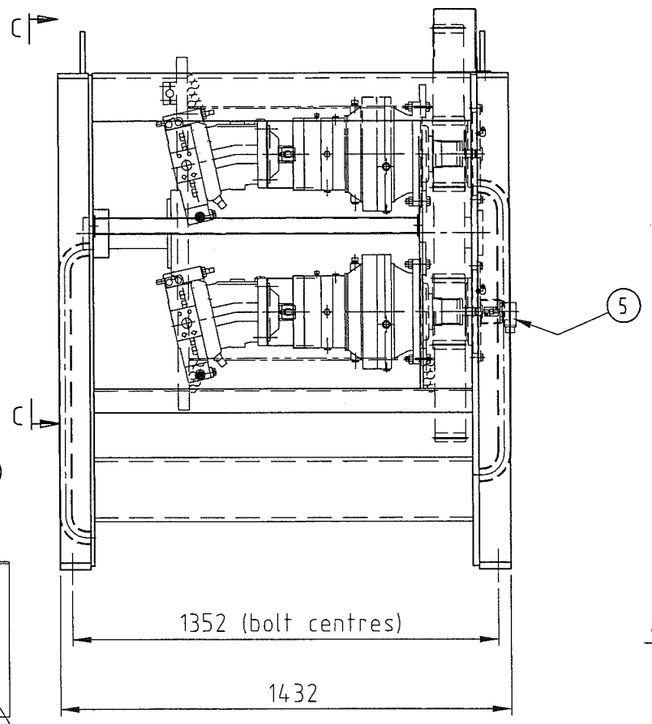
SECTION A-A

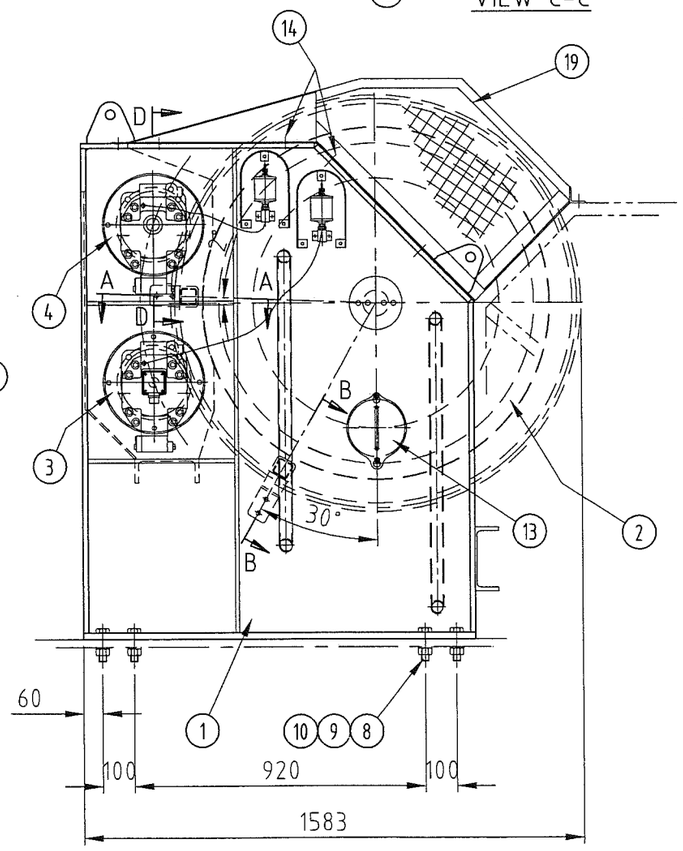


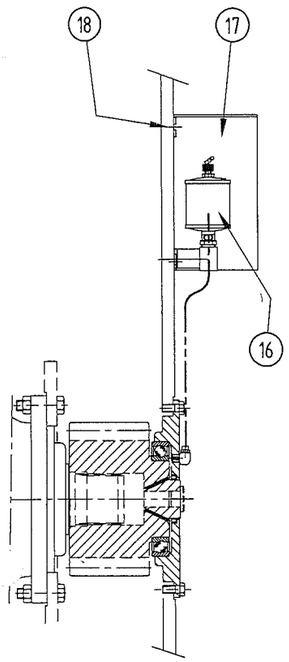
SECTION B-B



VIEW C-C







SECTION D-D

SCALE 1 : 10

Material List					Page 691	
Cat.	Item	Code	Qty	Description	Reference	kg
	1	REF	1	WINCH FRAME DETAILS	A1-2310.256	743
	2	REF	1	FLY DRUM ASSEMBLY	A3-2320.294	1579
	3	REF	1	DRUM DRIVE ASS'Y (Encoder drive)	A3-2390.322	261
	~~4~~	~~REF~~	~~1~~	~~DRUM DRIVE ASSEMBLY~~	~~A3-2390.323~~	~~261~~
	5	REF	1	ENCODER DRIVE ASSEMBLY	A3-2370.429	-
	6	REF	1	ROPE GUARD - Bottom	A4-2315.255	6
	7	REF	1	ROPE GUARD - Top	A4-2315.256	6
P	8	HEX	8	HEX BOLT M24 x 90	GR 10.9	2
P	9	NUT	8	HEX NUT M24	GR 10	-
	10	W	8	WASHER d=25	HARDENED	-
	11	HEX	6	HEX BOLT M12x50 c/w NUT	ST. STEEL	-
	12	HEX	2	HEX BOLT M12 x 25	ST. STEEL	-
	13	REF	2	180 Dia. ACCESS HOLE COVER	A4-2315.189	-
	14	HEX	6	HEX BOLT M10x40 c/w NUT	ST. STEEL	-
	15	HEX	4	HEX BOLT M10 x 20	ST. STEEL	-
	16	REF	2	SPLINE MAINTENANCE	A4-2394.010	1
	17	REF	2	OILER COVER	SK-3336	4
	18	HEX	6	HEX BOLT M8 x 25	ST. STEEL	-
	19	REF	1	GEAR GUARD	A2-2315.260	13

WEIGHT ASS'Y: WINCH ASS'Y (Empty drum) - 2.9 T
WINCH ASS'Y (with 24 dia rope - 450 m Long) - 4.2 T

NOTES:

1. U.O.N. ALL BOLTS TIGHTENED TO DWG. A3-9900.214.
2. DRILL (OR DRILL & TAP) HOLES IN WINCH FRAME TO SUIT ROPE GUARDS, COVERS AND OILERS AT ASSEMBLY.
3. ITEMS MARKED 'P' (PRIMARY), REQUIRE TRACEABILTY TO MECHANICAL & CHEMICAL MILL CERTIFICATES.
4. GRADE 10.9 BOLTS SUPPLIED OFF SHELF MAY NOT MEET CHARPY'S AS SPECIFIED IN THE CONTRACT. (SPECIAL BOLTS MAY BE REQUIRED).

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	1.02.05	ORIGINAL ISSUE	-	L.Z.	A
Checked	Date	Revision	ECN	Name	Issue

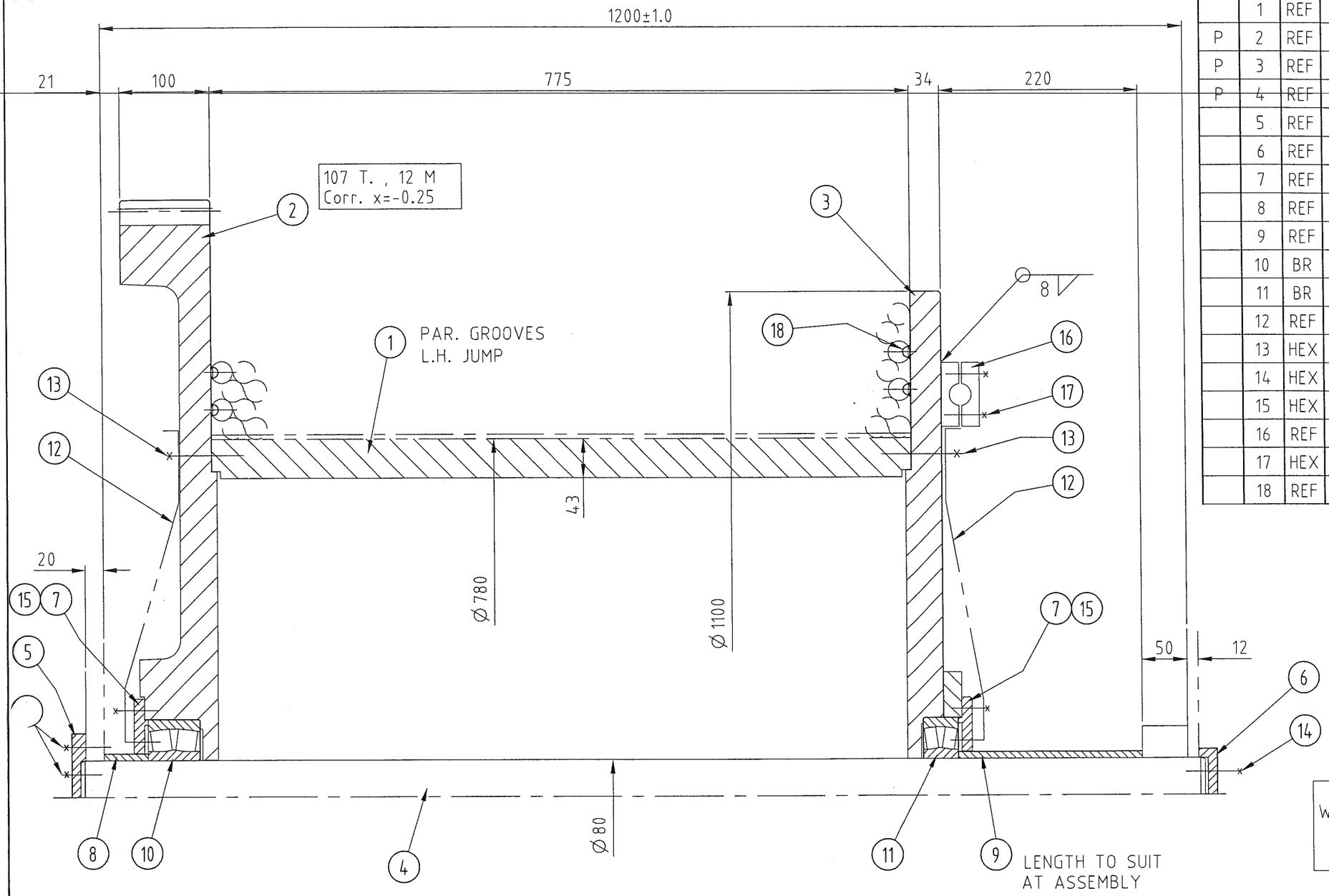
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A.C.N. 067 562 449
A subsidiary of Muhibbah Engineering (M) BHD

Project: M440D - (525-25-10) — First Used On S/No. 1234

Title: FLY WINCH ASSEMBLY — Activity No. 230

Drawn	Checked	Date Drawn	Sheet	Weight	M/Film	Issue
L.ZUBIC		1.02.05	1 of 1	2876 kg		A

Approved	Scale	Drawing Number
	1 : 20	A3-2300.302



Material List

Cat.	Item	Code	Qty	Description	Reference	kg
	1	REF	1	DRUM	A3-2321.092	690
P	2	REF	1	DRUM GEAR	A3-2340.155	540
P	3	REF	1	DRUM FLANGE	A3-2330.146	272
~~P~~	~~4~~	~~REF~~	~~1~~	~~DRUM SHAFT~~	~~A4-2345.163~~	~~49~~
	5	REF	1	END COVER	A4-2345.102	2
	6	REF	1	END COVER	A4-2345.052	2
	7	REF	2	BEARING COVER	A4-2331.154	2
	8	REF	1	SPACER (L=49mm) - GR.750	A4-9921.001/080	-
	9	REF	1	SPACER (L=204mm) - GR.750	A4-9921.001/080	-
	10	BR	1	BEARING (80/170/58)	22316	6
	11	BR	1	BEARING (80/170/39)	21316	4
	12	REF	2	GREASE LINE	A4-9230.028	-
	13	HEX	35	HEX BOLT M20 x 70	GRADE 8.8	7
	14	HEX	6	HEX BOLT M12 x 35	ST. STEEL	
	15	HEX	8	HEX BOLT M10 x 30	ST. STEEL	-
	16	REF	2	ROPE CLAMP	A4-9230.037.002	4
	17	HEX	8	HEX BOLT M16 x 40	GRADE 8.8	1
	18	REF	1	KICKER PLATES LAYOUT	A2-2322.031	-

WEIGHT ASS'Y: DRUM ASS'Y (Empty drum) - 1.6 T
DRUM ASS'Y (with 450m - Ø24 rope) - 2.9 T

ROPE CAPACITY: Ø24 ROPE

1st LAYER	_____	70.7 m
2nd LAYER	_____	79.6 m
3rd LAYER	_____	86.3 m
4th LAYER	_____	87.4 m
5th LAYER	_____	85.1 m
USABLE ROPE CAPACITY	__	409.1 m

NOTES:

1. U.O.N. ALL BOLTS TO BE TIGHTENED TO DWG. A3-9900.214
2. GREASE NIPPLES AT R400 FROM CL OF SHAFT.
3. ITEMS MARKED "P" ARE PRIMARY ITEMS AND REQUIRE TRACEABILITY TO MECHANICAL AND CHEMICAL MILL CERTIFICATES.

	Date	Revision	ECN	Name	Issue
	31.01.05	ORIGINAL ISSUE	-	L.Z.	A

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Project: M440D - (525-25-10) — First Used On S/No. 1234

Title: FLY DRUM ASSEMBLY — Activity No. 230

Drawn	Checked	Date Drawn	Sheet	Weight	M/Film	Issue
L.ZUBIC		31.01.05	1 of 1	1579 kg		A

Approved	Scale	Drawing Number
	1 : 5	A3-2320.294

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ATTENTION: MAINTENANCE PERSONNEL:

1. USE ONLY OIL AS NOMINATED IN CRANE MANUAL, SECTION 4 TO FILL GEARBOX, BRAKE AND MOTOR. DO NOT OVERFILL GEARBOX OR BRAKE.
2. FOR GEARBOX USE SYNTHETIC OIL, AS NOMINATED IN CRANE MANUAL.

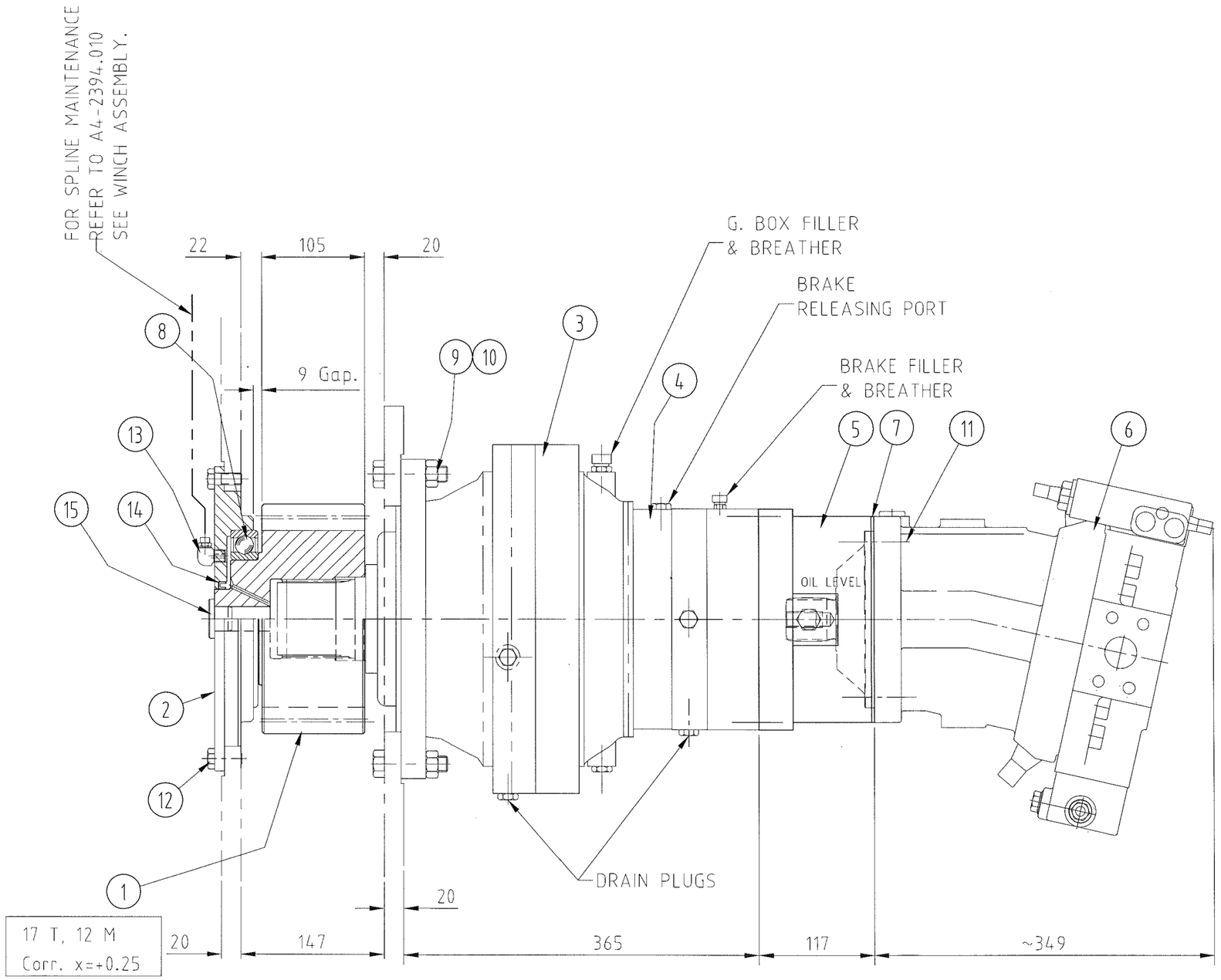
NOTES:

1. MATERIAL LIST IS FOR ONE (1) DRIVE ONLY. REFER TO WINCH ASSEMBLY FOR NUMBER OFF REQUIRED.
2. FULLY CLEAN MATING SURFACE OF GEARBOX AND WINCH, AND THEN APPLY "LOCTITE 277" TO PROVIDE FRICTION JOINT.
3. U.N.O. ALL BOLTS ARE TIGHTENED TO DWG. A3-9900.214.

**. TO BE ORDERED WITH SHAFT SEAL REMOVED, AND A LEVEL PLUG ON THE SHAFT CENTRELINE. **

Material List

Cat.	Item	Code	Qty	Description	Reference	kg
P	1	REF	1	DRIVE PINION	A4-2392.182	27
	2	REF	1	BEARING HOUSING	A3-2391.032	11
	3	GBX	1	GEARBOX		110
	4	REF	1	BRAKE		42
	5	ADP	1	MOTOR ADAPTOR SET		3
	6	MTR	REF	HYDRAULIC MOTOR		64
	7	REF	1	MOTOR GASKET	A3-2394.005	-
	8	BR	1	BEARING (120/180/28) - "S.K.F."	6024-2RS	2
	9	HEX	10	HEX BOLT M16 x 65	GRADE 8.8	1
	10	NUT	10	HEX NUT M16	GRADE 8	-
	11	HEX	4	HEX BOLT M16 x 50	GRADE 8.8	1
	12	HEX	4	HEX BOLT M12 x 30	ST. STEEL	-
	13	NPL	REF	OIL NIPPLE ELBOW 5/16" OD- 1/4"BSPT	BRASS	-
	14	-	1	SHAFT SEAL-(60/75/8) "CR Seals"	CRW1	-
	15	REF	1	DRIVE PINION PLUG	A4-2391.034/2	-



	31.01.05	ORIGINAL ISSUE	-	L.Z.	A
Checked	Date	Revision	ECN	Name	Issue

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Project: M440D - (525-25-10) — First Used On S/No. 1234

Title: DRUM DRIVE ASSEMBLY - (Fly) — Activity No. 230

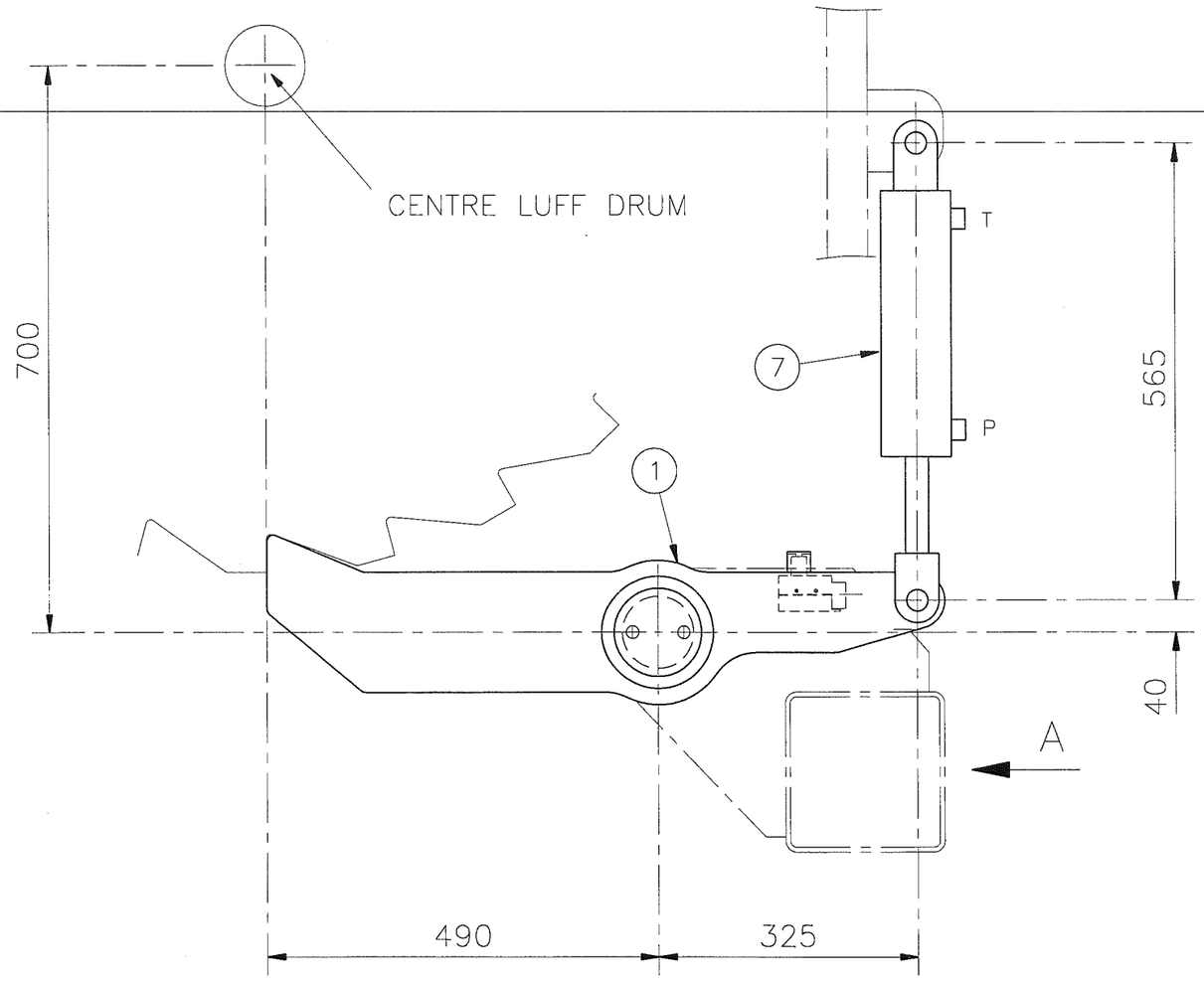
Drawn	Checked	Date Drawn	Sheet	Weight	M/Film	Issue
L.ZUBIC		31.01.05	1 of 1	261 kg		A
	Approved	Scale	Drawing Number			
		1 : 5	A3-2390.323.MDO			

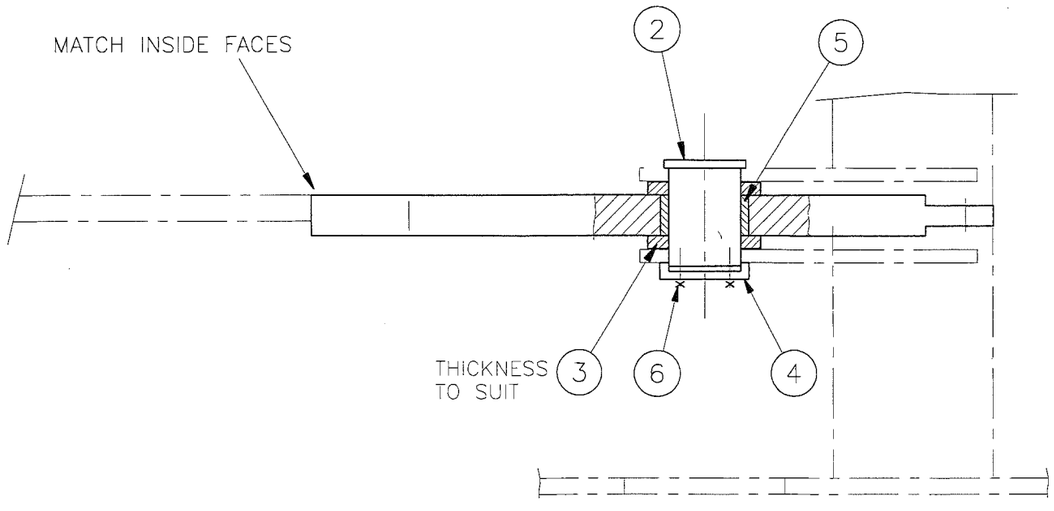
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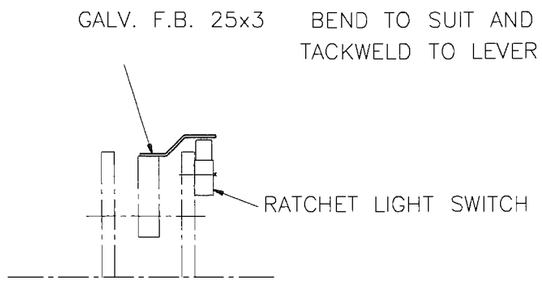
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MATERIAL LIST

ITEM	DESCRIPTION		QTY
1	PAWL	DWG. A4-2351.065	1
2	PIN	DWG. A4-2351.066	1
3	WASHER	DWG. A4-2351.067	2
4	END COVER	DWG. A4-2345.026	1
5	PLAIN BEARING	MB 90100DU CBC	1
6	HEX. SCREW	M16 x 30 GR 8.8	2
7	CYLINDER	REF. HYDR.CIRCUIT	REF







VIEW A

NOTE: ITEM 5 TO BE DIVIDED INTO
2 EQUAL LENGTH AND CUTOFF
STOCKED FOR NEXT WINCH.

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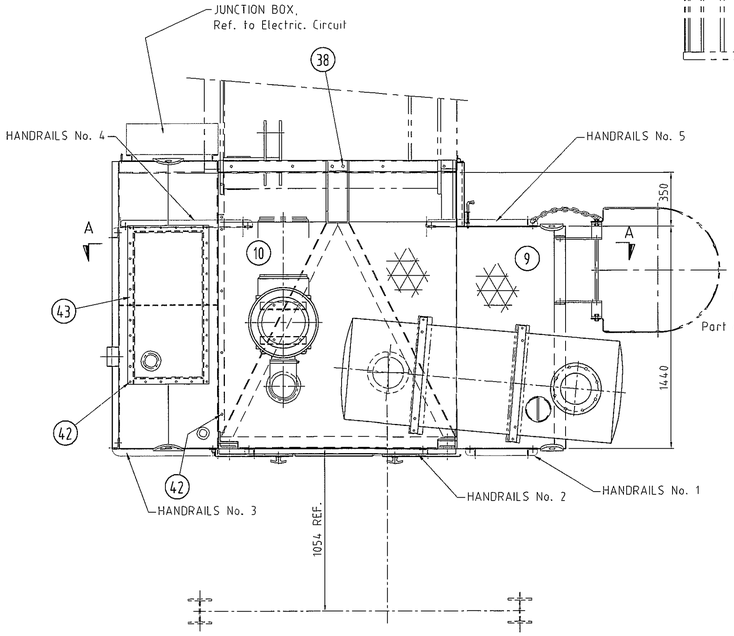
DATE	REVISION	NAME	ISSUE
20.4.95	ORIGINAL ISSUE	HB	A

FAVELLE FAVCO CRANES PTY LTD.
(INCORPORATED IN N.S.W.) A.C.N. 003 689 478
SYDNEY MELBOURNE BRISBANE PERTH

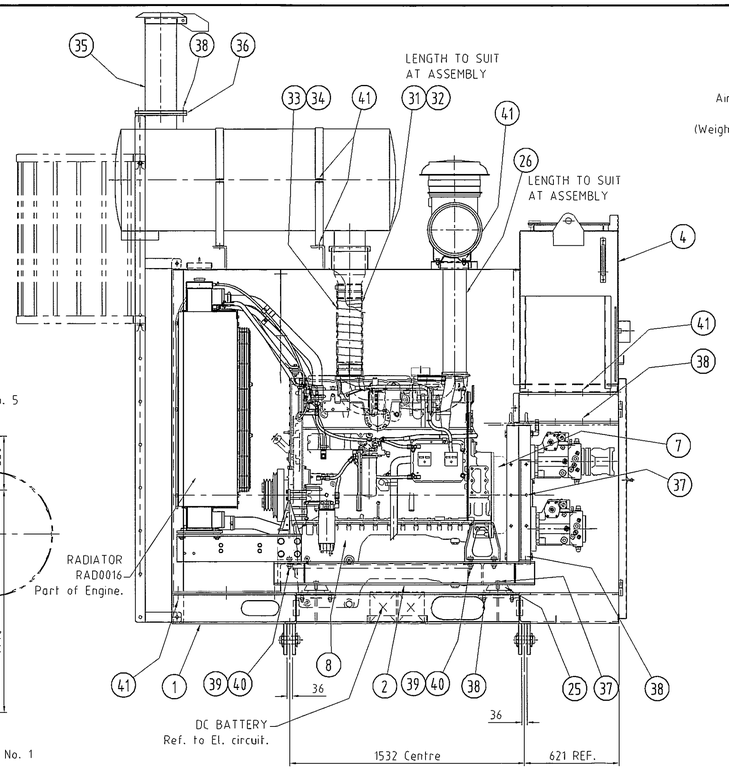
PROJECT: 760/600/440/380-XXX-32/25/16/12
FIRST USED ON S/NO

TITLE: LUFF RATCHET ASSEMBLY

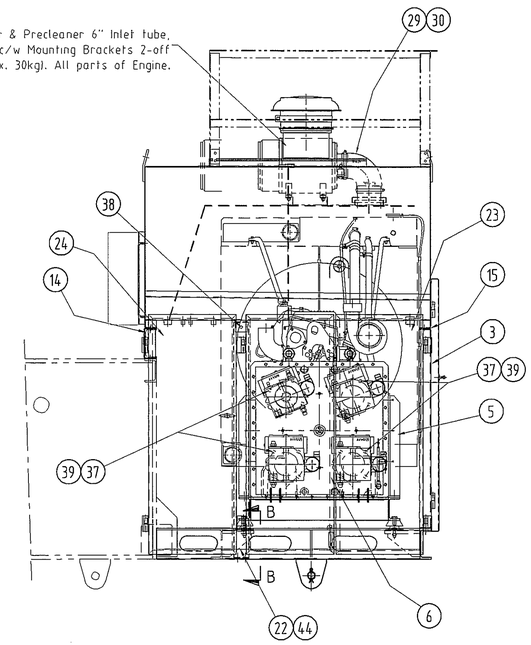
DRAWN	CHECKED	DATE DRAWN	SHEET	WEIGHT	ISSUE
H.Bli.	P.F.D	17.10.95	1 OF 1		A
	APPROVED	SCALE	DRAWING No.		
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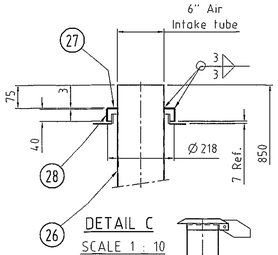


PLAN VIEW

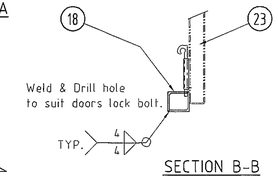


SECTION A-A

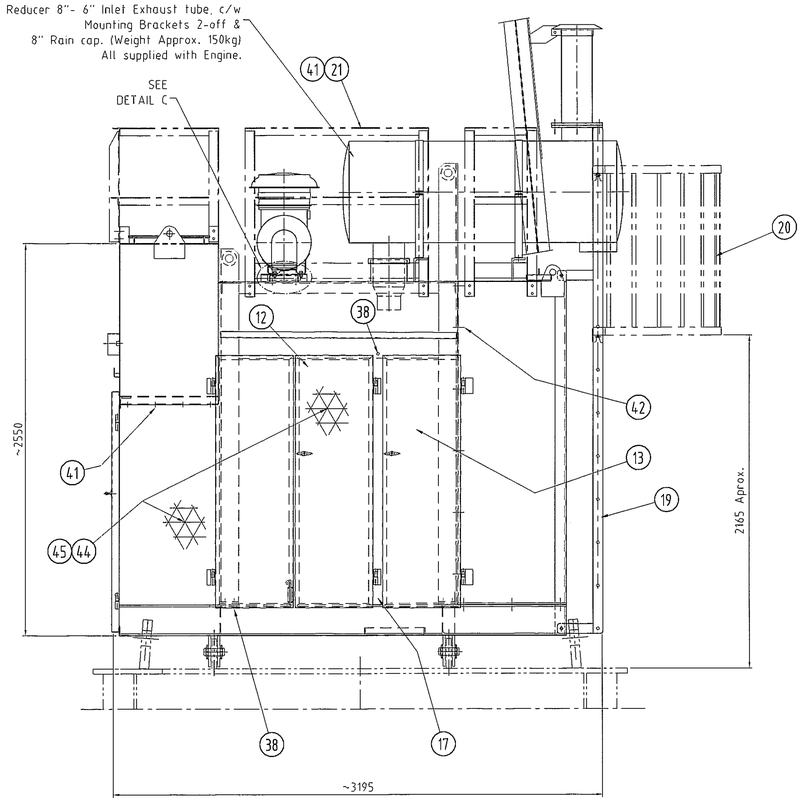


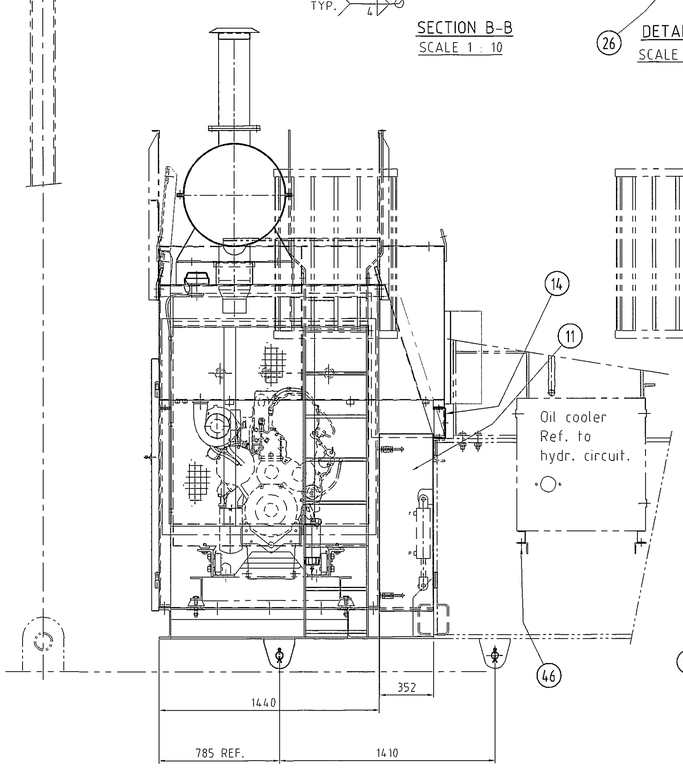


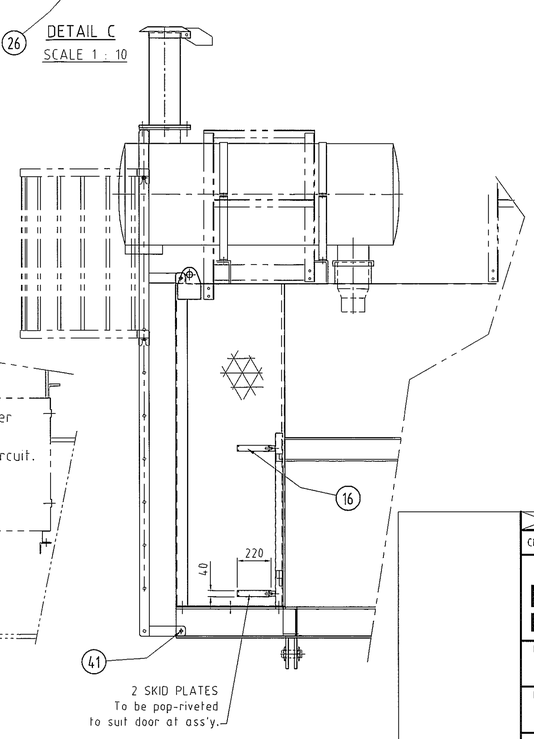
DETAIL C
SCALE 1 : 10



SECTION B-B
SCALE 1 : 10







NOTES:

1. U.N.O , ALL BOLTS TIGHTENED TO DWG. A3-9900.214
2. HOLD DOWN PINS WERE CALLED UP ON WINCH ASS'Y. SEE FFC DWG. No. A2-2300.306

WEIGHT ASS'Y: P. PACK ASS'Y (Dry) ~ 4.3 T
P. PACK (With oil) ~ 5.3 T

Material List

Cat	Item	Qty	Description	Reference	kg
	1	1	POWERPACK BASE FRAME	A3-2410.349	305
	2	1	ENGINE SUPPORT FRAME	A3-2410.328/1	117
	3	1	OIL TANK SUPPORT - RIGHT	A4-2421.119	27
	4	1	HYDRAULIC OIL TANK	A2-2420.162	373
	5	1Set	GEAR BOX SUPPORTS	A3-2410.328/6	15
	6	1	GEAR BOX SPECIFICATION	A4-2450.126	725
	7	1	ENGINE -GEAR BOX COUPLING	A4-2436.033	30
	8	1	ENGINE SPECIFICATION	A4-2430.097	1700
	9	1	RADIATOR COVER	A3-2411.357	211
	10	1	POWER PACK ROOF DETAILS	A2-2411.356	258
	11	1	REAR DOOR	A4-2411.292	17
	12	1	SIDE DOUBLE DOORS	A3-2411.193.007	60
	13	1	SIDE SINGLE DOOR	A4-2411.191.005	30
	14	1	OIL TANK SUPPORT LEFT	A4-2411.211	15
	15	1	SPACER 5mm Thick plate x 70 - 650 LG	250MPa FFC SPEC 114	2
	16	2	SKID PLATE 3mm x 40 - 220 LG	ST. STEEL	-
	17	1	ROOF SUPPORT	A4-2411.162	10
	18	1	EA 65 x 65 x 5 - 60mm LG	250MPa FFC SPEC 114	-
	19	1	ACCESS LADDER DETAILS	A3-2411.294	47
	20	1	ACCESS LADDER CAGE	A3-2421.127	10
	21	1	POWER PACK HANDRAILS	A2-2421.144	110
	22	1	PUMP'S DOORS SUPPORT	A4-2411.275	9
	23	1	PUMP'S DOUBLE DOORS	A3-2411.193.026	57
	24	1	PUMP'S SINGLE DOOR	A4-2411.191.011	28
	25	4	VIBRATION DAMP. - 1000 kg - "Blackwoods"	P/No. 0037 5700	4
	26	1	6" AIR INTAKE TUBE - 850mm LG	ALUMINIUM	4
	27	1	3mm PL x Ø218 O.D. / 6" I.D.	ALUMINIUM	-
	28	1	3mm PL x 40 x 694 - ROLLED to 218 I.D	ALUMINIUM	-
	29	2	6" - 90° RUBBER BEND - "Engine prot. equipm."	P/No. RL690	-
	30	4	6" T-BOLT CLAMP - "Clampco products"	P/No. C410C-75-0656-S	-
	31	1	6" FLEX. EXHAUST PIPE - 650mm LG	ST. STEEL	4
	32	2	6" SEAL CLAMP FOR FLEX. TUBING - "Donaldson"	P/No KYX00-4539	-
	33	1	LAGGING - GARLOCK ST. 1410 - 10m LG. - "Blackwoods"	P/No 0409 2665	-
	34	3	8" T-BOLT CLAMP - "Clampco products"	P/No C412C-75-0875-S	-
	35	1	EXHAUST TUBE EXTENSION	A4-2411.327	15
	36	1	15mm Thick GASKET - 335 O.D./8" I.D. - "Blackwoods"	ST-706 - GARLOCK	-
	37	26	HEX BOLT M20 x 40	GRADE 8.8	4
	38	30	HEX BOLT M16 x 50 - c/w NUT	GRADE 8.8	3
	39	26	WASHER M20 - HARD. - "Blackwoods catalog"	P/No. 0247 9901	1
	40	10	HEX BOLT M20 x 60 - c/w NUT	GRADE 8.8	2
	41	56	HEX BOLT M12 x 40 - c/w NUT	ST. STEEL	3
	42	54	HEX BOLT M10 x 35 - c/w NUT	ST. STEEL	2
	43	1	6mm THICK GASKET - (530 x 1030)	PERBUNAN	-
	44	1	INSULATION 50mm Thick x 12 sqm	PYROTECH	10
	45	20	CD PINS 0.105 x 2 1/4" c/w 0.105 SPEED CLIPS	ST. STEEL	-
	46	6	HEX BOLT M8 x 30 - c/w NUT	ST. STEEL	-

	Date	Revision	ECN	Name	Issue
Checked	3.01.06	TAKEN FROM A2-2400.136	-	L.Z.	A

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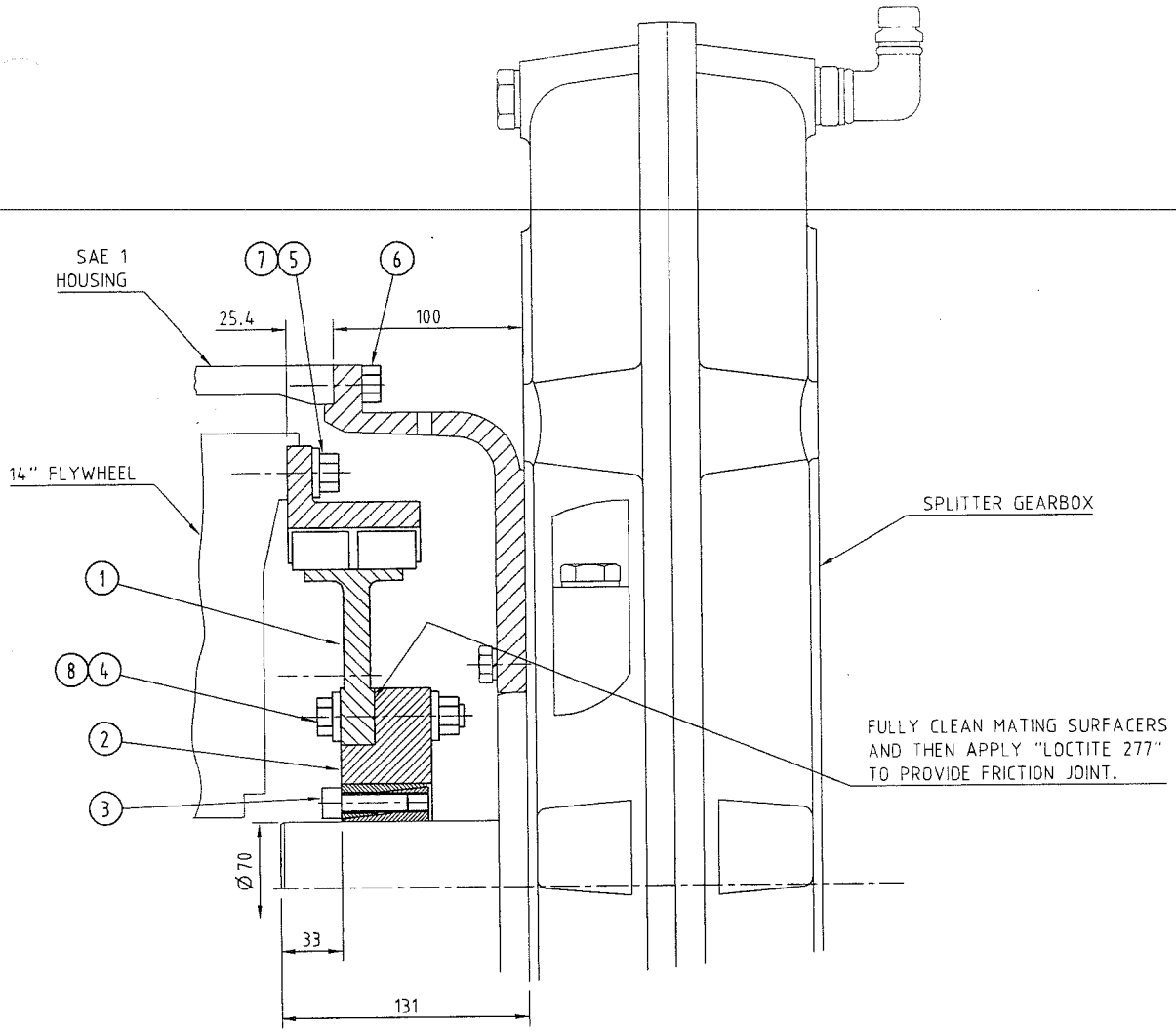
Project: M440E - (440-540-25) — First Used On S/No 1323

Drawing Number: POWER PACK ASSEMBLY — Activity No. 240

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
L.ZUBIC		3.01.06	1 : 20	1 of 1	4355 kg	A
	Approved	Eng Approved	Drawing Number			
			A1-2400.206			

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MAX.CAPACITY: 750HP (560KW)

CONTRACT DESIGN SPECIFICATION			
Please refer to the Contract Design Specification for all specific notes applicable to a particular contract. All information on this contract design specification takes precedence over any notes on this drawing.			
S/No	CDS No	S/No	CDS No

NOTES

1. ALL BOLTS AND SCREWS TO BE FITTED WITH LOCTITE
2. TIGHTENING TORQUES TO FFC DRAWING A3-9900.214
3. LOCKING DEVICE TO BE LIGHTLY OILED BEFORE ASSEMBLY.

NOTE:
IT IS IMPORTANT NOT TO USE MOLYKOTE, NEVER SEEZE OR SIMILAR LUBRICANTS.

TIGHTEN LOCKING SCREWS EVENLY CROSSWISE TO THE NOMINATED TIGHTENING TORQUE PER SCREW OF: 83Nm

Item	Description		Q'ty
8	HARDENED WASHER	14	24
7	HARDENED WASHER	12	8
6	HEX. SCREW	7/16" UNC x 1 1/4"	12
5	HEX. SCREW	1/2" UNC x 1 1/2"	8
4	HEX. BOLT & NUT	M14 x 70	12
3	LOCKING ASSEMBLY		1
2	INPUT FLANGE	DWG. A4-2437.043	1
1	TWINDISC COUPLING		1

Appr'd	Date	Revision	Drawn	Rev.
	05.08	ORIGINAL ISSUE	NPV	B

Title: ENG./GEARBOX COUPLING

First Used On S/No.

Favelle Favco Cranes Pty. Ltd.
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Drawn	Date Drawn	Sheet	Weight	M/Film	Issue
NPV	07.05.08	1 Of 1			B

Scale	Checked	Drawing Number
1:3	U.S.	A4-2436.033.MDO

Approved

C-15 ENGINE SPECIFICATION - (For M440E - USA) S/No. 1323

	: C15 ACERT DIT - ATAAC INDUSTRIAL ENGINE
	: FLYWHEEL HOUSING No.1 - SAE J617C
	: FLYWHEEL 14" - SAE J620D
EXHMDRY	: EXHAUST MANIFOLD DRY
ATAAC02	: AIR TO AIR AFTERCOOLER
CERTIF	: EPA / CARB TIER 3 & EC STAGE IIIA
INDUSTC	: INDUST INTERMITTENT C - RATING
HP00540	: 540BHP, (403 BKW) W/O FAN
2100RPM	: 2100 RPM
EXCEL14	: EXHAUST ELBOW - FRONT FACING EXHAUST (CLAMP KIT c/w FLEXIBLE FITTING)
RAD	: RADIATOR
AFTCL04	: AFTER COOLER LINES
FANB	: BLOWER FAN 43 IN
FANADB1	: BLOWER FAN ADAPTER 43 IN
FDV0016	: FAN DRIVE 0.681 RATIO
CLS0001	: COOLANT LEVEL SENSOR
ALT2405	: CHARGING ALTERNATOR 24 V 50 AMP (c/w ALTERNATOR MOUNTING LH)
ENGSUP8	: REAR ENGINE SUPPORT
ACLDE01	: AIR CLEANER - DUAL ELEMENT
LUBOIL3	: LUBRICATING OIL
FUMDIS1	: FUMES DISPOSAL
FULIN03	: FUEL LINES LH & FUEL COOLER (c/w PRIMARY FUEL FILTER / WATER SEPARATOR SL)
ELSML10	: ELECTRIC START MOTOR LH 24 V
	: CONTROL GROUP GIP CNTO-S 24 V
	: MESSENGER DISPLAY
DPX0002	: DOMESTIC PACK FOR EXPORT
JWH0001	: JACKET WATER HEATER
LITENGE	: PARTS BOOK - PAPER & ELECTRONIC
102-044-660	: SILENCER MOUNTING FRAME - (2 off)
SRSS/200	: RESIDENTIAL SILENCER 8" c/w RAIN CAP (Reducer Inlet 8" to 6")
EL150 KI	: LOW WATER LEVEL SWITCH GAUGE

Cat.	Item	Code	Q'ty	Description	kg	Checked	Date	Revision	ECN	Drawn	Rev.
						X	12/05	ORIGINAL ISSUE	-	L.Z.	A

Title		Drawn	Date Drawn	Sheet	Weight	M/Film	Issue
First Used On S/No. 1323 Activity No. 240		L.ZUBIC	19.12.05	1 of 1	1700 kg		A
ENGINE SPECIFICATION C15		Scale N/A	Checked DCB	Drawing Number			
Favelle Favco Cranes Pty. Ltd.			Approved	A4-2430.097			

PUMP DRIVE GEARBOX SPECIFICATION FOR:

CRANE TYPE : M900D
POWERPACK TYPE : 900 - 525 - 32

DIESEL ENGINE : CAT. C-15 - 525 HP @ 2100 RPM
FLYWHEEL HOUSING : No. 1 , SAE J617C
FLYWHEEL : No. 14" SAE J620D

GEARBOX TYPE AM 480 RATIO : 0.88 : 1

WITH CYLINDRICAL Ø70x103lg INPUT SHAFT, WITHOUT KEY

COMPLETE WITH 100mm BELLHOUSING ONLY

GEARBOX COOLING NO - (CENTR. PUMP WITH FILTER FOR OIL CIRCULATION PART OF THE GEAR BOX)

FOR COUPLING AND GEARBOX DRIVE FLANGE
REFER TO FAV./FAV. DWG: A4-2436.033

TOP LEFT - SLEW PUMP + Cooling

PUMP : A4VG90
SPIGOT DIA. : 152.4mm
FLANGE & SPLINE : SAE D
MTG. BOLTS : 4-M20
ROTATION : 20 DEG. CCW

TOP RIGHT - LUFF PUMP

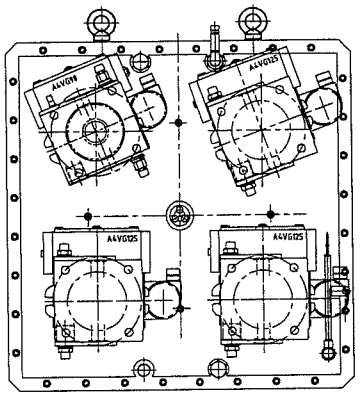
PUMP : A4VG125
SPIGOT DIA. : 152.4mm
FLANGE & SPLINE : SAE D
MTG. BOLTS : 4-M20
ROTATION : 20 DEG. CCW

BOTTOM LEFT - HOIST PUMP No.1

PUMP : A4VG125
SPIGOT DIA. : 152.4mm
FLANGE & SPLINE : SAE D
MTG. BOLTS : 4-M20
ROTATION : HORIZONTAL

BOTTOM RIGHT - HOIST PUMP No.2

PUMP : A4VG125
SPIGOT DIA. : 152.4mm
FLANGE & SPLINE : SAE D
MTG. BOLTS : 4-M20
ROTATION : HORIZONTAL



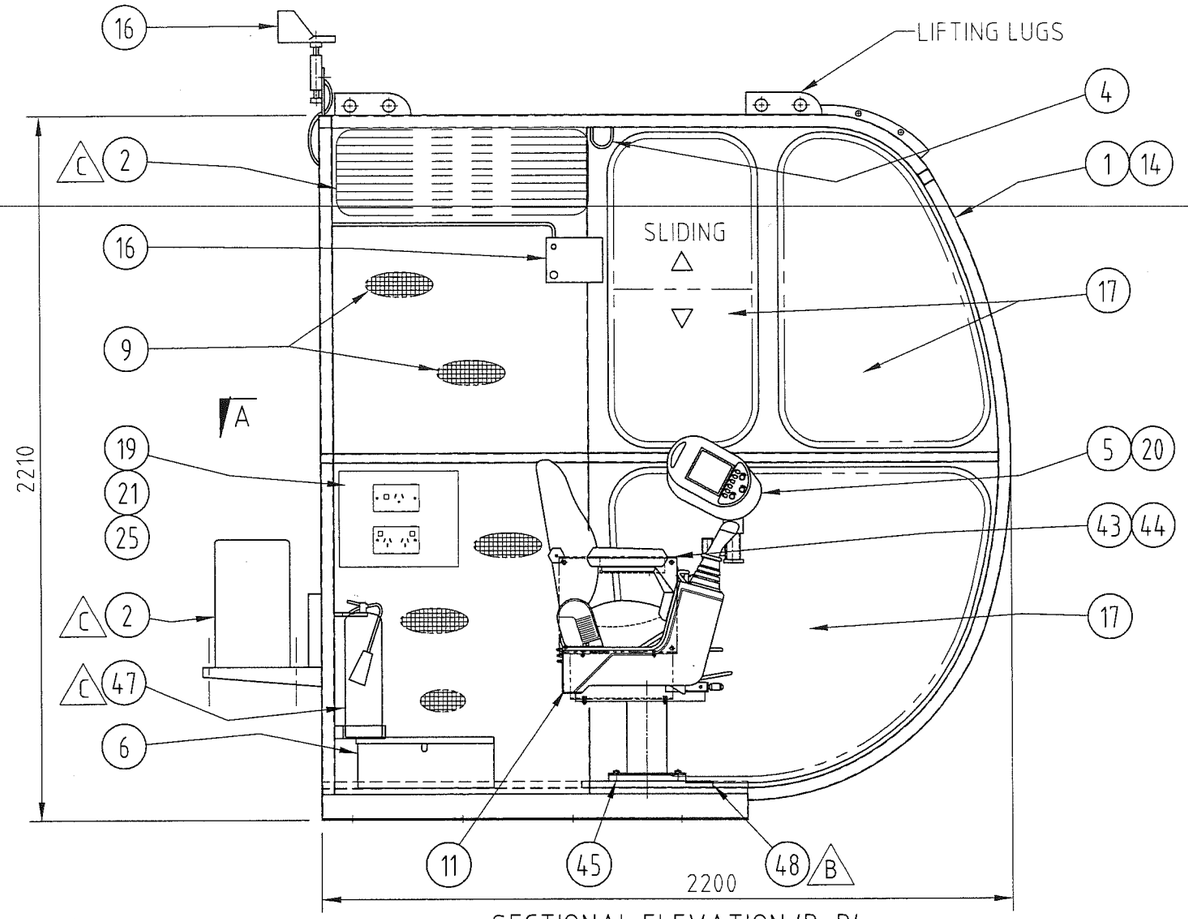
Cat.	Item	Code	Q'ty	Description	kg	Checked	Date	Revision	ECN	Drawn	Rev.
							11/04	ORIGINAL ISSUE	-	L.Z.	A

Title: GEAR BOX SPECIFICATION - (M900D)
First Used On S/No.1250 & 1251 Activity No. 240

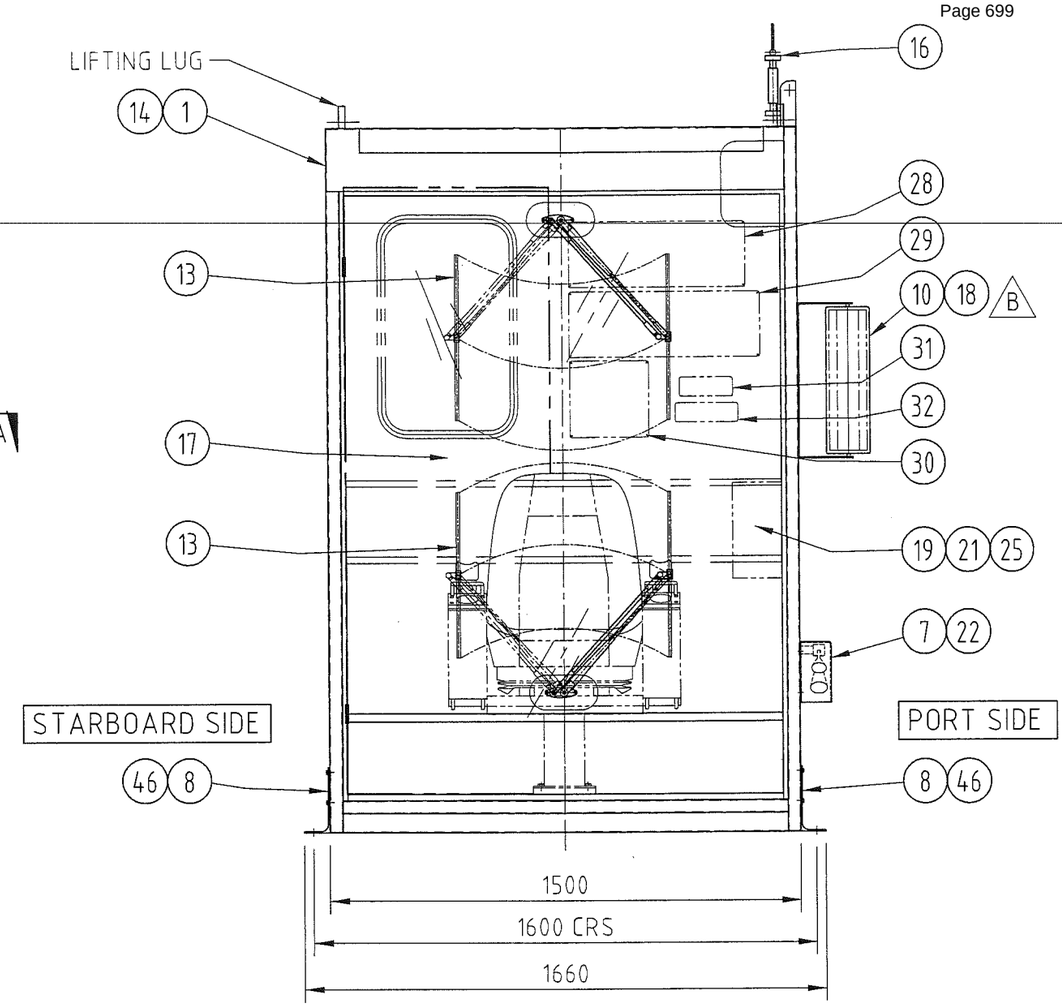
Drawn	Date Drawn	Sheet	Weight	M/Film	Issue
L.ZUBIC	19.11.04	1 of 1	725 kg		A

Scale: N/A
Checked:
Approved:
Drawing Number: A4-2450.126

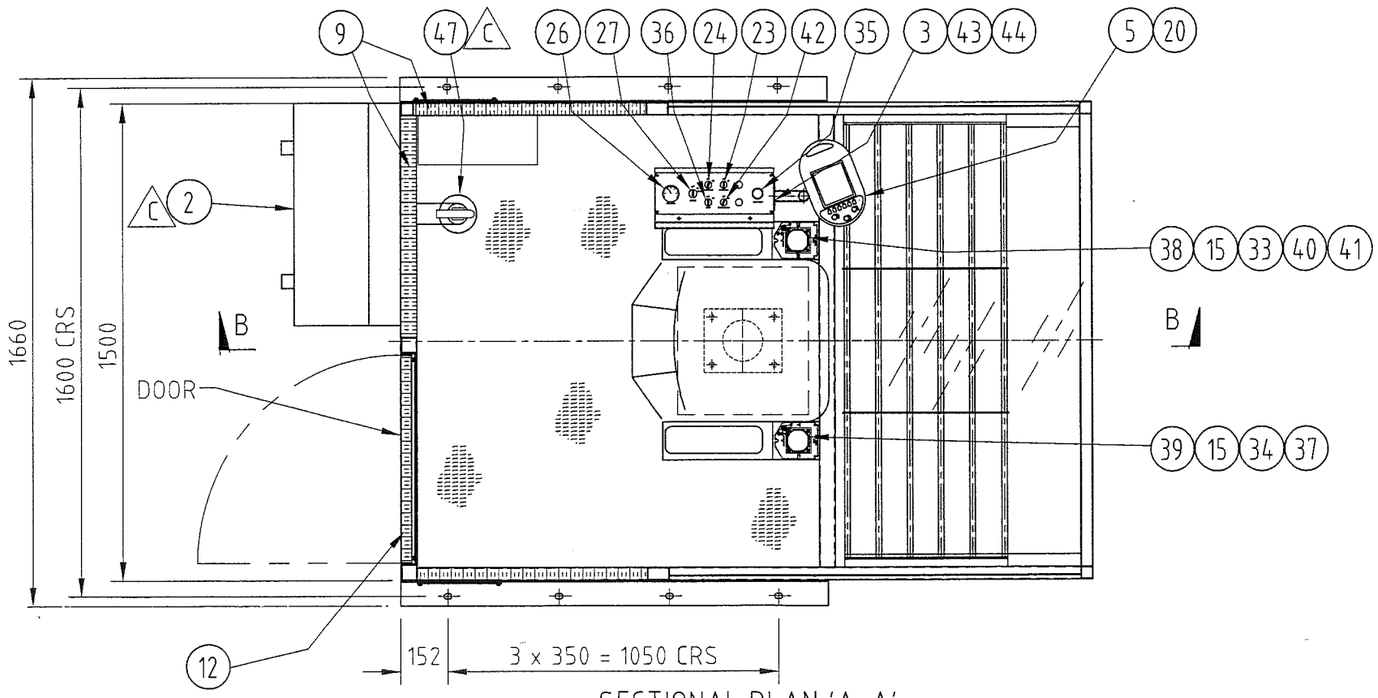
Favelle Favco Cranes Pty. Ltd.



SECTIONAL ELEVATION 'B-B'



FRONT ELEVATION



SECTIONAL PLAN 'A-A'

D.R.	28.04.08	ITEM 2 UPDATED & RELOCATED, ITEM 47	-	DF	C
		A/C SUPPORTS & CUTOUTS DELETED			
		& FIRE EXTINGUISHER ADDED.			
D.R	11.02.08	ITEM 2 UPDATED & RELOCATED, ITEM 47	-	DF	B
		& 48 ADDED & ITEM 10 &18 UPDATED			
X	29.05.07	ORIGINAL ISSUE FROM A3-2100.162	-	GNA	A
Checked	Date	Revision	ECN	Name	Issue

FAVELLE FAVCO

Favelle Favco Cranes Pty. Ltd.
A.B.N. 29 067 562 449
A subsidiary of Muhibbah Engineering (M) BHD

Project: M440E- USA — First Used On S/No. 1475

Title: CABIN ASSEMBLY — Activity No. 210

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
GNA	D.R	29.05.07	1:20	1 of 2	1000kg	C

Approved	Eng. Approved	Drawing Number
A.Mc		A3-2100.175

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Material List

Cat.	Item	Qty	Description	Reference	kg
	28	REF	MAIN HOIST - SINGLE FALL LOAD CHART		
	29	REF	AUXILIARY HOIST - SINGLE FALL LOAD CHART		
	30	1	ROPE SPECIFICATION PLATE	A3-2175.294	
	31	1	OPERATIONAL NAMEPLATE	A3-9900.613/1	
	32	1	OPERATIONAL NAMEPLATE	A3-9900.613/2	
	33	1	OPERATIONAL NAMEPLATE	A3-9900.613/4	
	34	1	OPERATIONAL NAMEPLATE	A3-9900.613/5	
	35	REF	EMERGENCY STOP	ELEC. EQUIP. SCHED.	
	36	REF	WIPER SWITCH	ELEC. EQUIP. SCHED.	
	37	REF	ENGINE THROTTLE	ELEC. EQUIP. SCHED.	
	38	REF	SLEW CONTROL LEVER	ELEC. EQUIP. SCHED.	
	39	REF	LUFF/HOIST CONTROL LEVER	ELEC. EQUIP. SCHED.	
	40	REF	HORN BUTTON	ELEC. EQUIP. SCHED.	
	41	REF	SLEW BRAKE	ELEC. EQUIP. SCHED.	
	42	REF	ENGINE ECONOMY	ELEC. EQUIP. SCHED.	
	43	REF	CONTROL CONSOLE BOX (X5)	ELEC. EQUIP. SCHED.	
	44	1	CONTROL PANEL CONSOLE BOX	A3-2121.176	
			SUPPORT BRACKET		
	45	4	M12 x 20LG HEX SCREW	GRADE 8.8	
	46	8	M8 x 20LG HEX SCREW C/W NUT & WASHER	GRADE 8.8	
C	47	1	FIRE EXTINGUISHER (DRY POWDER)	2Kg DRY CHEMICAL	
			COMPLETE WITH WALL MOUNTING BRACKET		
B	48	1	SEAT BASE PLATE	A3-2121.208	

Material List

Cat.	Item	Qty	Description	Reference	kg
	1	1	CABIN DETAILS	SK4803	
	2	REF	AIR CONDITIONER	ELEC. EQUIP. SCHED.	
	3	1	CONTROL PANEL	A3-9900.584	
	4	REF	CABIN LIGHT	ELEC. EQUIP. SCHED.	
	5	REF	SAFE LOAD DISPLAY UNIT (CANBUS)	ELEC. EQUIP. SCHED.	
	6	1	TOOLBOX	SPEC No. E700	
	7	REF	HORN - HELLA 6027	ELEC. EQUIP. SCHED.	
	8	1	ELECTRICAL CABLE ENTRY COVER PLATE	A3-2121.194	
	9	1	INSULATION - 38mm THICK SOUNDSORBER	SOUNDGUARD	
			PR NA (NON ADHESIVE) - GREY	PYROTECH	
			8.0 METRE SQUARE		
B	10	1	BRITAX REAR VIEW MIRROR	PN 1421100	
			WEST COAST TYPE 18"		
	11	1	SEAT - HEAD REST & BUILT IN ARM PODS	KAB MODEL T4	
	12	1	INSULATION - 38mm THICK SOUNDSORBER	SOUNDGUARD	
			PR NA (NON-ADHESIVE) - GREY	PYROTECH	
			1.5 METRE SQUARE		
	13	1	ELECTRIC WINDSCREEN WIPER	SK4803	
	14	1	CRANE NAME PLATE	A4-9900.408	
	15	2	JC600 JOY STICK PLATE ADAPTOR	SKU000 (USA)	
	16	1	WIND SPEED INDICATOR 108	DWYER MARK II	
			DWYER INSTRUMENTS		
	17	1	SET OF WINDOWS	SK4803	
B	18	1	SIDE MIRROR SUPPORT	A3-2121.224	
	19	REF	DISTRIBUTION BOARD X8	ELEC. EQUIP. SCHED.	
	20	1	CANBUS DISPLAY SUPPORT BRACKET	A3-2121.177	
	21	REF	AVIATION LIGHT GPO	ELEC. EQUIP. SCHED.	
	22	1	CABIN HORN COVER	A3-2121.081	
	23	REF	LMI BYPASS (LUFF OUT OVERRIDE)	ELEC. EQUIP. SCHED.	
	24	REF	CABIN LIGHT SWITCH	ELEC. EQUIP. SCHED.	
	25	REF	TWIN GPO OUTLET	ELEC. EQUIP. SCHED.	
	26	REF	FUEL LEVEL GAUGE	ELEC. EQUIP. SCHED.	
	27	REF	IGNITION/START	ELEC. EQUIP. SCHED.	

Checked	Date	Revision	ECN	Name	Issue
D.R.	28.04.08	REFER TO SHEET 1	-	DF	C
D.R	11.02.08	REFER TO SHEET 1	-	DF	B
X	29.05.07	ORIGINAL ISSUE FROM A3-2100.162	-	GNA	A

FAVELLE FAVCO

Favelle Favco Cranes Pty. Ltd.
A.B.N. 29 067 562 449
A subsidiary of Muhibbah Engineering (M) BHD

Project: M440E-USA — First Used On S/No. 1475

Title: CABIN ASSEMBLY — Activity No. 210

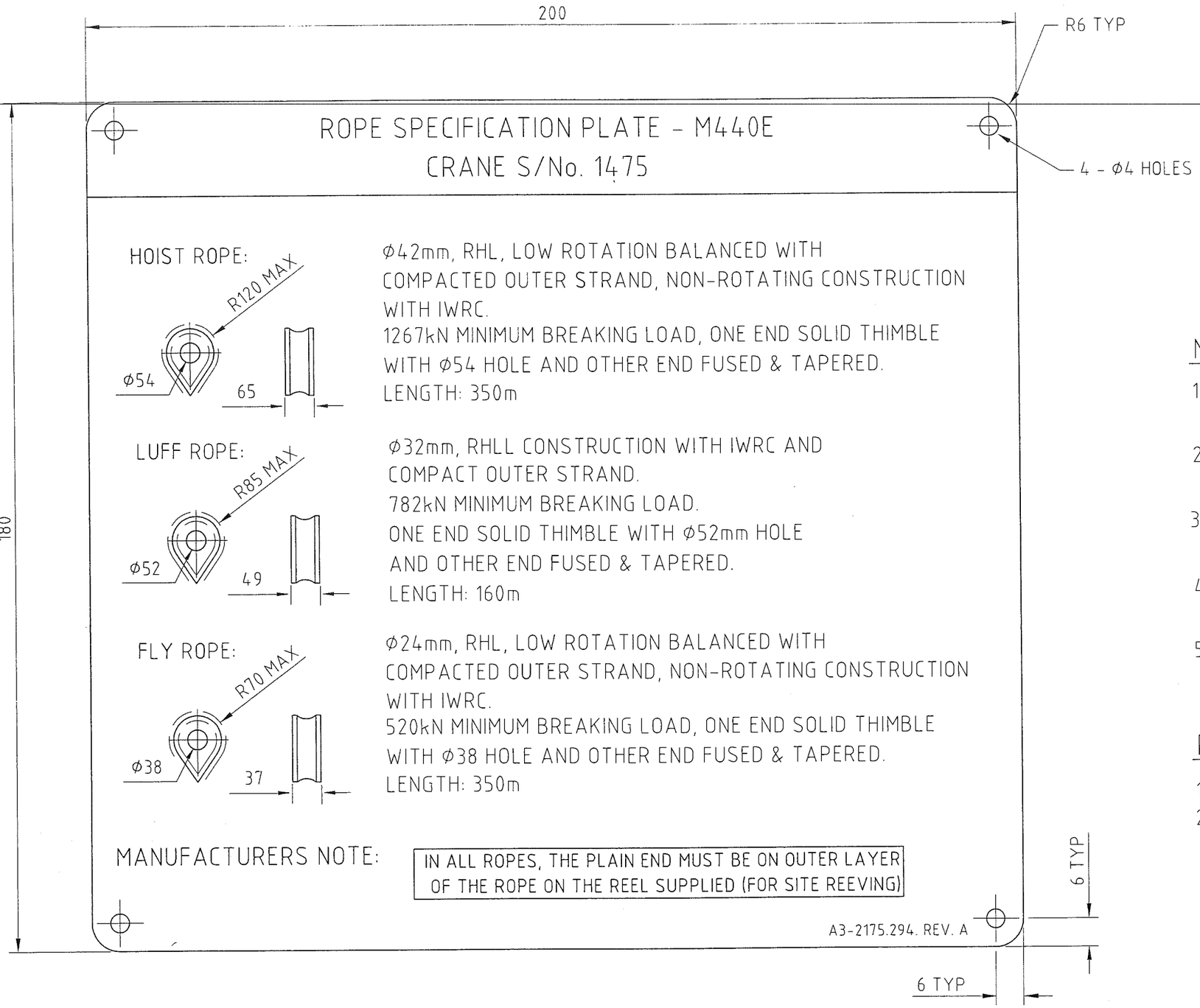
Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
GNA	D.R	29.05.07	1:1	2 of 2	SHT. 1	C

	Approved	Eng. Approved	Drawing Number
	A.Mc		A3-2100.175

FORM:F04.04.02

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ROPE SPECIFICATION PLATE - M440E
CRANE S/No. 1475

HOIST ROPE:

ϕ42mm, RHL, LOW ROTATION BALANCED WITH COMPACTED OUTER STRAND, NON-ROTATING CONSTRUCTION WITH IWRC.
1267kN MINIMUM BREAKING LOAD, ONE END SOLID THIMBLE WITH ϕ54 HOLE AND OTHER END FUSED & TAPERED.
LENGTH: 350m

LUFF ROPE:

ϕ32mm, RHLL CONSTRUCTION WITH IWRC AND COMPACT OUTER STRAND.
782kN MINIMUM BREAKING LOAD.
ONE END SOLID THIMBLE WITH ϕ52mm HOLE AND OTHER END FUSED & TAPERED.
LENGTH: 160m

FLY ROPE:

ϕ24mm, RHL, LOW ROTATION BALANCED WITH COMPACTED OUTER STRAND, NON-ROTATING CONSTRUCTION WITH IWRC.
520kN MINIMUM BREAKING LOAD, ONE END SOLID THIMBLE WITH ϕ38 HOLE AND OTHER END FUSED & TAPERED.
LENGTH: 350m

MANUFACTURERS NOTE: IN ALL ROPES, THE PLAIN END MUST BE ON OUTER LAYER OF THE ROPE ON THE REEL SUPPLIED (FOR SITE REEVING)

A3-2175.294. REV. A

NOTES

1. ROPE SPECIFICATION PLATE TO BE LOCATED IN DRIVERS CONTROL CABIN.
2. MATERIAL: "WHITE TRAFFOLYTE" 1.5mm THICK ENGRAVED LETTERS IN BLACK COLOUR
3. HOIST & FLY ROPE LENGTH IS BASED ON THE SCOPE OF SUPPLY.
4. SUPPLIER SHALL PROVIDE A TEST CERTIFICATE FOR HOIST & LUFF ROPES AS PER AS 3569-1989.
5. SUPPLIER SHALL PROVIDE A COMPLIANCE CERTIFICATE FOR SOLID THIMBLES AS PER AS113-1992.

REFERENCE DRAWINGS

1. REEVING DIAGRAM A3-5000.301
2. PENDANTS STRAP LINK ASSEMBLY A3-5600.133

	19.06.07	ORIGINAL ISSUE TAKEN FR A3-2175.261	-	IZA	A
Checked	Date	Revision	BCN	Name	Issue

FAVELLE FAVCO — Favelle Favco Cranes Pty. Ltd.
A.B.N. 29 067 562 449
A subsidiary of Muhibbah Engineering (M) BHD

Project: M440E TOWER CRANE — First Used On S/No. 1475

Title: ROPE SPECIFICATIONS PLATE — Activity No 210

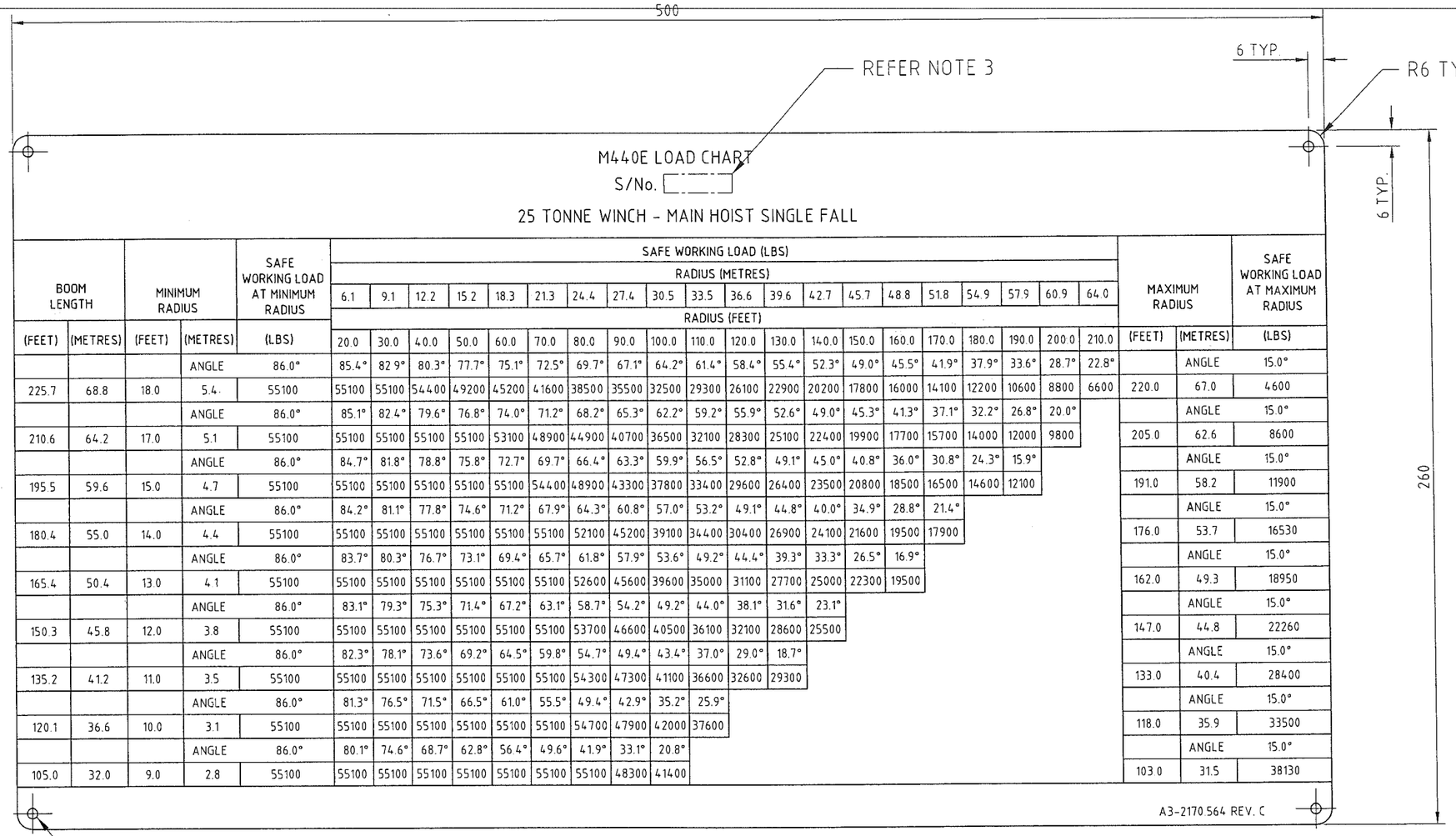
Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
Ariza	U.S.	19.06.07	1:1	1 of 1	-	A

Approved	Bnd Approved	Drawing Number
		A3-2175.294

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Material List

Cat.	Item	Qty	Description	Length	Material	kg
	1	1	15 x 260	500	WHITE TRAFFOLYTE	-



BOOM LENGTH		MINIMUM RADIUS		SAFE WORKING LOAD AT MINIMUM RADIUS	SAFE WORKING LOAD (LBS) RADIUS (METRES)																			MAXIMUM RADIUS		SAFE WORKING LOAD AT MAXIMUM RADIUS
					6.1	9.1	12.2	15.2	18.3	21.3	24.4	27.4	30.5	33.5	36.6	39.6	42.7	45.7	48.8	51.8	54.9	57.9	60.9	64.0			
(FEET)	(METRES)	(FEET)	(METRES)	(LBS)	RADIUS (FEET) 20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	(FEET)	(METRES)	(LBS)
			ANGLE	86.0°	85.4°	82.9°	80.3°	77.7°	75.1°	72.5°	69.7°	67.1°	64.2°	61.4°	58.4°	55.4°	52.3°	49.0°	45.5°	41.9°	37.9°	33.6°	28.7°	22.8°		ANGLE	15.0°
225.7	68.8	18.0	5.4	55100	55100	55100	54400	49200	45200	41600	38500	35500	32500	29300	26100	22900	20200	17800	16000	14100	12200	10600	8800	6600	220.0	67.0	4600
			ANGLE	86.0°	85.1°	82.4°	79.6°	76.8°	74.0°	71.2°	68.2°	65.3°	62.2°	59.2°	55.9°	52.6°	49.0°	45.3°	41.3°	37.1°	32.2°	26.8°	20.0°			ANGLE	15.0°
210.6	64.2	17.0	5.1	55100	55100	55100	55100	55100	53100	48900	44900	40700	36500	32100	28300	25100	22400	19900	17700	15700	14000	12000	9800		205.0	62.6	8600
			ANGLE	86.0°	84.7°	81.8°	78.8°	75.8°	72.7°	69.7°	66.4°	63.3°	59.9°	56.5°	52.8°	49.1°	45.0°	40.8°	36.0°	30.8°	24.3°	15.9°				ANGLE	15.0°
195.5	59.6	15.0	4.7	55100	55100	55100	55100	55100	55100	54400	48900	43300	37800	33400	29600	26400	23500	20800	18500	16500	14600	12100			191.0	58.2	11900
			ANGLE	86.0°	84.2°	81.1°	77.8°	74.6°	71.2°	67.9°	64.3°	60.8°	57.0°	53.2°	49.1°	44.8°	40.0°	34.9°	28.8°	21.4°						ANGLE	15.0°
180.4	55.0	14.0	4.4	55100	55100	55100	55100	55100	55100	55100	52100	45200	39100	34400	30400	26900	24100	21600	19500	17900						176.0	53.7	16530
			ANGLE	86.0°	83.7°	80.3°	76.7°	73.1°	69.4°	65.7°	61.8°	57.9°	53.6°	49.2°	44.4°	39.3°	33.3°	26.5°	16.9°							ANGLE	15.0°
165.4	50.4	13.0	4.1	55100	55100	55100	55100	55100	55100	55100	52600	45600	39600	35000	31100	27700	25000	22300	19500							162.0	49.3	18950
			ANGLE	86.0°	83.1°	79.3°	75.3°	71.4°	67.2°	63.1°	58.7°	54.2°	49.2°	44.0°	38.1°	31.6°	23.1°									ANGLE	15.0°
150.3	45.8	12.0	3.8	55100	55100	55100	55100	55100	55100	55100	53700	46600	40500	36100	32100	28600	25500									147.0	44.8	22260
			ANGLE	86.0°	82.3°	78.1°	73.6°	69.2°	64.5°	59.8°	54.7°	49.4°	43.4°	37.0°	29.0°	18.7°										ANGLE	15.0°
135.2	41.2	11.0	3.5	55100	55100	55100	55100	55100	55100	55100	54300	47300	41100	36600	32600	29300										133.0	40.4	28400
			ANGLE	86.0°	81.3°	76.5°	71.5°	66.5°	61.0°	55.5°	49.4°	42.9°	35.2°	25.9°												ANGLE	15.0°
120.1	36.6	10.0	3.1	55100	55100	55100	55100	55100	55100	55100	54700	47900	42000	37600												118.0	35.9	33500
			ANGLE	86.0°	80.1°	74.6°	68.7°	62.8°	56.4°	49.6°	41.9°	33.1°	20.8°													ANGLE	15.0°
105.0	32.0	9.0	2.8	55100	55100	55100	55100	55100	55100	55100	55100	48300	41400													103.0	31.5	38130

NOTES

1. CRANE LOAD CHART TO BE LOCATED IN DRIVERS CONTROL CABIN.
2. MATERIAL IS WHITE TRAFFOLYTE WITH 3.5mm & 5mm BLACK TEXT FOR EXTERNAL USE.
3. REFER TO WORKS ORDER FOR S/No.

Checked	Date	Revision	ECN	Name	Issue
J.C.F.	12.07.05	LOADS @ MAX. RADIUS FOR BOOM LENGTHS 41.2m, 64.2m & 68.8m UPDATED. LOADS ADDED FOR 32.0m, 45.8m, 50.4m, 59.6m & 64.2m BOOMS	-	D.R.	C
J.C.F.	12.07.05	MIN. RADIUS ANGLES ALL CHANGED TO 86° & ALL MIN RADII'S UPDATED MAX. RADIUS ANGLES ALL CHANGED TO 15° & ALL MAX. RADII'S AND LOADS UPDATED.	-	D.R.	B
	07.07.05	ORIGINAL ISSUE	-	D.R.	A

FAVELLE FAVCO

Favelle Favco Cranes Pty. Ltd.
A.B.N. 29 067 562 449
A subsidiary of Muhibbah Engineering (M) BHD

Project: M440E TOWER CRANE - MAIN HOIST — First Used On S/No. 1234

Title: LOAD CHART - 32.0 TO 68.8m BOOM (1 FALL) — Activity No. 210

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
D.ROBINSON	J.C.F.	07.07.05	1:2	1 of 1	-	C

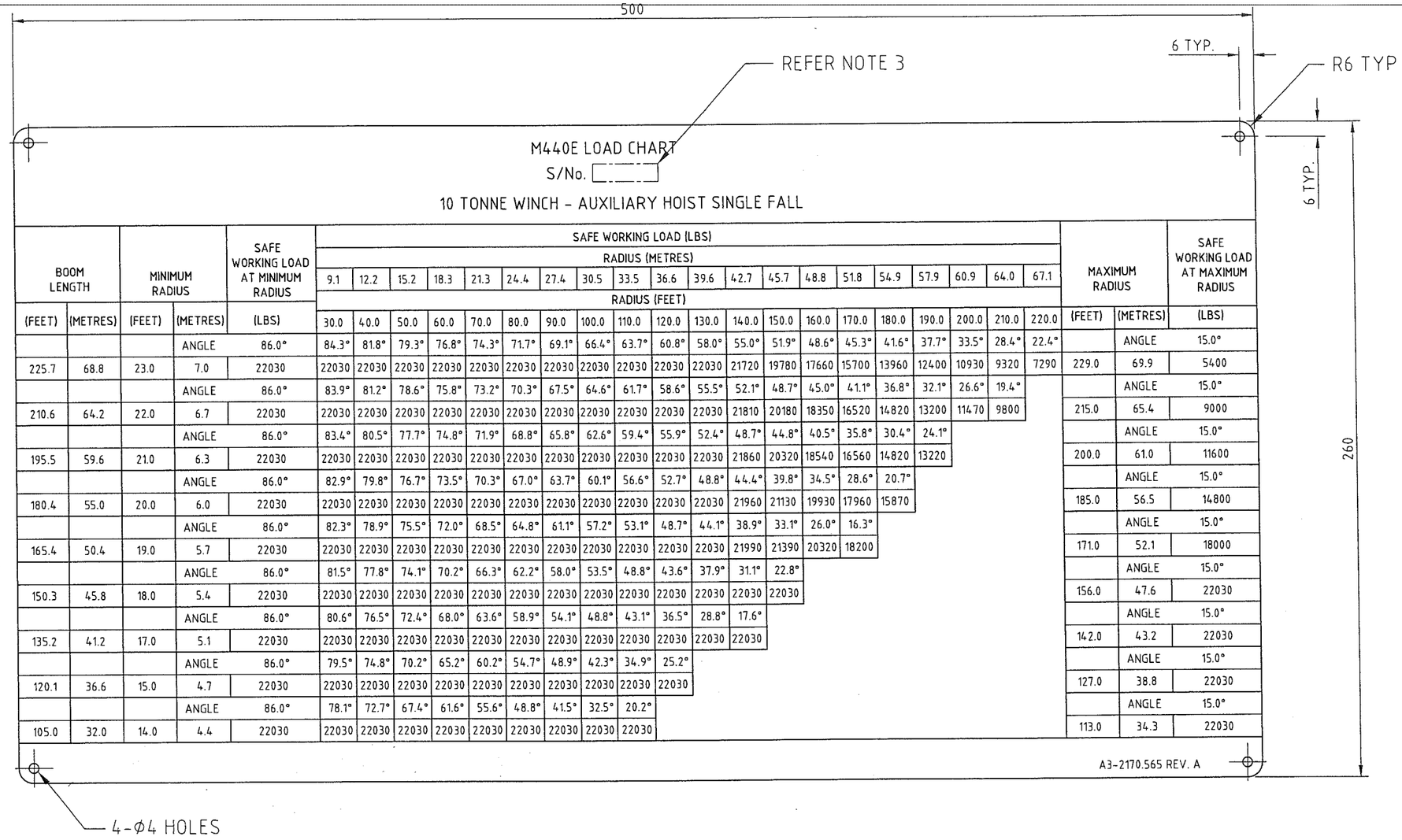
Approved	Eng. Approved	Drawing Number
A.Mc.	BY	A3-2170.564

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FORM FAV-04-02

Material List						Page 703
Cat.	Item	Qty	Description	Length	Material	kg
	1	1	1.5 x 260	500	WHITE TRAFFOLYTE	-



BOOM LENGTH		MINIMUM RADIUS		SAFE WORKING LOAD AT MINIMUM RADIUS	SAFE WORKING LOAD (LBS) RADIUS (METRES)																				MAXIMUM RADIUS		SAFE WORKING LOAD AT MAXIMUM RADIUS
					9.1	12.2	15.2	18.3	21.3	24.4	27.4	30.5	33.5	36.6	39.6	42.7	45.7	48.8	51.8	54.9	57.9	60.9	64.0	67.1			
					RADIUS (FEET)																						
(FEET)	(METRES)	(FEET)	(METRES)	(LBS)	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	220.0	(FEET)	(METRES)	(LBS)
			ANGLE	86.0°	84.3°	81.8°	79.3°	76.8°	74.3°	71.7°	69.1°	66.4°	63.7°	60.8°	58.0°	55.0°	51.9°	48.6°	45.3°	41.6°	37.7°	33.5°	28.4°	22.4°		ANGLE	15.0°
225.7	68.8	23.0	7.0	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	21720	19780	17660	15700	13960	12400	10930	9320	7290	229.0	69.9	5400
			ANGLE	86.0°	83.9°	81.2°	78.6°	75.8°	73.2°	70.3°	67.5°	64.6°	61.7°	58.6°	55.5°	52.1°	48.7°	45.0°	41.1°	36.8°	32.1°	26.6°	19.4°			ANGLE	15.0°
210.6	64.2	22.0	6.7	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	21810	20180	18350	16520	14820	13200	11470	9800		215.0	65.4	9000
			ANGLE	86.0°	83.4°	80.5°	77.7°	74.8°	71.9°	68.8°	65.8°	62.6°	59.4°	55.9°	52.4°	48.7°	44.8°	40.5°	35.8°	30.4°	24.1°					ANGLE	15.0°
195.5	59.6	21.0	6.3	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	21860	20320	18540	16560	14820	13220				200.0	61.0	11600
			ANGLE	86.0°	82.9°	79.8°	76.7°	73.5°	70.3°	67.0°	63.7°	60.1°	56.6°	52.7°	48.8°	44.4°	39.8°	34.5°	28.6°	20.7°						ANGLE	15.0°
180.4	55.0	20.0	6.0	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	21960	21130	19930	17960	15870					185.0	56.5	14800
			ANGLE	86.0°	82.3°	78.9°	75.5°	72.0°	68.5°	64.8°	61.1°	57.2°	53.1°	48.7°	44.1°	38.9°	33.1°	26.0°	16.3°							ANGLE	15.0°
165.4	50.4	19.0	5.7	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	21990	21390	20320	18200						171.0	52.1	18000
			ANGLE	86.0°	81.5°	77.8°	74.1°	70.2°	66.3°	62.2°	58.0°	53.5°	48.8°	43.6°	37.9°	31.1°	22.8°									ANGLE	15.0°
150.3	45.8	18.0	5.4	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030								156.0	47.6	22030
			ANGLE	86.0°	80.6°	76.5°	72.4°	68.0°	63.6°	58.9°	54.1°	48.8°	43.1°	36.5°	28.8°	17.6°										ANGLE	15.0°
135.2	41.2	17.0	5.1	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030									142.0	43.2	22030
			ANGLE	86.0°	79.5°	74.8°	70.2°	65.2°	60.2°	54.7°	48.9°	42.3°	34.9°	25.2°												ANGLE	15.0°
120.1	36.6	15.0	4.7	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030											127.0	38.8	22030
			ANGLE	86.0°	78.1°	72.7°	67.4°	61.6°	55.6°	48.8°	41.5°	32.5°	20.2°													ANGLE	15.0°
105.0	32.0	14.0	4.4	22030	22030	22030	22030	22030	22030	22030	22030	22030	22030												113.0	34.3	22030

NOTES

1. CRANE LOAD CHART TO BE LOCATED IN DRIVERS CONTROL CABIN.
2. MATERIAL IS WHITE TRAFFOLYTE WITH 3.5mm & 5mm BLACK TEXT FOR EXTERNAL USE.
3. REFER TO WORKS ORDER FOR S/No.

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Checked	Date	Revision	ECN	Name	Issue
	10.07.05	ORIGINAL ISSUE	-	D.R.	A

FAVELLE FAVCO

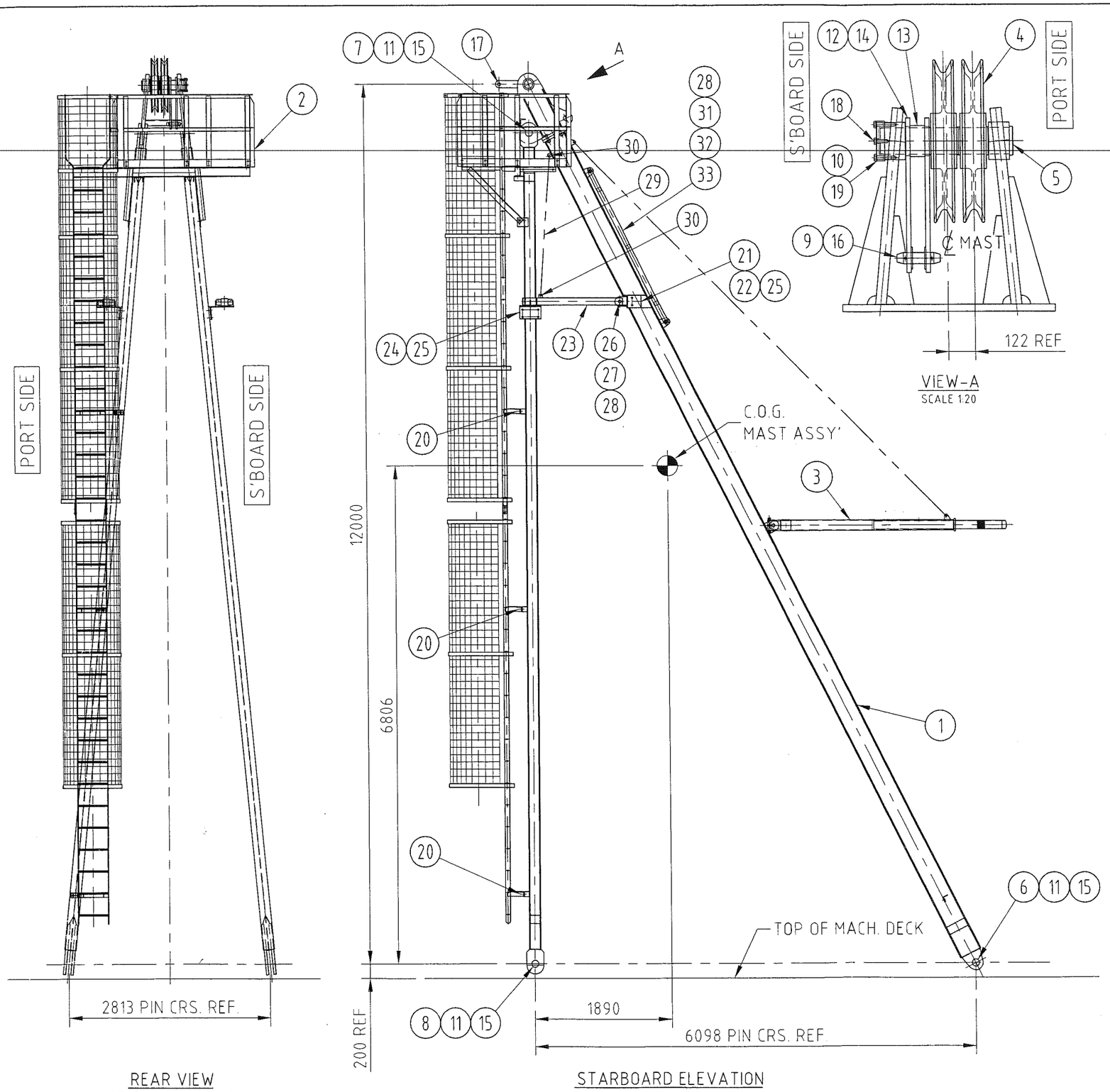
Favelle Favco Cranes Pty. Ltd.
A.B.N. 29 067 562 449
A subsidiary of Muhibbah Engineering (M) BHD

Project: M440E TOWER CRANE - AUXILIARY HOIST — First Used On S/No. 1234

Title: LOAD CHART - 32.0 TO 68.8m BOOM (1 FALL) — Activity No. 210

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
D.ROBINSON	AC S	10.07.05	1:2	1 of 1	-	A

Approved	Eng. Approved	Drawing Number
		A3-2170.565



REAR VIEW
FRONT LEGS AND BRACES
NOT SHOWN FOR CLARITY

STARBOARD ELEVATION

VIEW-A
SCALE 1:20

Material List

Cat.	Item	Qty	Description	Reference	kg
	1	1	MAST DETAILS	A1-3200.136	4495
	2	1	PLATFORM & LADDER DETAILS	A1-3301.116	608
	3	1	BUFFER ASSEMBLY	A3-3100.112	366
	4	2	SHEAVE ASSEMBLY, ⌀620	A4-9510.017	240
	5	1	MAST SHEAVE PIN, ⌀120	A3-3050.087/1	54
	6	2	FRONT LEG PIN, ⌀100	A3-3050.087/2	34
	7	2	TOP REAR LEG PIN, ⌀100	A3-3050.087/3	34
	8	2	BOTTOM REAR LEG PIN, ⌀100	A3-3050.087/2	34
	9	1	LUFF ANCHOR PIN, ⌀50	A3-3050.087/4	3
	10	1	⌀120 SHEAVE PIN COVER	A4-9912.034	5
	11	12	CLEVIS PIN	A4-9910.021.002	5
	12	2	ANCHOR PLATE	A3-3050.087/5	32
	13	1	ANCHOR SPACER	A3-3050.087/6	2
	14	2	ANCHOR BUSH	A3-3050.087/7	1
	15	12	SPLIT PIN ⌀5 x 32 LONG	ST. STEEL 316	-
	16	2	SPLIT PIN ⌀8 x 70 LONG	ST.STEEL 316	-
	17	1	ROPE GUARD C/W SPLIT PINS	A3-9550.006/17	2
	18	2	M16 x 40 LG HEX HD. SCREW	GRADE 8.8	-
	19	2	M16 x 70 LG HEX HD. BOLT	GRADE 8.8	-
	20	6	M16 x 40 LG HEX HD. BOLT C/W NUT & WASHER	GAL. GRADE 8.8	-
	21	1	STOPPER PIVOT BRACKET L/H	A1-3200.136/39	REF
	22	1	STOPPER PIVOT BRACKET R/H	A1-3200.136/40	REF
	23	2	MAST REAR LEG STOPPER	A4-3230.039/A	52
	24	2	STOPPER REST	A1-3200.136/36	REF
	25	12	M16 x 70 LG HEX HD. BOLT C/W NUT & WASHER	GAL. GRADE 8.8	-
	26	2	STOPPER PIN	A4-3230.039/B	3
	27	4	CLEVIS PIN, ⌀11 S.1443 "SPAREX"	ST. STEEL	-
	28	8	GRIP CLIP, ⌀2.5 S 9 "SPAREX"	ST. STEEL	-
	29	2	CHAIN SIZE 5 x 2.2m LG. GAL. "B'WOODS"	PART No 0549 4213	3
	30	2	M8 x 30 LG HEX HD. SCREW C/W NUT & 2 WASHERS	GALVANISED	-
	31	2	MAST LIFTING LINK	A3-3303.018/1, 2	50
	32	4	LIFTING LINK PIN	A3-3303.018/3	4
	33	4	CLEVIS PIN, ⌀9 S.1439 "SPAREX"	ST. STEEL	4

	Date	Revision	ECN	Name	Issue
	01.06.05	ORIGINAL ISSUE TAKEN FROM A3-3000.081	-	DVR	A

FAVELLE FAVCO

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Project: M440D — First Used On S/No. 1234

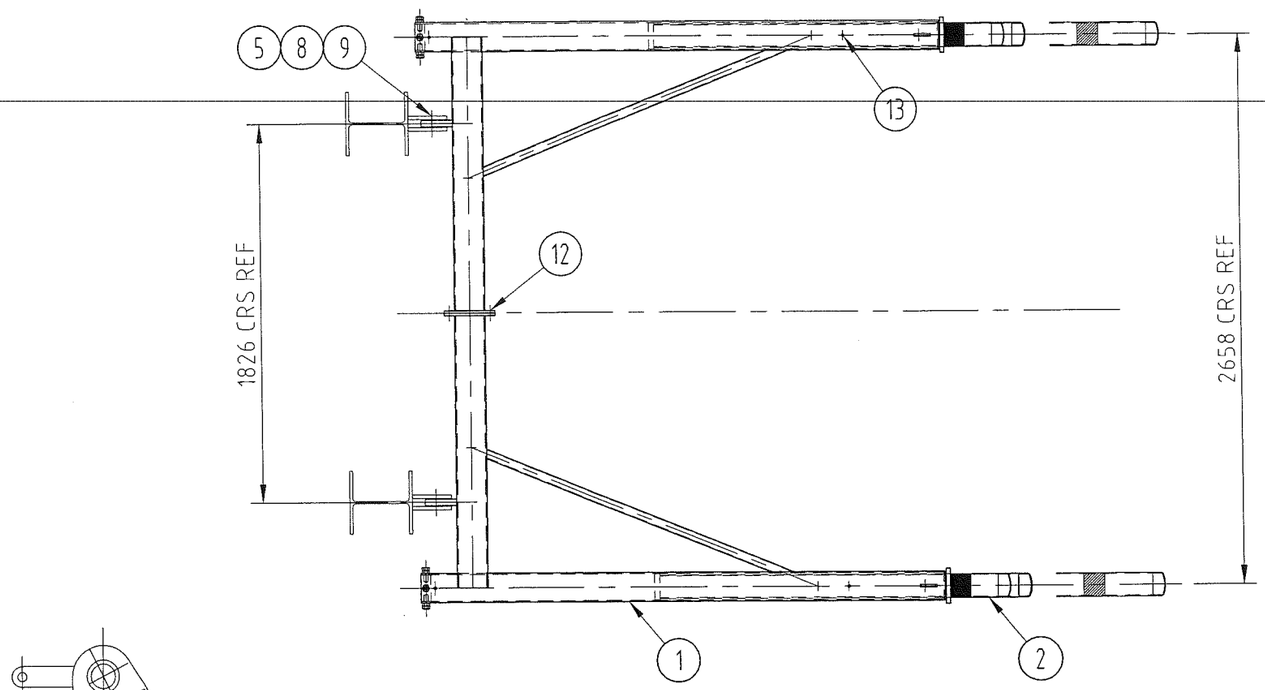
Title: MAST ASSEMBLY — Activity No. 300

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
D. RUDAK	U.S.	01.06.05	NTS	1 of 1	6031 kg	A

Approved	Eng. Approved	Drawing Number
BM		A3-3000.140

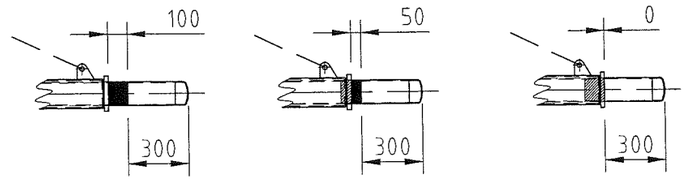
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Material List

Cat.	Item	Qty	Description	Reference	kg
	1	1	BUFFER FRAME	A3-3101.099	204
	2	2	EXTENSION PIPE	A3-3101.099	50
	3	4	COMPRESSION SPRING	A4-3101.S01	80
	4	2	CHAIN SIZE 10, GRADE T(8), 7.5 m LG	"NOBLES" CMAC 10	15
	5	2	BUFFER PIN	A4-3101.065/1	2
	6	2	TURN BUCKLE, 12mm C/W PINS, LOCK NUT		
			& BOTH ENDS WITH CLEVIS FITTING	"NOBLES" GR - P	4
	7	4	DEE SHACKLE, No. 10, GRADE - S	"NOBLES" KSDFG 10	1
	8	2	CLEVIS PIN "SPAREX" S.1443	ST. STEEL 316	-
	9	2	GRIP CLIP "SPAREX" S.9	ST. STEEL 316	-
	10	2	STOPPER	A3-3101.099/6	10
	11	8	HEX HD. SET SCREW M20 x 50 LONG	GRADE 8.8	-
	12	4	HEX HD. BOLT M16 x 60 LG C/W NUT &	GRADE 8.8	-
			FLAT WASHER		
	13	2	1/4" BSP GREASE NIPPLE	-	-



BUFFER AT MIN. RADIUS

BUFFER AT ULTIMATE POSITION

BUFFER AT FULLY COMPRESSED POSITION

NOTES:

1. AT MIN. RADIUS, THE RED MARK WILL START GOING INSIDE THE TUBE.
2. AT ULTIMATE POSITION THE RED MARK MUST BE VISIBLE & OUTSIDE THE TUBE ABOUT 50mm. AT NO NO POSITION, RED MARK SHOULD DISAPPEAR.

	27.05.05	ORIGINAL ISSUE	-	DVR	A
Checked	Date	Revision	ECN	Name	Issue

FAVELLE FAVCO

Favelle Favco Cranes Pty. Ltd.
A.B.N. 29 067 562 449
A subsidiary of Muhibbah Engineering (M) BHD

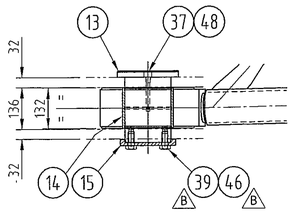
Project: M440D — First Used On S/No. 1234

Title: BUFFER ASSEMBLY — Activity No. 320

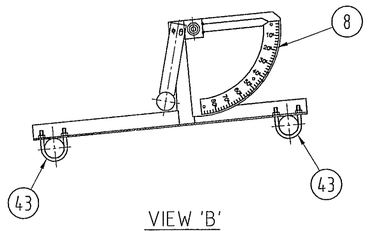
Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
D. RUDAK	U.S.	27.05.05	1:30	1 of 1	366 kg	A
	Approved	Eng Approved	Drawing Number			
			A3-3100.112			

DO NOT SCALE FROM DRAWING. IF IN DOUBT ASK FFC PTY LTD ENGINEERING DEPARTMENT.

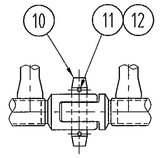
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SECTION 'A-A'
SCALE 1:10
WIRE BOLT HEADS TOGETHER



VIEW 'B'
BOOM ANGLE INDICATOR
SCALE 1:10

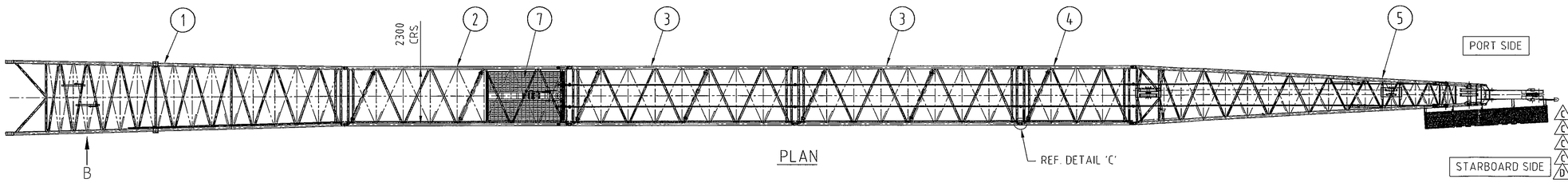


DETAIL 'C'
SCALE 1:10

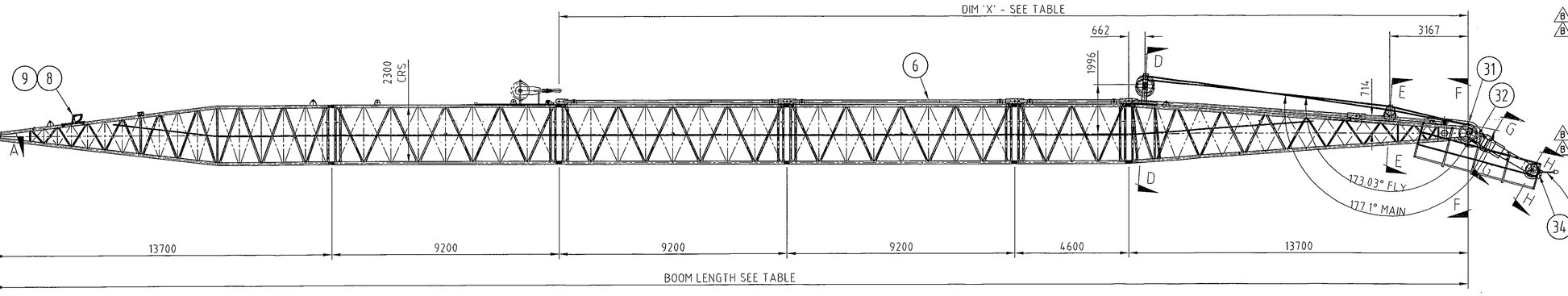
TABLE

ITEM No	Description	BOOM LENGTHS - QUANTITIES					
		36.6	41.2	45.8	50.4	55	59.6
1	BOOM BOTTOM SECTION - 13.7m - A1-4100.139	1	1	1	1	1	1
2	BOOM EXT. SECT. WITH ERECTION LUGS- 9.2m - A1-4200.273	1	1	1	1	1	1
3	BOOM EXTENSION SECTION - 9.2m - A1-4200.261	-	-	1	1	2	2
4	BOOM EXTENSION SECTION - 4.6m - A1-4200.262	-	1	-	1	-	1
5	BOOM TOP SECTION - 13.7m - A1-4300.174	1	1	1	1	1	1
10	BOOM CONNECTOR PIN - A4-9400.056.002	8	12	12	16	16	20
11	Φ12 CLEVIS PIN - SPAREX S.1444	16	24	24	32	32	40
12	GRIP CLIP - SPAREX S.9	16	24	24	32	32	40
	BRIDLE POSITION - DIM "X" (m)	13.7	18.3	22.9	27.5	32.1	36.7
	TOTAL WEIGHT (kg)	6751	7523	8086	8858	9421	10193

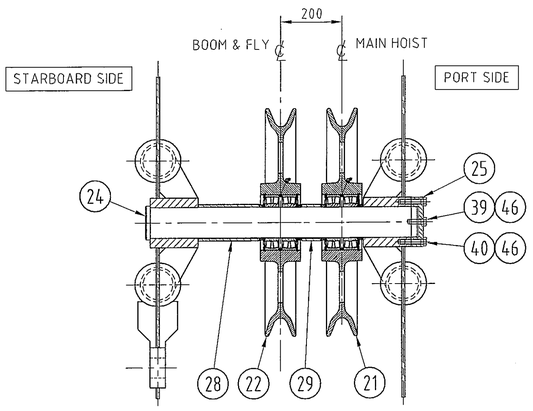
NOTES:
1. REFER TO SCOPE OF SUPPLY FOR BOOM LENGTH.
2. TOTAL WEIGHT DOES NOT INCLUDE WEIGHT OF PENDANT STRAP LINK ASSEMBLY - REFER TO A3-5600.097 FOR CORRESPONDING LENGTHS.



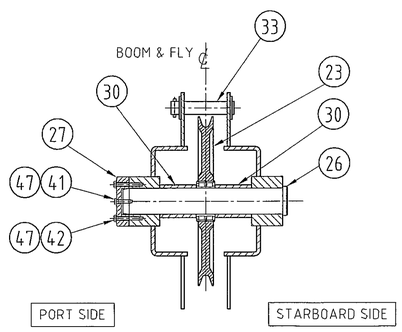
PLAN



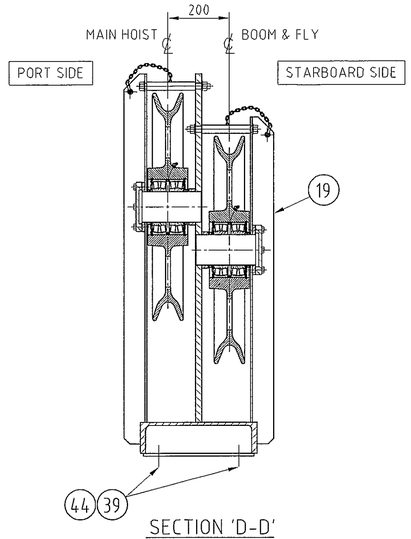
ELEVATION



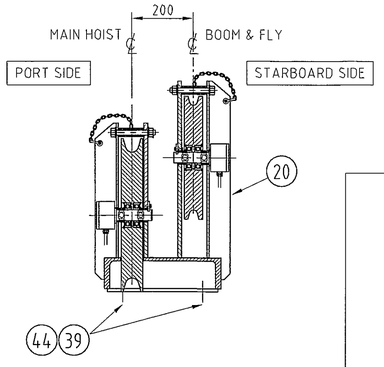
SECTION 'F-F'
SCALE 1:10
WIRE BOLT HEADS TOGETHER



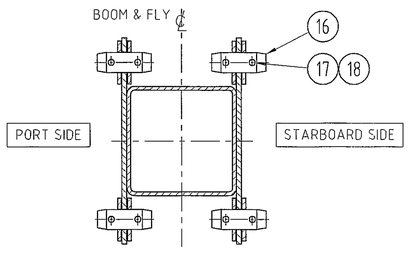
SECTION 'H-H'
SCALE 1:10
WIRE BOLT HEADS TOGETHER



SECTION 'D-D'
SCALE 1:10



SECTION 'E-E'
SCALE 1:10



SECTION 'G-G'
SCALE 1:10

Material List

Cat	Item	Qty	Description	Reference	kg
*	1	-	13.7m BOOM BOTTOM SECTION	A1-4100.139	2209
*	2	-	9.2m BOOM EXT. SECTION WITH ERECTION LUGS	A1-4200.273	1317
*	3	-	9.2m BOOM EXTENTION SECTION	A1-4200.261	1319
*	4	-	4.6m BOOM EXTENTION SECTION	A1-4200.262	756
*	5	-	13.7m BOOM TOP SECTION	A1-4300.174	3197
	6	1	PENDANT STRAP LINK ASSEMBLY	A3-5600.097	-
	7	1	BRIDLE PLATFORM	A1-4701.152	350
	8	1	BOOM ANGLE INDICATOR (STARBOARD SIDE)	A3-4800.036	7
	9	1	BOOM ANGLE INDICATOR (PORT SIDE)	A3-4800.032	7
*	10	-	CONNECTOR PIN	A4-9400.056.001	-
*	11	-	CLEVIS PIN - ST. STEEL	SPAREX S.1444	-
E *	12	-	DIA. M3.2 X 40 LG SPLIT PIN	ST. STEEL	-
	13	2	BOOM HEEL PIN	A4-4050.232.009	64
	14	2	BOOM HEEL BUSH	A4-4050.159	4
	15	2	BOOM HEEL PIN END COVER	A4-2345.171	6
	16	4	FLY CONNECTOR PIN	A4-4050.117	18
	17	8	Φ19 CLEVIS PIN	SPAREX S.1446	-
E	18	8	DIA. M5 x 32 LG SPLIT PIN	ST. STEEL	-
	19	1	MAIN/FLY DEFLECTOR SHEAVE ASSEMBLY	A4-4020.055	317
	20	1	MAIN/FLY SLI LOAD SHEAVE ASSEMBLY	A4-4400.149	119
	21	1	Φ620/Φ42 MAIN HOIST SHEAVE ASSEMBLY	A4-9510.103	160
	22	1	Φ620/Φ24 FLY HOIST SHEAVE ASSEMBLY	A4-9510.620.001	65
	23	1	Φ480/Φ24 FLY HEAD SHEAVE ASSEMBLY	A4-9510.000.011	41
	24	1	Φ100 HEAD SHEAVE PIN	A4-4050.252	53
	25	1	Φ100 SHEAVE PIN COVER	A4-9912.019	5
	26	1	Φ85 FLY HEAD SHEAVE PIN	A4-4050.251	22
	27	1	Φ85 FLY SHEAVE PIN COVER	A49912.043	5
	28	1	SPACER - 100 I.D. x 199 LG	A3-9901.002.184	-
	29	1	SPACER - 100 I.D. x 62 LG	A3-9901.002.185	-
	30	2	SPACER - 85 I.D. x 118 LG	A3-9901.002.186	-
C	31	1	ROPE GUARD - HEAD SHEAVE	A1-4300.174/13	-
C	32	1	ROPE GUARD - HEAD SHEAVE	A1-4300.174/12	-
C	33	1	ROPE GUARD - FLY SHEAVE	A1-4300.174/16	-
C	34	1	ROPE GUARD - FLY SHEAVE	A1-4300.174/15	-
D	35	1	AVIATION LIGHT BRACKET	A4 4501.149	3
	36	1	AVIATION LIGHT	EQUIP. SCHEDULE	-
	37	2	GREASE NIPPLE - 1/4" BSP	-	-
B	38		DELETED		-
B	39	14	HEX HEAD SCREW - M16 x 40 LG	GR 8.8	-
	40	2	HEX HEAD SCREW - M16 x 65 LG	GR 8.8	-
	41	2	HEX HEAD SCREW - M12 x 40 LG	S.S. 316	-
	42	2	HEX HEAD SCREW - M12 x 65 LG	S.S. 316	-
	43	4	Φ12 'U' BOLT x 240 LG, 20mm THREAD AT ENDS C/W M12 NUTS & WASHERS	S.S. 316	-
	44	8	HEX HEAD NUT - M16	GR 8.8	-
	45		DELETED		-
	46	8	Φ16 SPRING WASHER	GALV.	-
	47	4	Φ12 SPRING WASHER	S.S. 316	-
	48	2	M20 GREASE BOLT	A4-9512.007	-

* = REFER TO TABLE

Checked	Date	Revision	ECN	Name	Issue
JCF	05.07.06	ITEM 12 & 18 WERE ST. STEEL GRIP CLIPS.	-	CN	E
JCF	16.05.06	ITEM 35 WAS A3-4501.055.	-	CN	D
U.S.	28.04.06	ITEMS 31 TO 34 INCORRECT REF, WAS A1-4000.174	-	JCF	C
JCF	14.07.05	ITEMS 39 & 46 WERE 38 & 45, QTY ITEMS 39 & 46 WERE	-	JI	B
		10 & 4, ITEMS 38 & 45 DELETED, TOWER CRANE WAS M440D	-		
	23.05.05	ORIGINAL ISSUE	-	JI	A

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A subsidiary of Muhibbah Engineering (M) BHD

Project: M440E TOWER CRANE
First Used On S/No. 1234

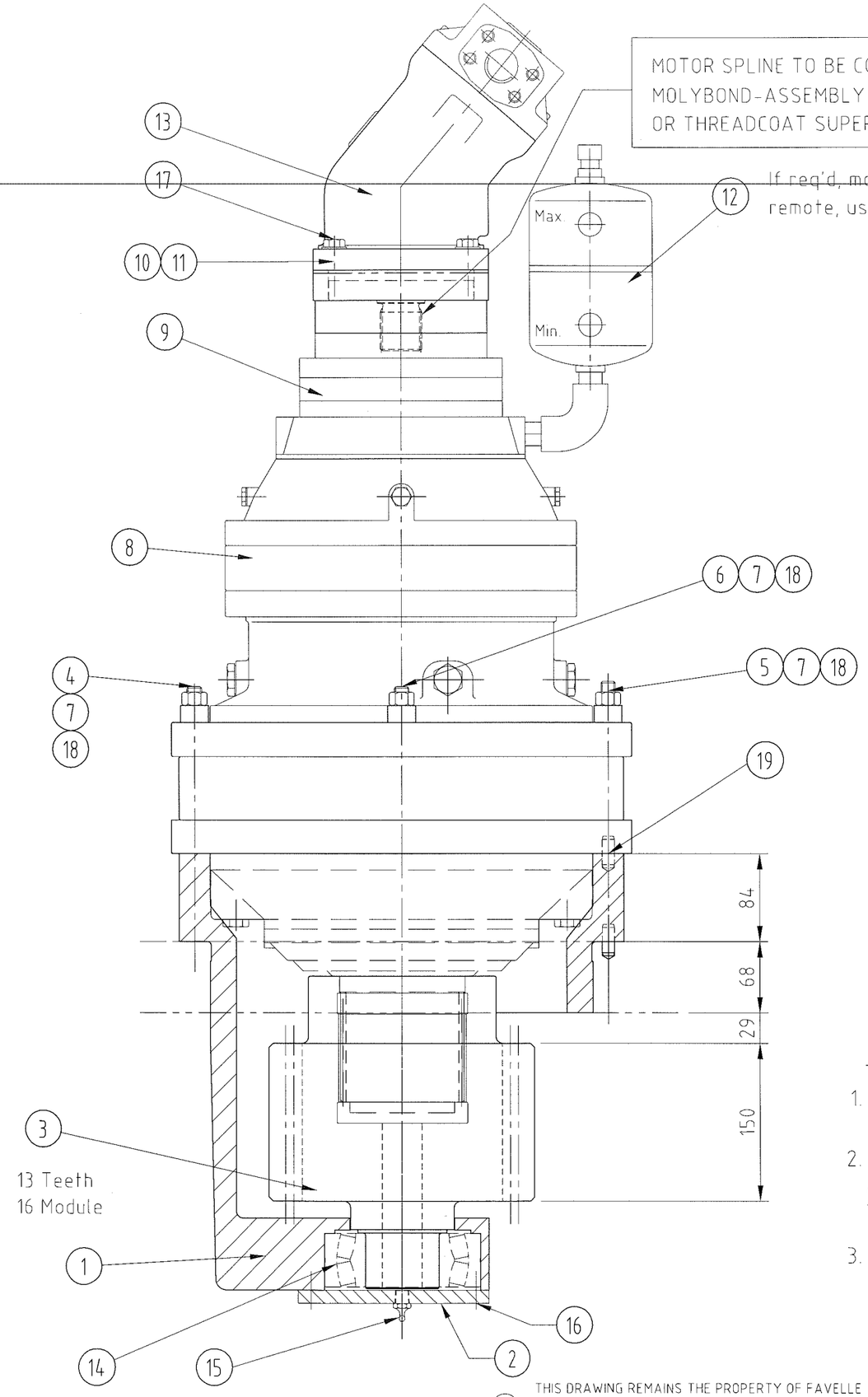
Title: BOOM ASSEMBLY
Activity No. 400

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
J.I.	JCF	23.05.05	1:100	1 of 1	REF.TABLE	E

Approved	Eng Approved	Drawing Number
AMc		A1-4000.183

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Material List

Cat.	Item	Qty	Description	Reference	kg
	1	1	OUTRIGGER HOUSING	A3-2501.098	-
	2	1	BEARING COVER	A4-2501.096	-
	3	1	SLEW PINION	A3-2501.122	-
	4	18	STUD BOLT	A4-2501.085/1	-
	5	10	STUD BOLT	A4-2501.085/2	-
	6	2	STUD BOLT	A4-2501.085/3	-
	7	30	SPACER	A4-2501.085/4	-
	8	1	GEARBOX		-
	9	1	BRAKE		-
	10	1	MOTOR ADAPTOR		-
	11	1	ADAPTOR SPLINE		-
	12	1	HEADER TANK	1 lt	-
	13	REF	HYDR. MOTOR	A2 FM90	-
	14	1	BEARING	22314 (70/150/51)	-
	15	1	GREASE NIPPLE	1/4" BSP	-
	16	7	HEX SCREW M12 X 30	Gr. 4.6	-
	17	4	HEX SCREW M12 X 50	Gr. 8.8	-
	18	48	HEX NUT M14	Gr. 8	-
	19	6	BISSELL ROLL PIN	ϕ 12 X 30	-

ATTENTION: MAINTENANCE PERSONNEL

USE ONLY OIL AS NOMINATED IN CRANE MANUAL, SECTION 4 TO FILL GEARBOX, BRAKE AND MOTOR.
DO NOT OVERFILL GEARBOX OR BRAKE.

NOTES:

1. MATERIAL LIST IS FOR ONE (1) DRIVE ONLY REFER TO SLEW ASSEMBLY FOR NUMBER OFF REQUIRED.
2. FULLY CLEAN MATING SURFACES OF GEARBOX AND DRIVE HOUSING AND THEN APPLY "LOCTITE 277" TO PROVIDE FRICTION JOINT.
3. U.O.N , ALL BOLTS TIGHTENED TO DWG. A3-9900.578

	Date	Revision	ECN	Name	Issue
	20.02.07	REDRAWN TO ACAD	-	AZ	B
X	30.09.98	ORIGINAL ISSUE TAKEN FROM A3-2500.064	-	C.N	A

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Project: First Used On S/No.

Title: SLEW DRIVE ASSEMBLY
Activity No.

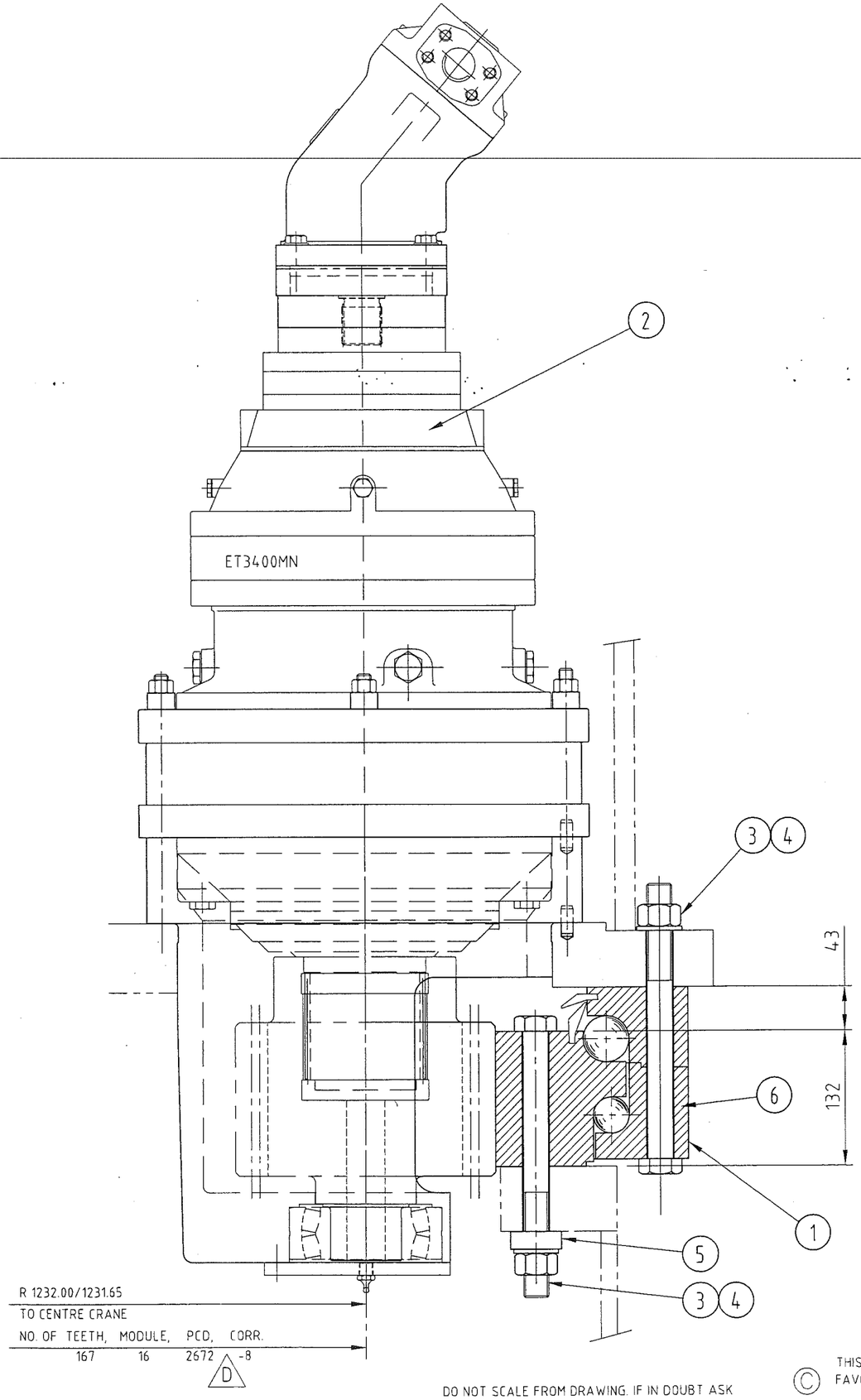
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CHERYL	MR	30.09.98	None	1 of 1		B
	Approved	Eng. Approved	Drawing Number			
	BM		A3-2500.098.MDO			

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Material List

Cat.	Item	Qty	Description	Length	Reference	kg
	1	1	SLEWRING		012.45.2940.001.49.1502	-
	2	1	SLEWDRIVE ASSEMBLY		A3-2500.098	-
	3	132	HEX BOLT & NUT		A3-9260.008.0014	
	4	132	FLAT HARDENED WASHER M30			-
	5	66	SPACER		A4-2651.017	-
	6	1	GREASE LINE ASSEMBLY		A3-2651.015	-



NOTES:

1. THE SOFT ZONE (MARKED "S) ON THE OUTER RING MUST BE POSITIONED 90° TO THE BOOM DIRECTION.
2. THE RECOMMENDED TIGHTENING TORQUE VALUE GIVEN IS BASED ON LIGHTLY OILED THREADS AND CONTACTS SURFACES : T.T + 1890 Nm (1390 Lbft.).
3. BACKLASH AT COLOURED GREEN TEETH TO BE 0.5-0.7mm.

	29.10.07	PCD WAS 2688 & CORR WAS 8	-	A.S.	D
U.S.	11.09.07	DRAWING NUMBER INCORRECT	-	JCF	C
JCF	20.02.07	REDRAWN TO ACAD	-	AZ	B
	30.09.98	ORIGINAL ISSUE TAKEN FROM A3-2600.022	-	C.N	A
Checked	Date	Revision	ECN	Name	Issue

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Project: First Used On S/No.

Title: SLEW DRIVE ASSEMBLY
Activity No.

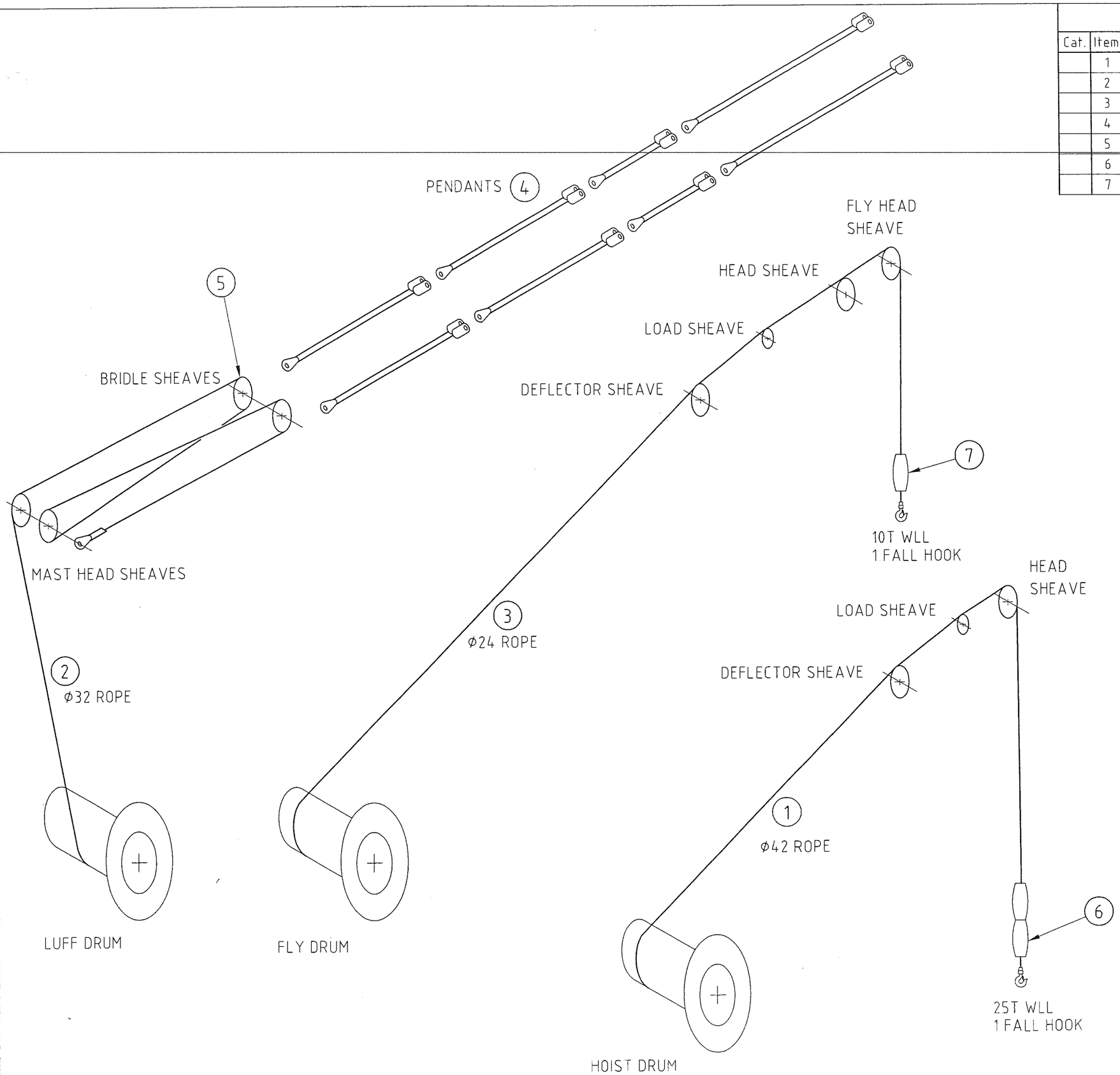
Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
CHERYL	MR	30.09.98	None	1 of 1	2250 kg	D
	Approved	Eng. Approved	Drawing Number			
	BM		A3-2600.044			

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Material List

Cat.	Item	Qty	Description	Reference	kg
	1	1	HOIST ROPE ϕ42	A3-2175.294	-
	2	1	LUFF ROPE ϕ32	A3-2175.294	-
	3	1	FLY ROPE ϕ24	A3-2175.294	-
	4	1	PENDANTS STRAPS LINK ASSEMBLY	A3-5600.133	-
	5	1	BRIDLE ASSEMBLY	A3-5200.126	-
	6	1	25T WLL 1 FALL HOOK ASSEMBLY	A3-5300.225	-
	7	1	10T WLL 1 FALL HOOK ASSEMBLY	A3-5300.204	-



LIST OF SHEAVES			
DIAM.	DWG.NO.	QTY.	USED ON
ϕ620/32/120	A4-9510.017	2	LUFF-MAST HEAD
ϕ620/32/100	A4-9510.010	2	LUFF-BRIDLE
ϕ620/42/100	A4-9510.103	1	HOIST-BOOM HD
ϕ620/42/100	A4-9510.103	1	HOIST DEFLECTOR
ϕ620/24/100	A4-9510.620.001	1	FLY-BOOM HD
ϕ480/24/85	A4-9510.000.011	1	FLY HEAD
ϕ620/24/100	A4-9510.620.001	1	FLY DEFLECTOR

	19.06.07	ORIGINAL ISSUE TAKEN FROM A3-5000.294	-	IZA	A
Checked	Date	Revision	BCN	Name	Issue

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Project: M440E TOWER CRANE — First Used On S/No 1475

Title: REEVING DIAGRAM — Activity No 500

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
ARIZA	U.S.	19.06.07	NTS	1 of 1	N/A	A

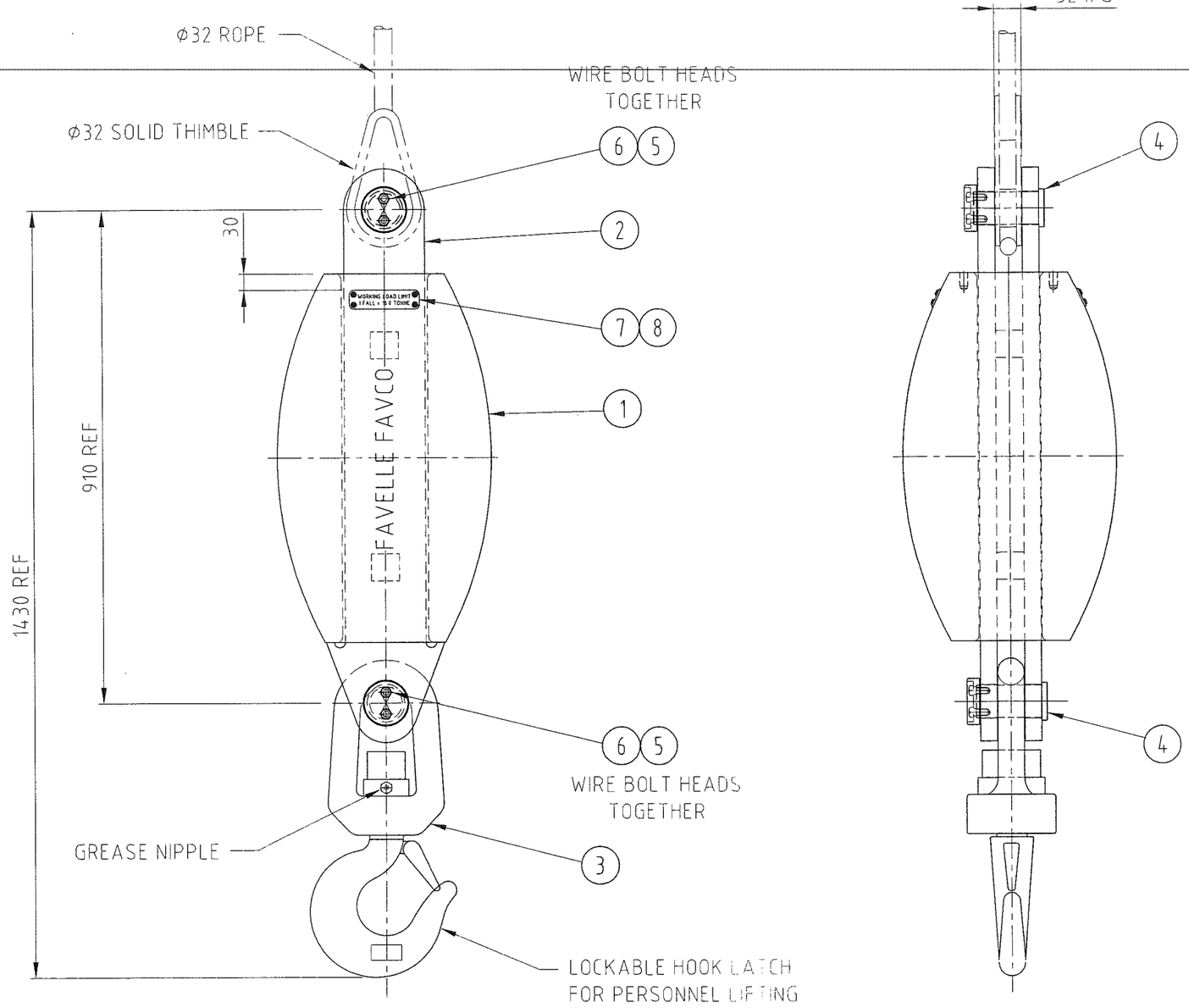
Approved: [signature] — Eng. Approved: — Drawing Number: A3-5000.301

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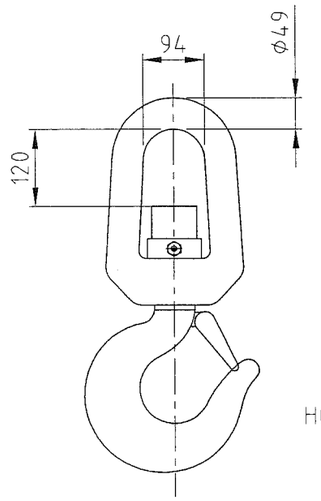
Material List

	Cat.	Item	Qty	Description	Reference	kg
		1	1	PONDER WEIGHT	A3-5302.014	368
	P	2	1	HOOK CONNECTOR	A3-5301197/1, 2	68
*	P	3	1	TSF SWIVEL HOOK-25T WLL c/w ROLLER	'NOBLES'	36
				THRUST BRG, GREASE NIPPLE & LOCKABLE		
				LATCH		
	P	4	2	ANCHOR & HOOK PIN	A3-5301197/3	6
		5	2	END COVER ⌀60	A4-5301165.006	2
		6	4	M12x20LG SOCKET HD CAP SCREW	GRADE 8.8	-
		7	2	HOOK NAME PLATE, 16 TONNE	A4-9900469	-
		8	8	M5x12LG CHEESE HD SCREW	GRADE 8.8	-

* NOTE: HOOK ITEM-3 MUST COMPLY WITH THE DIMENSIONS GIVEN BELOW



NOTE : ITEMS MARKED CATERGORY 'P' (PRIMARY) REQUIRE MATERIAL TRACEABILITY TO MECHANICAL & CHEMICAL CERTIFICATES.



HOOK ITEM-3

(B) HOOK CONNECTOR CALCULATION NO. A4 0560.027

Checked	Date	Revision	ECN	Name	Issue
LCF	11.02.08	ADDED CALCULATION NUMBER	-	K.R.	B
	09.11.07	ORIGINAL ISSUE	-	US	A

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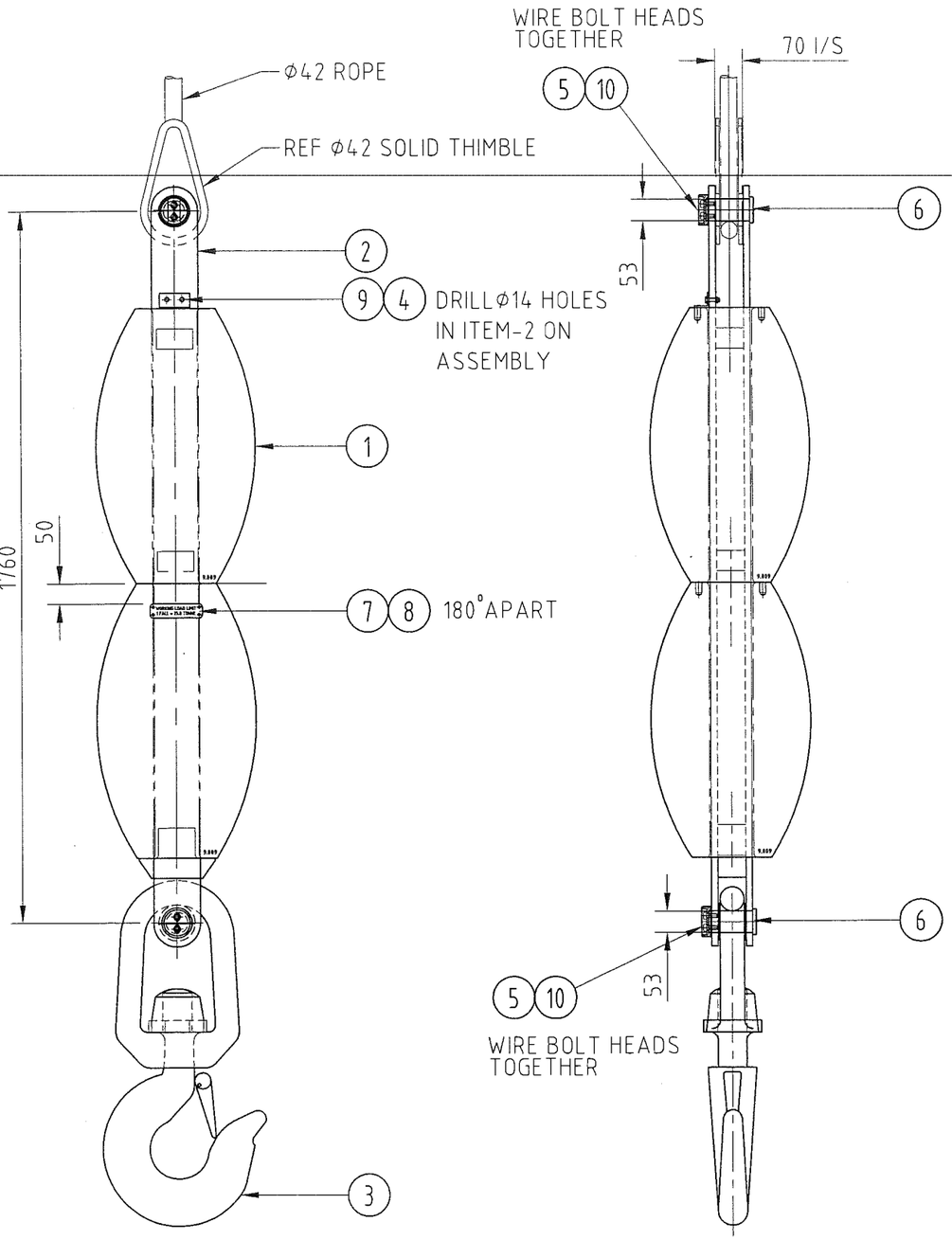
Project: M220E TOWER CRANE — First Used On S/No 1474

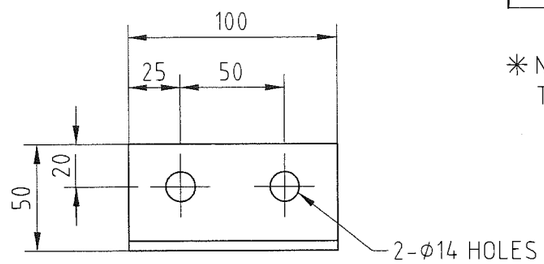
Title: 16T WLL 1 FALL HOOK ASSEMBLY — Activity No. 510

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
Ujjal Singh	JCF	09.11.07	1:10	1 of 1	480 kg	B

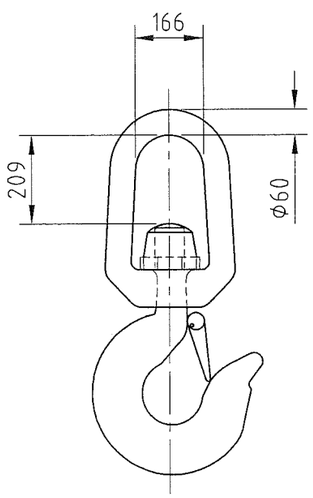
Approved: A Mc — Not Approved — Drawing Number: A3-5300.235

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DETAIL ITEM-4
NTS



HOOK ITEM-4

Material List

Cat.	Item	Qty	Description	Reference	kg
	1	2	OVERHAULING WEIGHT	A3-5302.009	764
	2	1	HOOK CONNECTOR	A3-5301.211/1	65
P	3	1	25T WLL BALL BEARING SWIVEL HOOK	NOBLES GR-'P'	60
			C/W TOP BOW & SAFETY LATCH.	BSS 2903-1970	
	4	1	EA 50 x 50 x 6 x 100LG.	250 MPa FFC SPEC 114	-
	5	2	END COVER ϕ53	A3-5301.221/7	1
	6	2	ANCHOR & HOOK PIN ϕ53	A3-5301.221/6	4
	7	2	25T WLL 1 FALL HOOK NAME PLATE	A4-9900.474	-
	8	8	M5 x 12LG. CHEESE HD SCREW	ST STEEL 316	-
	9	2	M12 x 35LG. HEX HD BOLT	ST STEEL 316	-
	10	4	M12X20LG SOCKET HD CAP SCREW	ST. STEEL 316	1

✳ NOTE : HOOK ITEM-3 MUST COMPLY THE DIMENSIONS GIVEN BELOW

NOTE :

ITEMS MARKED CATERGORY "P" (PRIMARY) REQUIRE MATERIAL TRACEABILITY TO MECHANICAL & CHEMICAL CERTIFICATES.

TOLERANCES				
Machined Dimensions: Tolerances required UNO.				
≤30	>30 - ≤100	>100 - ≤300	>300 - ≤1000	>1000 - ≤2000
±0.2	±0.3	±0.5	±0.8	±1.2
Structural Components: Tolerances required UNO				
≤1000	>1000 - ≤2000	>2000 - ≤3000	>3000 - ≤6000	>6000 - ≤9000
±1	±2	±3	±4	±5

DO NOT SCALE FROM DRAWING. IF IN DOUBT ASK FFC PTY LTD ENGINEERING DEPARTMENT

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FORM F04 04 02

	04.06.07	ORIGINAL ISSUE FROM A3-5300.119	.	IZA	A
Checked	Date	Revision	BCN	Name	Issue

FAVELLE FAVCO

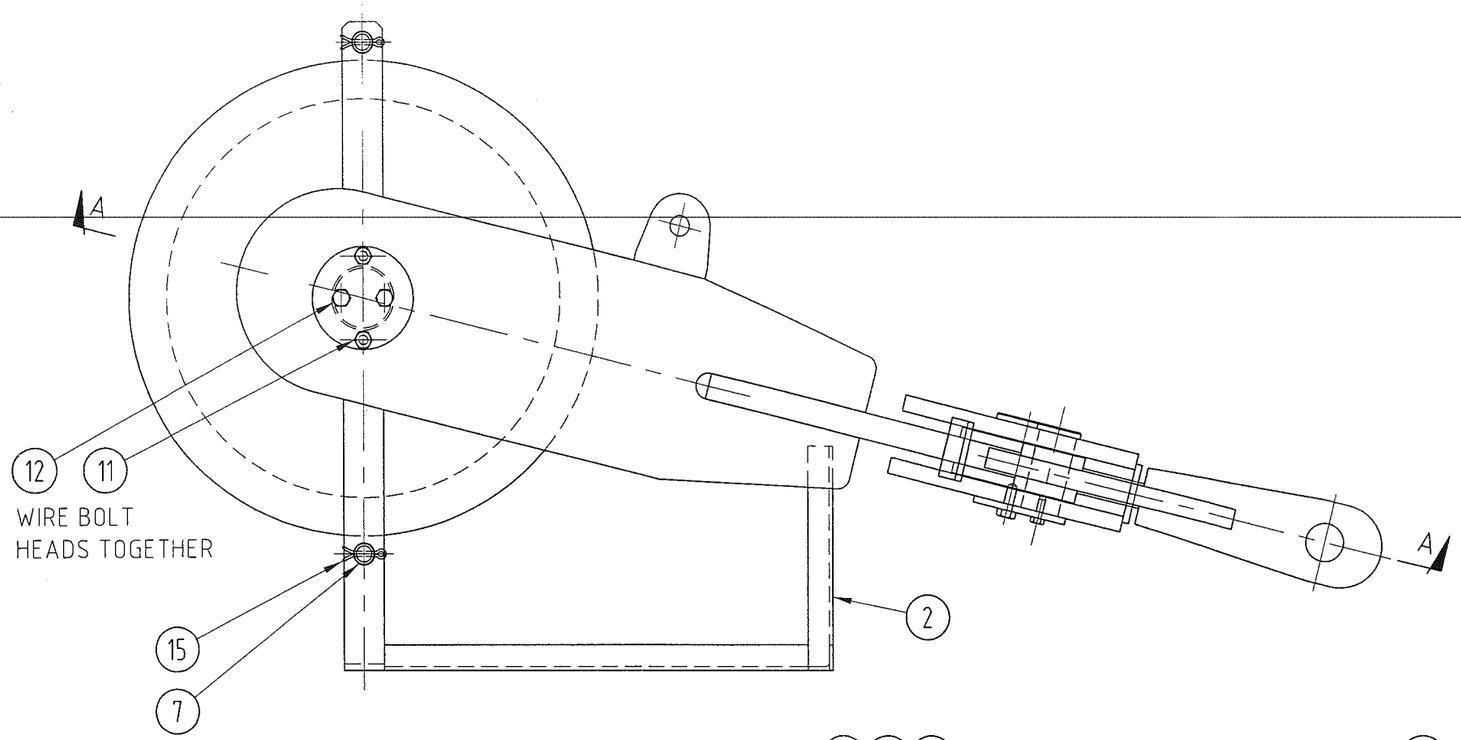
Favelle Favco Cranes Pty. Ltd.
A.B.N. 29 067 562 449
A subsidiary of Muhibbah Engineering (M) BHD

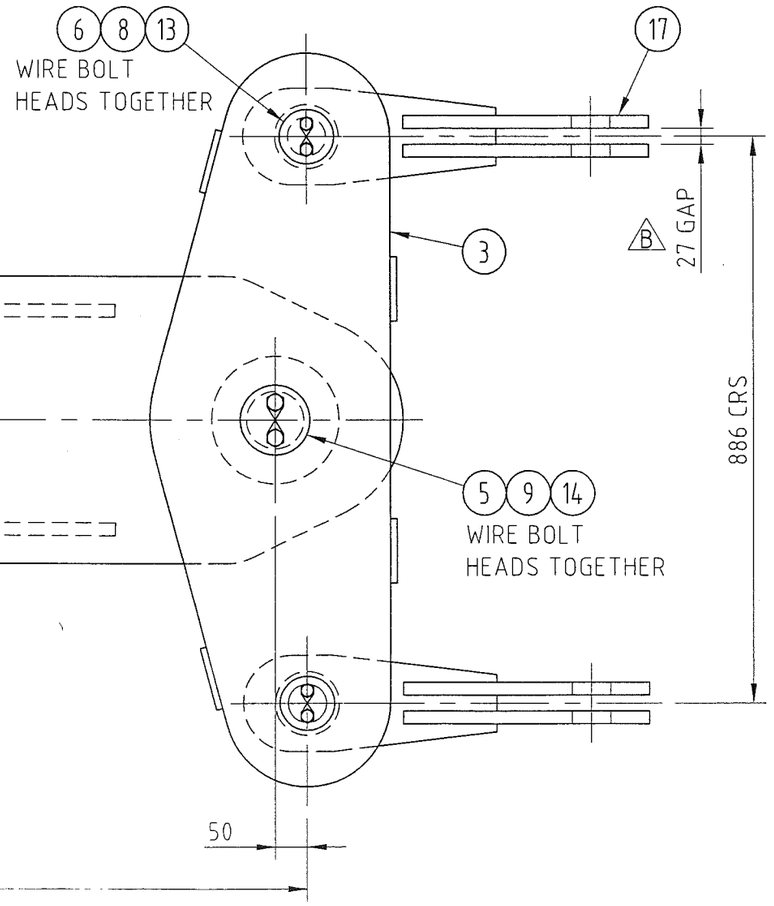
Project: M440E — First Used On S/No. 1475

Title: 25T WLL HOIST HOOK ASSEMBLY — Activity No. 510

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
ARIZA	U.S.	04.06.07	1:15	1 of 1	900 kg	A

Approved	Eng. Approved	Drawing Number
AM		A3-5300.225





VIEW A-A

Material List

Page 712

Cat.	Item	Qty	Description	Reference	kg
	1	2	SHEAVE ASSEMBLY ⌀620 / ⌀32 / ⌀100	A4-9510.010	160
	2	1	BRIDLE FRAME	A3-5210.047	197
	3	1	EQUALISING BEAM	A3-5210.047	134
	4	1	BRIDLE SHEAVE PIN ⌀100	A3-5220.020.001	24
	5	1	PIVOT PIN ⌀90	A3-5220.020.002	7
	6	2	PENDANT PIN ⌀60	A3-5220.020.003	6
	7	2	ROPE GUARD	A4-9550.019.008	2
	8	2	KEEPER PLATE	A4-5601.031.002	1
	9	1	KEEPER PLATE	A4-5601.031.003	1
	10	1	END COVER	A4-9912.019	1
	11	2	M16 x 60 LG. HEX HEAD SET SCREW	GRADE 8.8	-
	12	2	M16 x 40 LG. HEX HEAD SET SCREW	GRADE 8.8	-
	13	4	M12 x 25 LG. HEX HEAD SET SCREW	ST. STEEL 316	-
	14	2	M16 x 30 LG. HEX HEAD SET SCREW	GRADE 8.8	-
	15	4	SPLIT PIN ⌀8 x 50LG.	ZINC PLATED	-
	16	2	SPACER 114 O/D x 100 I/D x 25 LG	A3-9901.002.018	-
B	17	2	BRIDLE PENDANT STRAP CONNECTOR	A4-5610.080	20

Dm.	21.06.07	ITEM-17 WAS A4-5610.048, 27 GAP WAS 25 GAP	-	US	B
	17.05.06	ORIGINAL ISSUE TAKEN FROM A3-5200.116.	-	CN	A
Checked	Date	Revision	BCN	Name	Issue

FAVELLE FAVCO

Favelle Favco Cranes Pty. Ltd.
A.B.N 29 067 562 449
A subsidiary of Muhibbah Engineering (M) BHD

Project: M440E TOWER CRANE — First Used On S/No. 1323

Title: B324 BRIDLE ASSEMBLY — Activity No 520

Drawn	Checked	Date Drawn	Scale	Sheet	Weight	Issue
CHERYL	US	17.05.06	1:10	1 of 1	553 kg	B

Approved: AMc — Eng. Approved: — Drawing Number: A3-5200.126

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ORIGINAL DEALER DRAWING IS IN DOUBT ASK FAVELLE FAVCO ENGINEERING DEPARTMENT

FORM F24.04.03

7 COMPONENTS AND PARTS

7.1 General..... 7-2

7.2 Hydraulic Components.....7-3

7.1 General

Great care has been taken to provide the maximum information required for replacement of faulty equipment through stocked spares or to order additional spares required through normal wear.

However, not all components parts pictures are available to us to fit into this crane manual.

When ordering spares, always state;

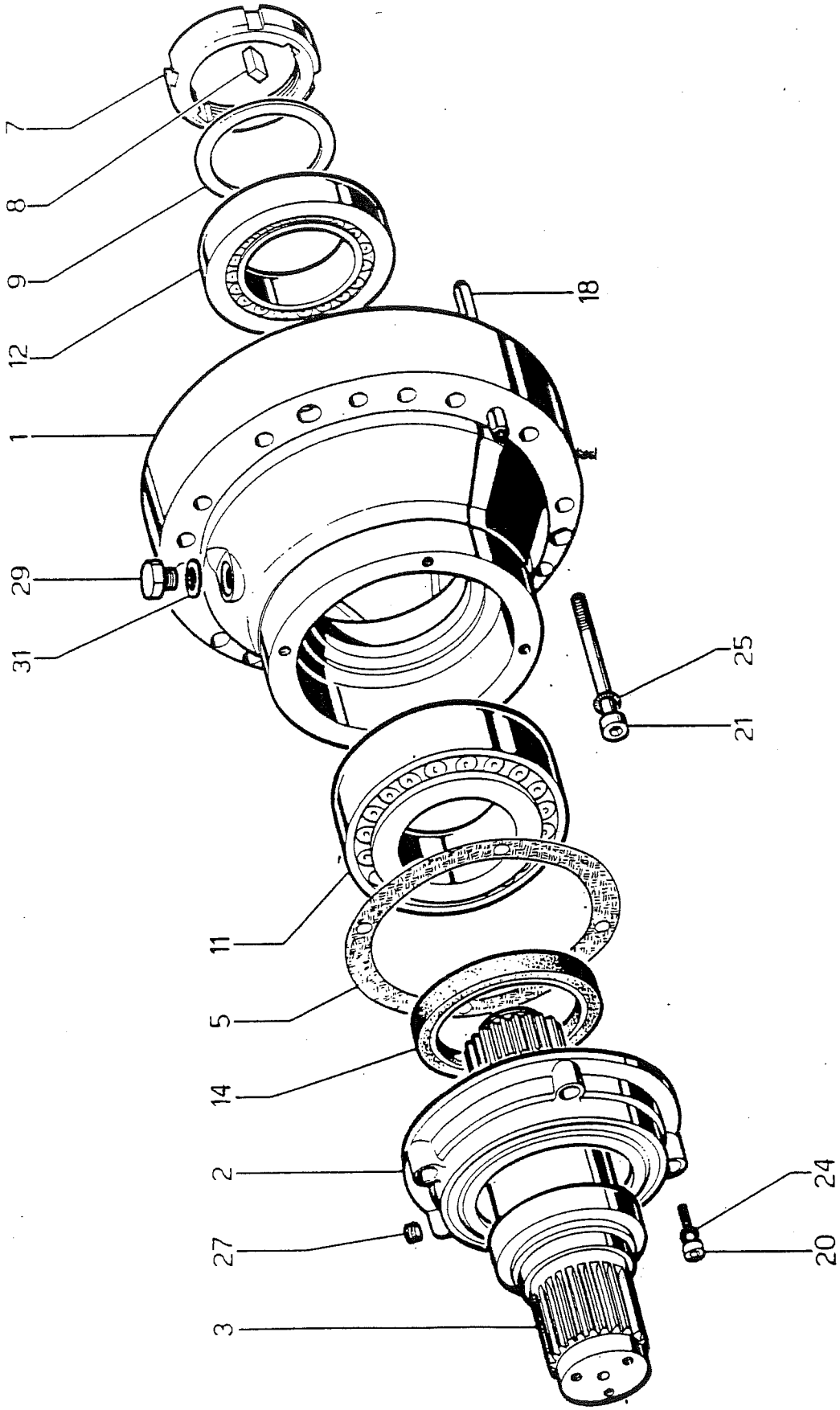
1. Crane Type :	**M440E**
2. Crane Serial Number :	**1475**
3. Name of Part	*(eg Filter element)*
4. Drawing No. of Part	*eg. A3.6200.265M*
5. Revision No.	*eg. Rev. B*
6. Item No.	
7. A description of what is wanted	
8. Include any manufacturer's data that is stamped on the part	

7.2 Hydraulic Components

The following hydraulic component literature is supplied to assist in inspection, maintenance and minor repair work to the system or valves. However, any repairs or settings on pumps, motors and relief valves must be carried out by competent and trained personnel with extensive hydraulic knowledge, special tools and clean facilities.
Major components should be replaced wholly and repair carried out only at original manufacturers of Favelle Favco Cranes Pty. Ltd. service centres. Repaired or reconditioned units can then be made available as required.
If hydraulic repair work is necessary on the crane, the surrounding area must be cleaned prior to any removal of components and all openings should immediately be closed off to prevent the ingress of dirt.
If so desired, seal kits and filter elements can be supplied to eliminate excessive shut down time in case of breakdown.
It is strongly recommended to hold spares of this type in stock.
When ordering spares, always state;

1.	Crane Type :	**M440E**
2.	Crane Serial Number :	**1475**
3.	Name of Part	*(eg Filter element)*
4.	Drawing No. of Part	*eg. A3.6200.265*
5.	Revision No.	*eg. Rev. B*
6.	Item No.	
7.	A description of what is wanted	
8.	Include any manufacturer's data that is stamped on the part	

DENOMINAZIONE	SUPPORTO	DISTINTA N° 00/1175
TIPO	BM 1150/MN	DISEGNO N° G.016MX.00/001.1
VERSIONE	SCANALATO STANDARD	



COMPONENTS LISTINGS.

DESCRIPTION: OUTPUT HOUSING

MODEL: 150

VERSION: STANDARD

PART LIST NO. 00/1175

FOG NO

MODEL NO.

NO.	CODE.	DESCRIPTION.	QTY.	NOTE.
1	352/031.0/4000	OUTPUT CASING	1	
2	354/028.2/4000	OUTPUT COVER	1	
3	351.2CE.2 CSCC	OUTPUT SHAFT	1	
4				
5	366/011.4/9000	GASKET	1	
6				
7	365/003.4/0000	LOCKNUT	1	
8	369/002.4/0000	KEY	1	
9	362/003.4/6400	SPACER RING	1	
10				
11	422/198.0/0000	BEARING 32220	1	
12	422/164.0/0000	BEARING 30217	1	
13				
14	411/375.0/0000	OIL SEAL 120x150x15	1	
15				
16				
17				
18	438/430.0/0100	DOWEL Ø 12x60	6	
19				
20	462/104.0/0000	BOLT M10x30	4	
21	462/149.0/0000	BOLT M12x100	3	
22				
23				
24	469/036.0/0000	WASHER "SCHNORR" Ø 10.5	4	
25	469/037.0/0000	WASHER "SCHNORR" Ø 13	3	
26				
27				
28				
29	451/044.0/0000	PLUG Ø 3/8 BSP GAS	1	
30				
31	417/003.0/0100	WASHER Ø16	1	

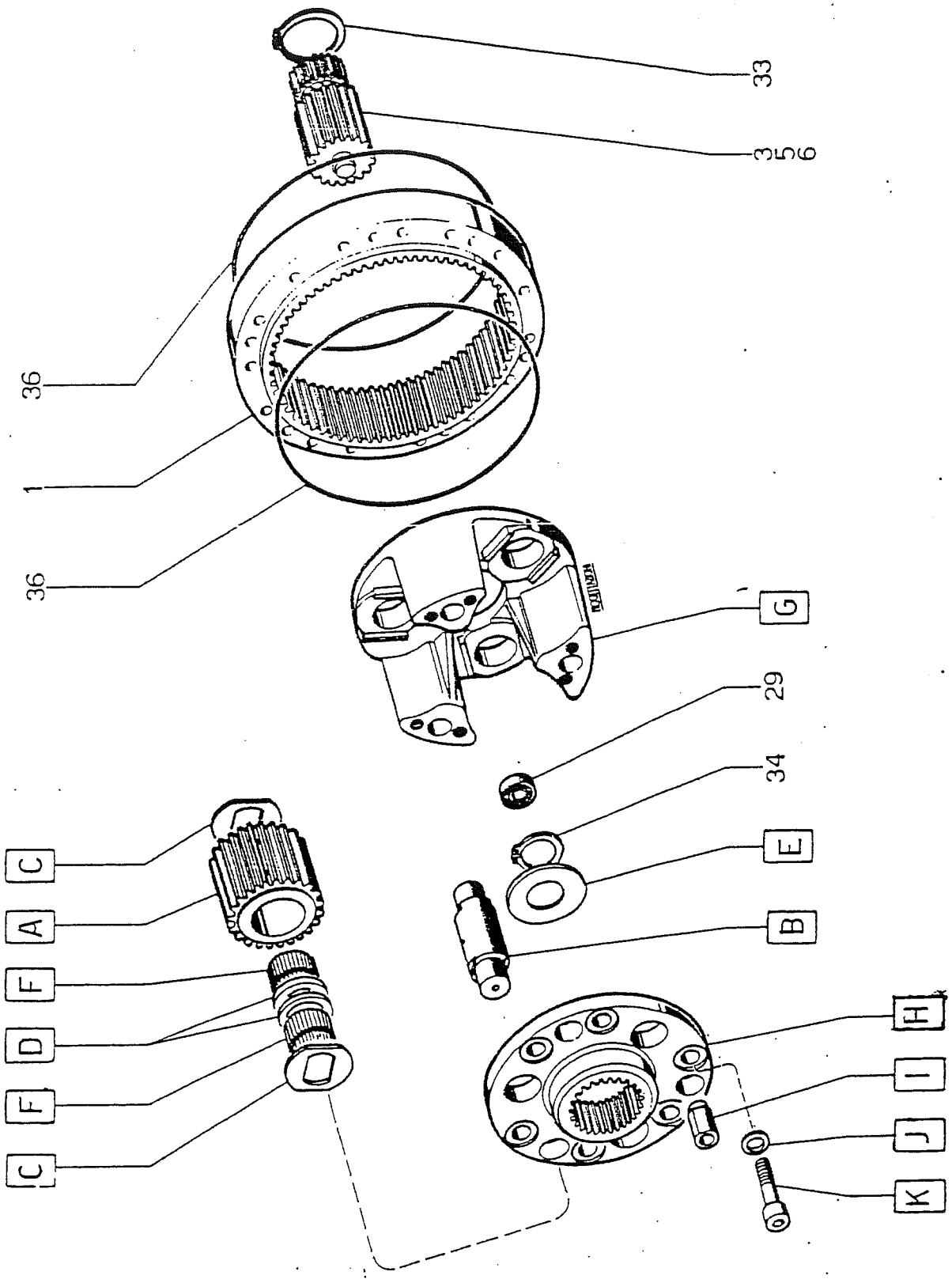
MODIFICATIONS.	DATA	CONFIRM	SOSTITUISCE
.....			.....
.....			SOSTITUITO DA
.....			.....

EURO-TRANS S.p.A.
REGGIO EMILIA - ITALIA
MOD. T.S. 1001

DESCRIZIONE	RIDUZIONE EPICICLOIDALE	ESPLOSO	00/4176
TIPO	EM 1150	DISTINTA	00/4176
VERSIONE	GIUNTO CENTRALE		

Data			
Controllata			
Eseguita			
Mod.			

Originale: Gasparini
Controllato:
Data: 22.10.93



Kit P01 - P02

Brevini

DISTINTA BASE COMPONENTI
Component part list - Liste des pieces
Stueckliste - Lista de despieces

00/4176

FOGLIO
Sheet - Page
Seite - Hoja
1/1

Compilata	NERONI	il	25/10/93	Controllata	INCERTI	il	25/10/93

DESCRIZIONE : RIDUZIONE EPICICLOIDALE
PLANETARY STAGE — REDUCTION PLANETAIRE
PLANETENGETRIEBESTUFE — REDUCCION EPICICLOIDAL

TIPO..... : EM 1150

VERSIONE... : G.C. Z=27 (B 58X53 DIN 5482)
SUN PINION — PIGNON CENTRAL
ZENTRALRITZEL — PIñON SOLAR

P.	CODICE Code - Codigo	DENOMINAZIONE Description - Description Beschreibung - Denominacion	Q.	NOTE Note - Plan Bemerk - Notas
P01	211E9230000	PREMONTATO RIDUZIONE i=3,9 SUBASSEMBLED - PREMONTÉ VORMONTIERT - PRE-MONTADO	1	
P02	211E9250000	PREMONTATO RIDUZIONE i=5,14 SUBASSEMBLED - PREMONTÉ VORMONTIERT - PRE-MONTADO	1	
P03	211E9270000	PREMONTATO RIDUZIONE i=6,27 SUBASSEMBLED - PREMONTÉ VORMONTIERT - PRE-MONTADO	1	
001	32002821100	CORONA DENTATURA INTERNA RING-GEAR - COURONNE HOHLRAD - CORONA	1	
003	32717140300	GIUNTO CENTRALE i=3,9 SUN PINION - PIGNON CENTRAL ZENTRALRITZEL - PIÑON SOLAR	1	
005	32717340300	GIUNTO CENTRALE i=5,14 SUN PINION - PIGNON CENTRAL ZENTRALRITZEL - PIÑON SOLAR	1	
006	32717440300	GIUNTO CENTRALE i=6,27 SUN PINION - PIGNON CENTRAL ZENTRALRITZEL - PIÑON SOLAR	1	
029	42109900000	CUSCINETTO 16004 DIN 625 BEARING - ROULEMENT LAGER - COJINETE	1	
033	43106100000	SEEGER "E" ϕ 57 UNI 7435 CIRCLIP - CIRCLIP SEEGERRING - ANILLO FIJACION	1	
034	43105600000	SEEGER "E" ϕ52 UNI 7435 CIRCLIP - CIRCLIP SEEGERRING - ANILLO FIJACION	1	
036	41251100000	O-RING 2-379 O-RING - JOINT TORIQUE O-RING - JUNTA TORICA	2	

Mod.	Descrizione modifica	Data	Es/Ct	Sostituisce la:
			/	P.N.

Complessivo ①	Dimensionale ②	Studio fattibilità ③	Esploso ④
G.016M.02/003.1			00/4176

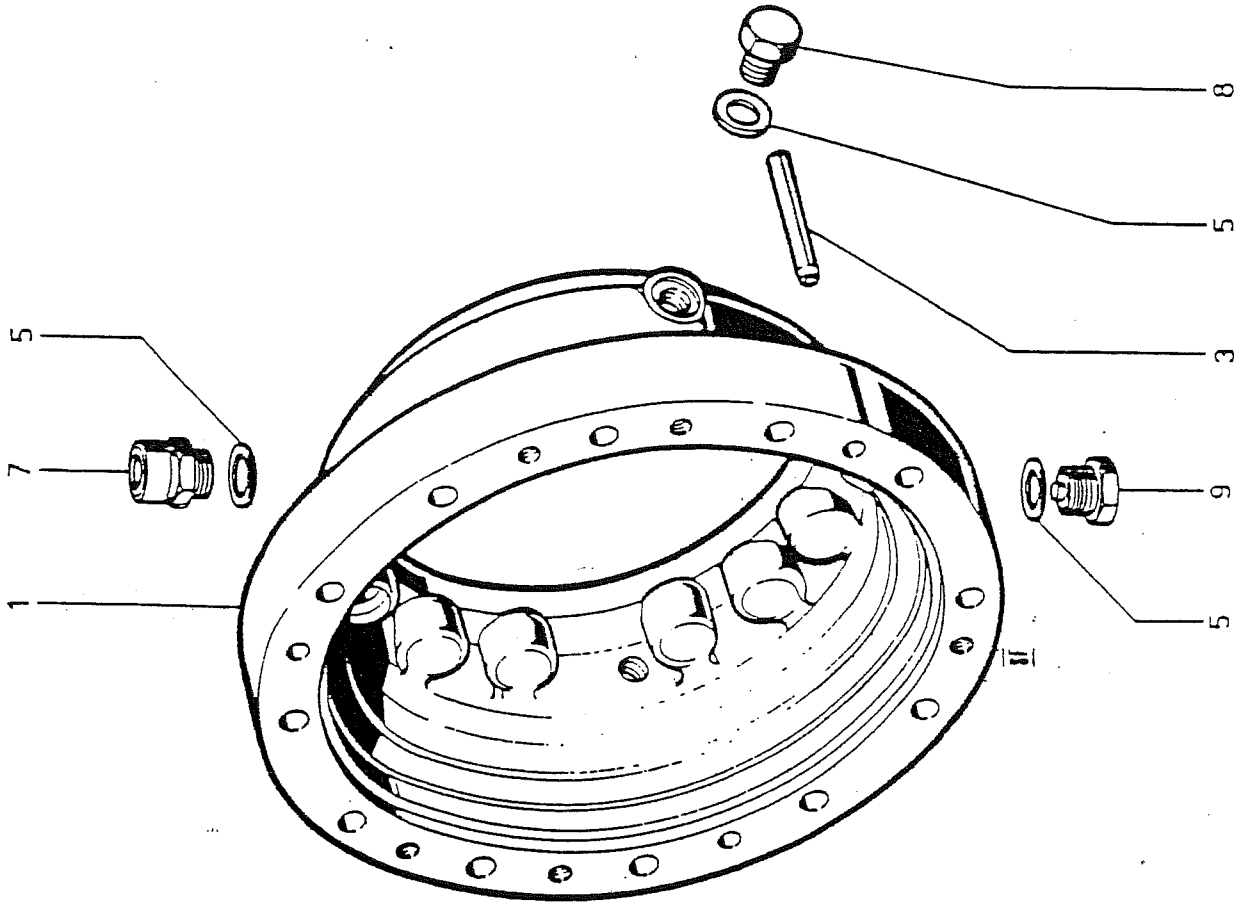
② Plano dimensional ③ Estudio de facilidad ④ Lista de repuestos

② Dimensionszeichnung ③ Realisierbarkeitsstudie ④ E.T.-Mappe

② Plan encombrement ③ Etude de faisab ④ Liste de rechanges

② Dimensional drawing ③ sability plan ④ Parts list

DENOMINAZIONE	FLANGIATURA INTERMEDI.A	DISTINTA N° 00/3017
TIPO	ED 2150	DISEGNO N°
VERSIONE	STANDARD	



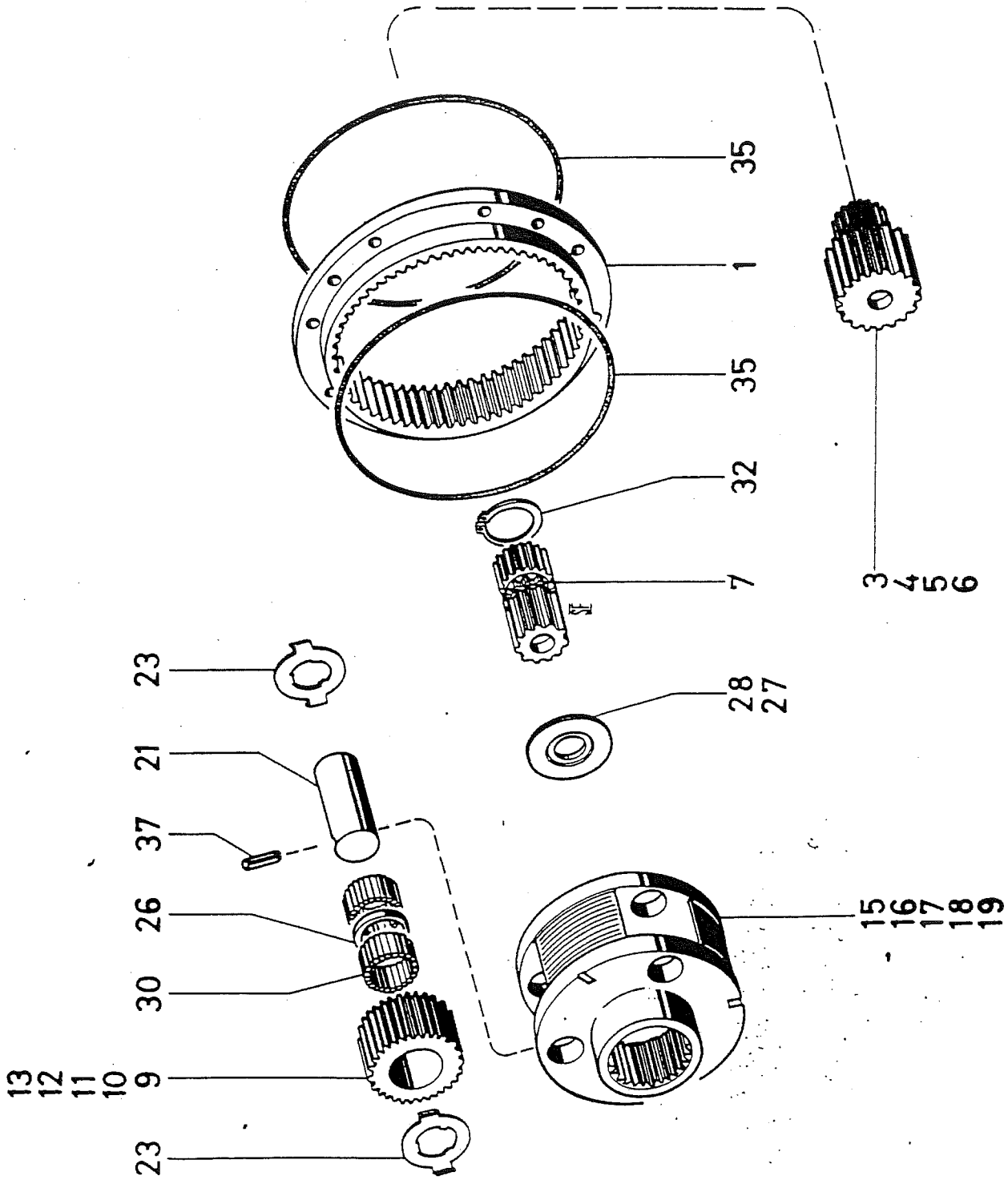
DATA	DISTINTA BASE COMPONENTI	DISTINTA Nº	FOG. Nº
09-88			
DESCRIZIONE	FLANGIATURA ENTERMEDIA	00/3017	1/ 1
TIPO	ED/2150	DISEGNO Nº	
VERSIONE	STANDARD		

P	CODICE	DENOMINAZIONE	Q.TA'	NOTE
1	342.0201.4000	FLANGIA INTERMEDIA	1	
3	438.3960.0100	SPINA ELASTICA ø10X60 UNI 6875	4	
5	417.0030.0100	RONDELLA ø16,7x22x1,5	3	ALLUMINIO
7	451.0640.0000	TAPPO SFIATO 3/8"GAS	1	
8	451.1040.0000	TAPPO LIVELLO OLIO 3/8"GAS	1	
9	451.2040.0000	TAPPO MAGNETICO 3/8"GAS	1	

Nº	MODIFICA	DATA	F.MA	SOST. IL
				SOST. DA

brevini s.p.a.

DESCRIPTION	PLANETARY STAGE	PART LIST N° 00/4072
TYPE	EM 1045 SERIES 80	DRAWING N° G.014G.00/020.1
VERSION	SUN PINION Z = 20	



COMPONENT PART LIST

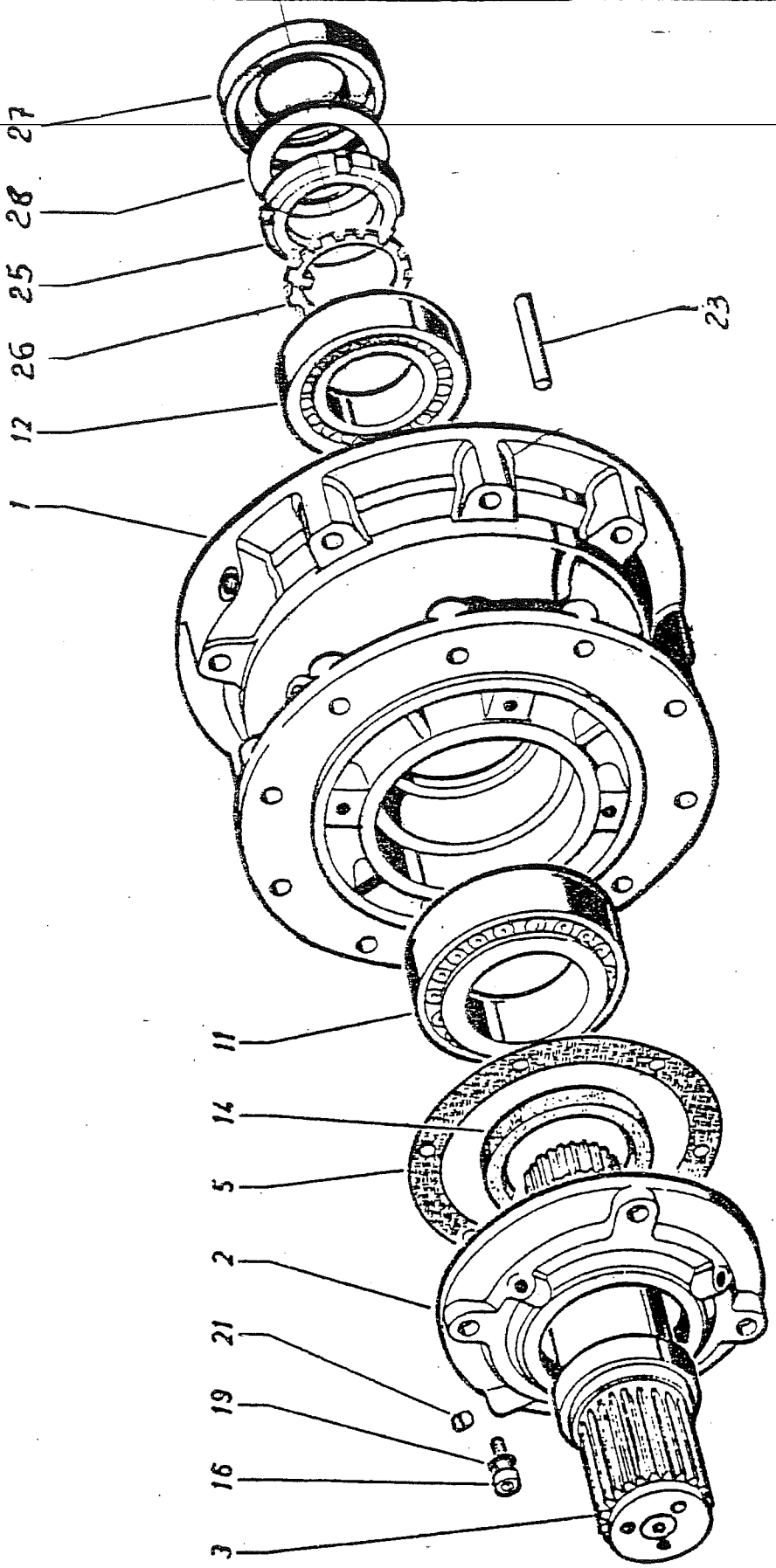
DATE	PART LIST Nº	SHEET
09-91	00/4072	1/ 1

DESCRIPTION	PLANETARY STAGE	DRAWING Nº
TYPE	EM-1045 SERIE 80	
VERSION	SUN PINION Z=20	G.014G.00/020.1

P	CODE	DESCRIPTION	Q.TY	NOTE
1	320.0142.1100	INTERNAL TOOTHED RING GEAR	1	
3	327.3073.0300	SUN PINION i=3,5	1	
4	327.3083.0300	SUN PINION i=4	1	
5	327.3093.0300	SUN PINION i=5,16	1	
6	327.3103.0300	SUN PINION i=6	1	
7	327.3113.0300	SUN PINION i=7,25	1	
9	325.1144.1100	PLANET GEAR i=3,5	3	
10	325.1154.1100	PLANET GEAR i=4	3	
11	325.1164.1100	PLANET GEAR i=5,16	3	
12	325.1174.1100	PLANET GEAR i=6	3	
13	325.1184.1100	PLANET GEAR i=7,25	3	
15	345.7161.4400	PLANET CARRIER i=3,5	1	
16	345.7171.4400	PLANET CARRIER i=4	1	
17	345.7181.4400	PLANET CARRIER i=5,16	1	
18	345.7191.4400	PLANET CARRIER i=6	1	
19	345.7201.4400	PLANET CARRIER i=7,25	1	
21	315.0324.0100	PLANET PIN	3	
23	361.1084.6400	THRUST WASHER	6	
26	363.0794.6300	SPACER	3	
27	361.0563.6400	THRUST WASHER Øi=7	1	
28	361.0583.6400	THRUST WASHER Øi=22,5	1	
30	427.0440.0000	NEEDLE ROLL.Ø3,5x15,8 DIN 5402	180	
32	431.0400.0000	EXT.CIRCLIP "E" Ø36 UNI 7435	1	
35	412.2090.0000	O-RING 2-170	2	
37	438.2850.0100	SPRING PIN Ø5x26 UNI6875	3	

Nº	REVISION	DATE	BY	REPLAC. OF
1	-VAR. 15-16-17-18-19 (ERANO ...4500)	11-09-91		REPLAC. BY
2				
3				
4				

brevini s.p.a.


27
28
25
26
12
1
23
11
14
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2
21
19
16
3

COMPONENTS LISTINGS.

DESCRIPTION: OUTPUT ASSY

MODEL: DK 11

VERSION:

PART LIST Page 727 | FOG NO

00/1125 | 1

MODEL NO.

011x-00/001

NO.	CODE.	DESCRIPTION.	QTY.	NOTE.
1	352/025.0/4200	OUTPUT HOUSING	1	
2	354/022.2/4000	OUTPUT COVER	1	
3	311/171.3/0600	SPLINED OUTPUT SHAFT	1	
4				
5	366/009.4/9000	GASKET	1	
6				
7				
8				
9				
10				
11	422/165.0/0000	BEARING 32217 DIN 720	1	
12	422/139.0/0000	BEARING 30215 DIN 720	1	
13				
14	411/345.0/0000	OIL SEAL BASL 95x120x12	1	
15				
16	462/103.0/0000	BOLT M 10x25 UNI 5931-67-8G	4	
17				
18				
19	469/036.0/0000	WASHER "SCHNORR" Ø 10,5	4	
20				
21	451/003.0/0000	PLUG ⅛ GAS DIN 906	1	
22				
23	438/430.0/0000	DOWEL 12x60 UH1 6875-71	4	
24				
25	471/016.0/0000	LOCKNUT KM 15 M75x2x6H	1	
26	372/113.4/6400	LOCK WASHER	1	
27	363/642.4/6300	DISTANCE RING	1	
28	431/845.0/0103	PLATE	3	80x100x0,3

MODIFICATIONS.	DATA	CONFIRM	SOSTITUISCE
.....			.....
.....			SOSTITUITO DA
.....			.....

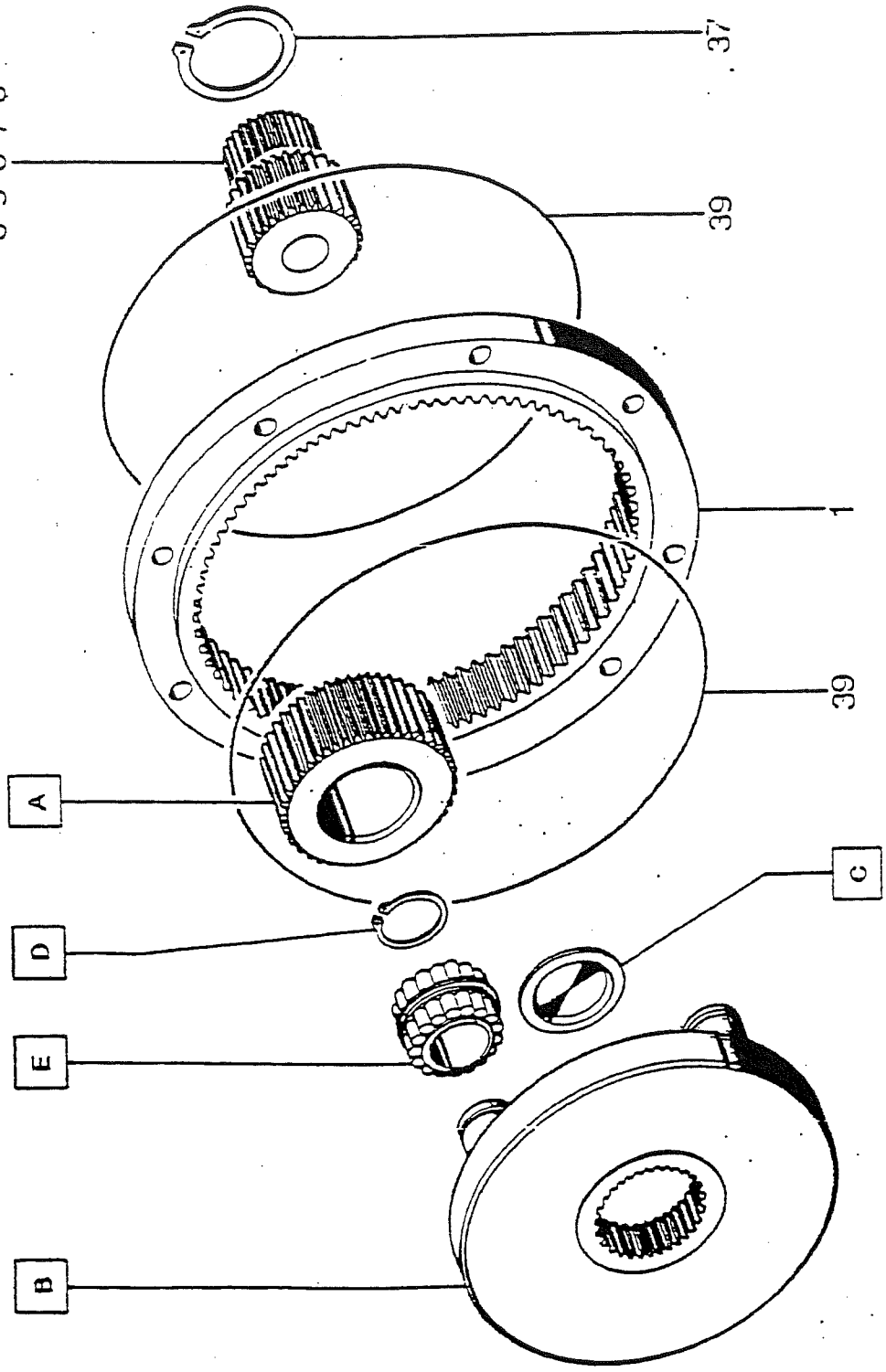
EURO-TRANS PTY. LTD.

REGGIO - ITALIA MOD. T.B. 1001

Mod.	Eseguita	Controllata	Data

Disegnato: CERVI
Controllato:
Data: 21/10/93

DESCRIZIONE	RIDUZIONE EPICICLOIDALE	ESPLOSO 00/4130
TIPO	EM 1090	DISTINTA 00/4130
VERSIONE	G.C. Z=27 (B58X53 DIN 5482)	



KIT = P01÷P05

Brevini

Compilata	NERONI	il	21/10/93	Controllata	INCERTI	il	21/10/93

DESCRIZIONE : RIDUZIONE EPICICLOIDALE
PLANETARY STAGE — REDUCTION PLANETAIRE
PLANETENGETRIEBESTUFE — REDUCCION EPICYCLOIDAL

TIPO..... : EM 1090

VERSIONE... : G.C. Z=27 (B 58X53 DIN 5482)
SUN PINION — PIGNON CENTRAL
ZENTRALRITZEL — PIÑON SOLAR

P.	CODICE Code - Codigo	DENOMINAZIONE Description - Description Beschreibung - Denominacion	Q.	NOTE Note - Plan Bemerk - Notas
P01	211E423X200	PREMONTATO RIDUZIONE I=4,08 SUBASSEMBLED - PREMONTÉ VORMONTIERT - PRE-MONTADO	1	
P02	211E425X200	PREMONTATO RIDUZIONE I=5,05 SUBASSEMBLED - PREMONTÉ VORMONTIERT - PRE-MONTADO	1	
P03	211E429X200	PREMONTATO RIDUZIONE I=8,8 SUBASSEMBLED - PREMONTÉ VORMONTIERT - PRE-MONTADO	1	
P04	211E429X200	PREMONTATO RIDUZIONE I=6,92 SUBASSEMBLED - PREMONTÉ VORMONTIERT - PRE-MONTADO	1	
P05	211E436X200	PREMONTATO RIDUZIONE I=8,7 SUBASSEMBLED - PREMONTÉ VORMONTIERT - PRE-MONTADO	1	
001	32002321100	CORONA DENTATURA INTERNA RING-GEAR - COURONNE HOHLRAD - CORONA	1	
003	32788130300	GIUNTO CENTRALE i=4,08 SUN PINION - PIGNON CENTRAL ZENTRALRITZEL - PIÑON SOLAR	1	
005	32788230300	GIUNTO CENTRALE i=5,05 SUN PINION - PIGNON CENTRAL ZENTRALRITZEL - PIÑON SOLAR	1	
006	32788330300	GIUNTO CENTRALE i=5,8 SUN PINION - PIGNON CENTRAL ZENTRALRITZEL - PIÑON SOLAR	1	
007	32788430300	GIUNTO CENTRALE i=6,92 SUN PINION - PIGNON CENTRAL ZENTRALRITZEL - PIÑON SOLAR	1	
008	32714530300	GIUNTO CENTRALE i=8,7 SUN PINION - PIGNON CENTRAL ZENTRALRITZEL - PIÑON SOLAR	1	

Mod.	Descrizione modifica	Data	Es/Ct	Sostituisce la:
				P.N.

Complessivo 1	Dimensionale 2	Studio fattibilità 3	Esploso 4
G.011.00/032.2			00 4130

① Lista de repuestos ② Plano dimensional ③ Estudio de factibilidad
① E.T.-Mappe ② Dimensionszeichnung ③ Realisierbarkeitsstudie
① Liste de rechanges ② Plan encombrement ③ Etude de faisabilité
① Parts list ② Dimensional drawing ③ Feasability plan

Brevini Motori

P.	CODICE Code - Codigo	DENOMINAZIONE Description - Description Beschreibung - Denominacion	Q.	NOTE Note - Plan Bemerk - Notas
037	43106100000	SEEGER "E" Ø 57 UNI 7435 CIRCLIP - CIRCLIP SEEGERRING - ANILLO FIJACION	1	
039	41238200000	O-RING 2-277 O-RING - JOINT TORIQUE O-RING - JUNTA TORICA	2	

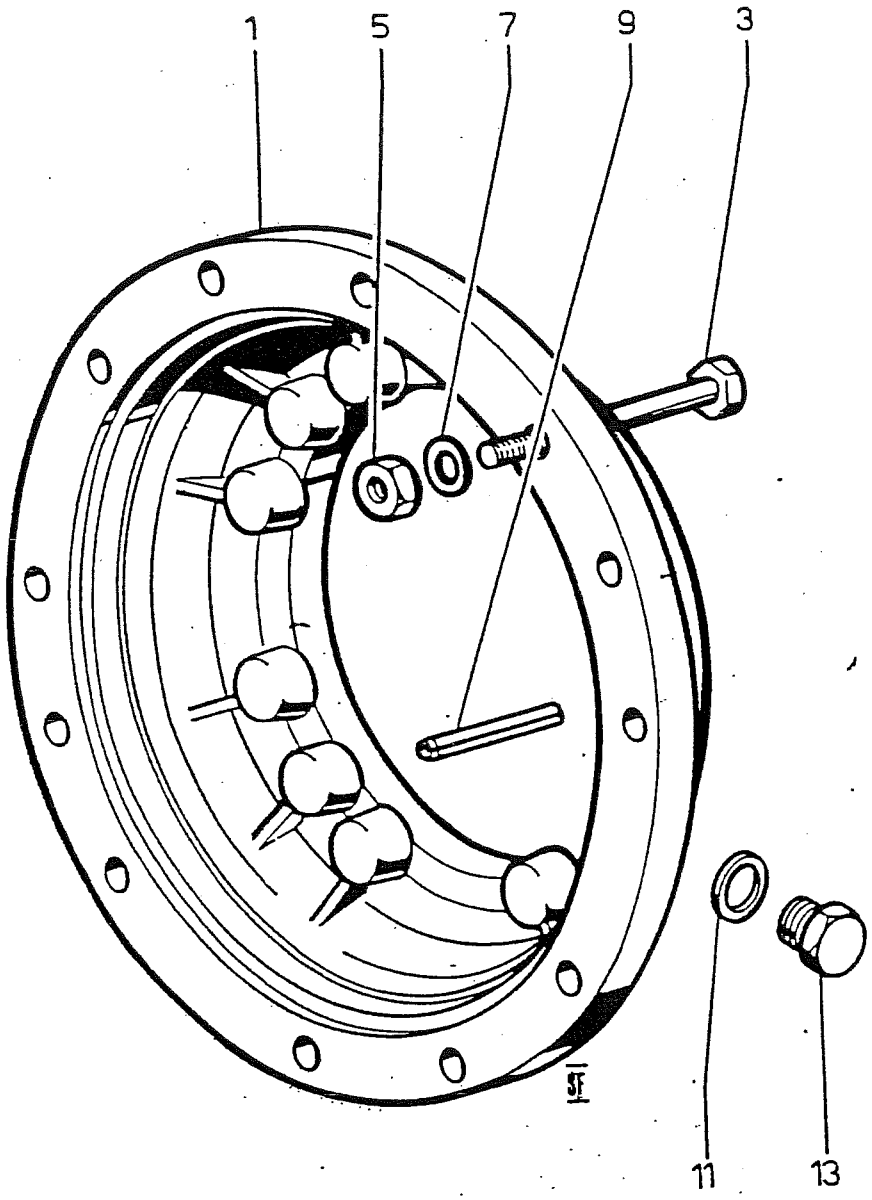
Ligier Images

COMPONENTS LIST
==========

DESCRIPTION: INTERMEDIATE FLANGE P/LIST NO: 00/3012

MODEL: ED 2090 MODEL NO:.....

VERSION: STANDARD SERIES 80 PAGE:.....



brevini australia
BREVINI AUSTRALIA PTY. LTD.
9 Prince William Drive, Seven Hills, NSW Australia
TEL: (02) 838 9475 FAX: (02) 674 3886

COMPONENTS LIST
==========

DESCRIPTION: INTERMEDIATE FLANGE **P/LIST NO:** 00/3012

MODEL: ED 2090 **MODEL NO:**.....

VERSION: STANDARD SERIES 80 **PAGE:**.....

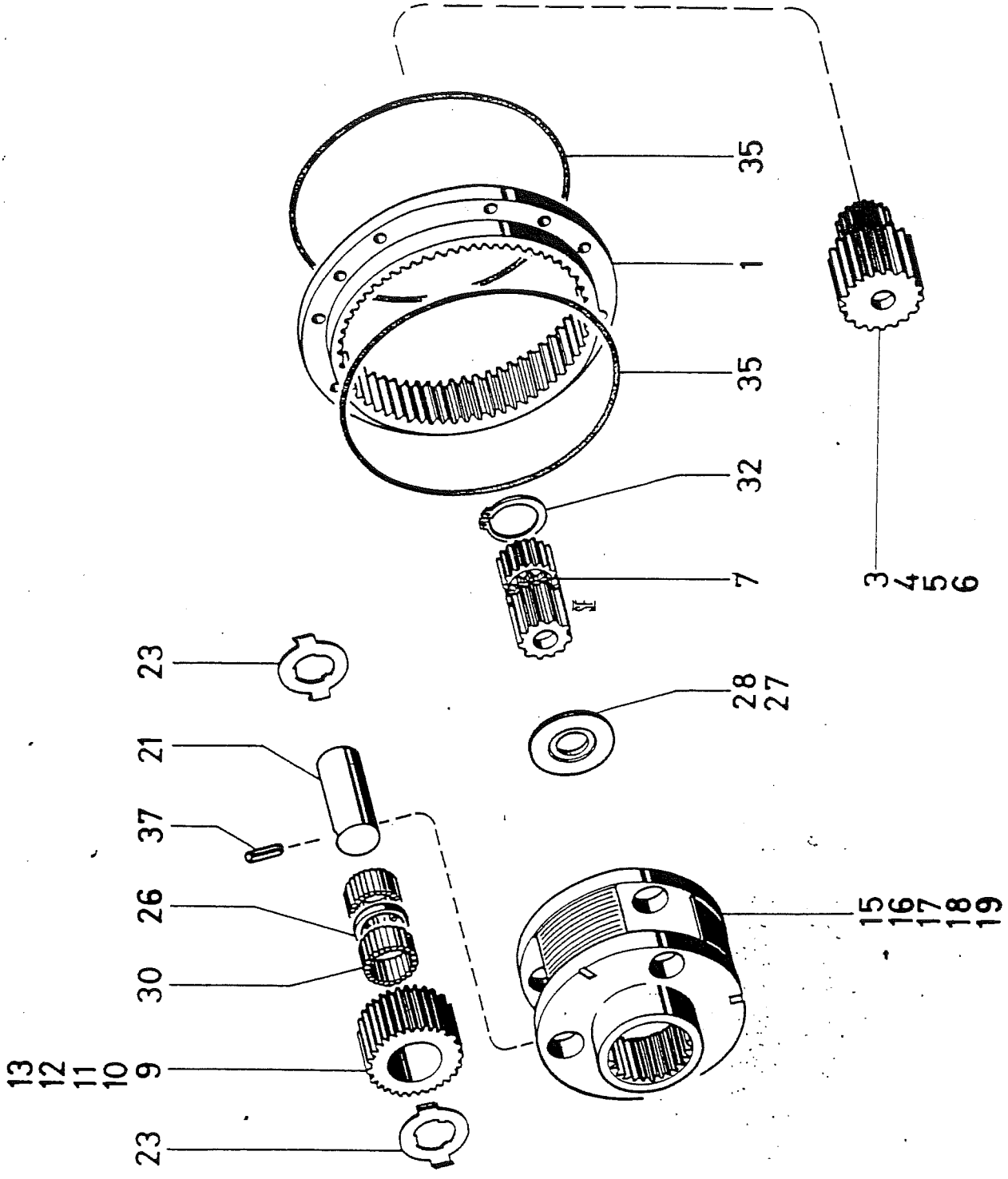
POS:	CODE:	DESCRIPTION:	QTY:	NOTE:
1	342.0132.4000	INTERMEDIATE FLANGE 090/045	1	
3	461.1840.0100	FASTENER HEX M14X110 G8.8	8	
5	466.0100.0100	NUT M14 G 8.8	8	
7	467.0130.0001	WASHER DIA 15X28X25	8	
9	438.3960.0100	DOWEL DIA 10 X 60	4	

MODIFICATIONS: **DATE.APPR.**

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brevini australia
BREVINI AUSTRALIA PTY. LTD.
Prince William Drive, Seven Hills, NSW Australia
TEL: (02) 838 9475 FAX: (02) 674 3886

DESCRIPTION	PLANETARY STAGE	PART LIST N° 00/4072
TYPE	EM 1045 SERIES 80	DRAWING N° G.014G.00/020.1
VERSION	SUN PINION Z=20	



DATE	COMPONENT PART LIST	PART LIST Nº	SHEET
09-91		00/4072	1/ 1

DESCRIPTION	PLANETARY STAGE	DRAWING Nº
TYPE	EM-1045 SERIE 80	
VERSION	SUN PINION Z=20	G.014G.00/020.1

P	CODE	DESCRIPTION	Q.TY	NOTE
1	320.0142.1100	INTERNAL TOOTHED RING GEAR	1	
3	327.3073.0300	SUN PINION i=3,5	1	
4	327.3083.0300	SUN PINION i=4	1	
5	327.3093.0300	SUN PINION i=5,16	1	
6	327.3103.0300	SUN PINION i=6	1	
7	327.3113.0300	SUN PINION i=7,25	1	
9	325.1144.1100	PLANET GEAR i=3,5	3	
10	325.1154.1100	PLANET GEAR i=4	3	
11	325.1164.1100	PLANET GEAR i=5,16	3	
12	325.1174.1100	PLANET GEAR i=6	3	
13	325.1184.1100	PLANET GEAR i=7,25	3	
15	345.7161.4400	PLANET CARRIER i=3,5	1	
16	345.7171.4400	PLANET CARRIER i=4	1	
17	345.7181.4400	PLANET CARRIER i=5,16	1	
18	345.7191.4400	PLANET CARRIER i=6	1	
19	345.7201.4400	PLANET CARRIER i=7,25	1	
21	315.0324.0100	PLANET PIN	3	
23	361.1084.6400	THRUST WASHER	6	
26	363.0794.6300	SPACER	3	
27	361.0563.6400	THRUST WASHER Øi=7	1	
28	361.0583.6400	THRUST WASHER Øi=22,5	1	
30	427.0440.0000	NEEDLE ROLL.Ø3,5x15,8 DIN 5402	180	
32	431.0400.0000	EXT.CIRCLIP "E" Ø36 UNI 7435	1	
35	412.2090.0000	O-RING 2-170	2	
37	438.2850.0100	SPRING PIN Ø5x26 UNI6875	3	

Nº	REVISION	DATE	BY	REPLAC. OF
1	-VAR. 15-16-17-18-19 (ERANO ...4500)	11-09-91		REPLAC. BY
2				
3				
4				

brevini s.p.a.

Item	Description
1	Variable Displacement Pump A4VG
2	Repair Instructions for A4VG series 250 Hoist Pump
3	Repair Instructions for A4VG series 71 - 180 Luff & Slew Pump
4	Fixed Displacement Motor A10FM
5	Variable Displacement Motor A6VM
6	Repair Instructions for A6VM Motor
7	Fixed Displacement Motor A2FM
8	Repair instruction for A2FM
9	Control Valve 4WE6 /S
10	Shuttle Valve kk8
11	3 Way Ball Valves KHB3K
12	Fluid Level Gauge FSK
13	Check Valve Type S
14	Pressure Line Filters LF and DF

RE 92 003/05.99

replaces: 02.98

engineering
Mannesmann Rexroth

Variable Displacement Pump A4VG

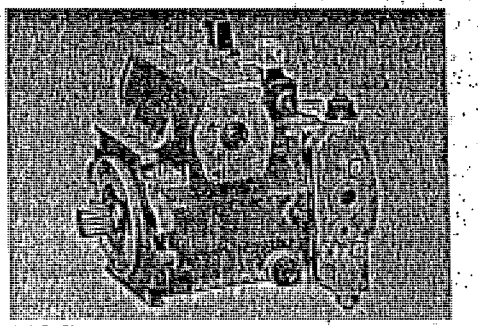
for closed circuits

Sizes 28...250

Series 3

Nominal pressure 400 bar

Peak pressure 450 bar



A4VG...EP

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Features

- variable displacement axial piston pump of swashplate design for hydrostatic closed circuit transmissions
- flow is proportional to drive speed and displacement and is infinitely variable
- output flow increases with swivel angle from 0 to its maximum value
- swivelling the pump over centre smoothly changes the direction of flow
- a highly adaptable range of control and regulating devices is available
- the pump is equipped with two pressure relief valves on the high pressure ports to protect the hydrostatic transmission (pump and motor) from overloads
- these valves also function as boost inlet valves
- an integral auxiliary pump serves as boost and pilot oil pump
- the maximum boost pressure is limited by a built-in boost pressure relief valve
- the integral pressure cut-off is standard

- Further Informations:

  Variable Displacement Pump A4VTG RE 92 012
  for drum drives on mobile concrete Mixers

RE 92 003/05.99

Ordering Code / Standard Program

Hydraulic fluid

Mineral oil (no code)

Axial piston unit

Variable swashplate design, nominal pressure 400 bar, peak pressure 450 bar — A4V

Operation

Pump in closed circuits — G

Size

a Displacement $V_{g\,max}$ in cm³	28	40	56	71	90	125	180	250

Control device

		28	40	56	71	90	125	180	250	
without control module	NV	•	•	•	•	•	•	•	•	NV
Hydraulic control, pilot pressure related	HD	•	•	•	•	•	•	•	•	HD
Hydraulic control, mechanical servo	HW	○	○	○	○	○	•	•	•	HW
Hydraulic control, speed related	DA	○	○	○	○	○	○	○	•	DA
Hydraulic control, direct operated	DG	○	○	○	○	○	○	○	•	DG
Electrical two-position control with switching solenoid	EZ	•	•	•	•	•	•	•	•	EZ
Electrical control with proportionel solenoid	EP	○	○	○	○	○	○	○	•	EP

Solenoid voltage (only for EP, EZ or DA)

U = 12 V	○	○	•	•	•	•	•	•	1
U = 24 V	○	○	•	•	•	•	•	•	2

Pressure cut-off

with pressure cut-off (standard)	•	•	•	•	•	•	•	•	D

Zero position switch (only for HW)

without zero position switch (no code)	○	○	○	○	○	○	○	•	
with zero position switch	•	•	•	•	•	•	•	•	L

Mechanical stroke limiter

without mechanical stroke limiter (no code)	○	○	○	○	○	○	○	•	
with mechanical stroke limiter, external adjustable	•	•	•	•	•	•	•	•	M

Ports X_3, X_4 for positioning pressure

without ports X_3, X_4 (no code)	○	○	○	○	○	○	○	•	
with ports X_3, X_4	•	•	•	•	•	•	•	•	T

DA control valve

		NV	EZ	DG	EP	HW	HD	DA	28...250	
without DA control valve		•	•	○	○	○	•	–	•	1
with DA control valve, fixed setting		–	–	○	○	○	•	○	•	2
with DA control valve, mech. adjust. with control lever	L	–	–	•	•	•	•	•	•	3L
	R	–	–	•	•	•	•	•	•	3R
with DA control valve, fixed setting and hydraulic inch valve built-on, control with breaking fluid		–	–	–	–	–	–	•	•	4
with DA control valve, mech. adjust. with control lever and hydraulic inch valve built-on, control with breaking fluid	L	–	–	–	–	–	–	•		5L
	R	–	–	–	–	–	–	•	•	5R
with DA control valve, fixed setting and connections for master controller		–	–	•	•	•	•	•	•	7
with DA control valve, fixed setting and hydraulic inch valve built-on, control with mineral oil		–	–	•	•	•	•	•	•	8
with DA control valve, mech. adjust. with control lever and hydraulic inch valve built-on, control with mineral oil	L	–	–	–	–	–	–	•	•	9L
	R	–	–	–	–	–	–	•	•	9R

DA control valve with control lever

without control lever (no code)	
with control lever - anti-clockwise operation direction	L
with control lever - clockwise operation direction	R

Series

3

A4V	G			/	3	2		–							

Axial piston unit
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Seals

NBR, shaft seal in FPM	N

Shaft end (permissible input torque see page 38)

	28	40	56	71	90	125	180	250	
Splined shaft DIN 5480 (standard for single pump)	●	●	●	●	●	●	●	●	Z
Splined shaft DIN 5480 (standard for combi. pump, 1st pump)	– [1]	●	●	●	●	●	– [1]	– [1]	A
Splined shaft SAE (standard for single pump)	●	●	●	●	●	●	●	●	S
Splined shaft SAE (standard for combi. pump, 1st pump)	– [2]	– [2]	●	●	– [2]	●	●	●	T
Splined shaft SAE (only for combination pump, 2nd pump)	–	●	–	–	–	–	–	–	U

Mounting flange

SAE		28	40	56	71	90	125	180	250	
	2-hole	●	●	●	–	–	–	–	–	C
	4-hole	–	–	–	–	–	–	●	●	D
	2 + 4-hole	–	–	–	●	●	●	–	–	F

Service line connections

	28	40...180	250	
Ports A and B SAE, (metric fixing screws), at side (on opposite sides)	–	●	–	02
Ports A and B SAE, (metric fixing screws), at side (same side)	●	–	●	10

Auxiliary pump

	28	40	56	71	90	125	180	250	
with integral auxiliary pump, without through drive	●	●	●	●	●	●	●	●	F00
without integral auxiliary pump, without through drive	●	●	●	●	●	●	●	●	N00
with integral auxiliary pump, with through drive	●	●	●	●	●	●	●	●	F...
without integral auxiliary pump, with through drive	●	●	●	●	●	●	●	●	K...

Through drive

flange	hub		28	40	56	71	90	125	180	250	
SAE A, 2-hole	SAE A	(N5/8"-9T 16/32DP)	●	●	●	●	●	●	●	●	...01
SAE B, 2-hole	SAE B	(N7/8"-13T 16/32DP)	●	●	●	●	●	●	●	●	...02
SAE B, 2-hole	SAE B-B	(N1"-15T 16/32DP)	●	●	●	●	●	●	●	●	...04
SAE C, 2-hole	SAE B-B	(N1"-15T 16/32DP)	–	●	–	–	–	–	–	–	...09
SAE C, 2-hole	SAE C	(N1 1/4"-14T 12/24DP)	–	–	●	●	●	●	●	●	...07
SAE D, 2+4-hole	DIN 5480	(N35x2x30x16x9H)	–	–	–	–	●	–	–	–	...73
SAE D, 2+4-hole	SAE D	(N1 3/4"-13T 8/16DP)	–	–	–	–	–	●	●	●	...69
SAE E, 4-hole	SAE E	(N1 3/4"-13T 8/16DP)	–	–	–	–	–	–	●	●	...72

Valves

	setting range		28	40	56	71	90	125	180	250	
with high press. relief valve, pilot controlled	100...420 bar	with bypass	–	–	–	●	●	●	●	●	1
with high pressure relief valve, direct controlled, (fixed setting)	250...420 bar	without bypass	●	●	●	–	–	–	–	–	3
		with bypass	●	●	●	–	–	–	–	–	5
	100...250 bar	without bypass	●	●	●	–	–	–	–	–	4
		with bypass	●	●	●	–	–	–	–	–	6

Filtration

	28	40	56	71	90	125	180	250	
Filtration in the suction line of the auxiliary (boost) pump	●	●	●	●	●	●	●	●	S
Filtration in the pressure line of the auxiliary (boost) pump: ports for external boost circuit filter, (F_s and F_a)	●	●	●	●	●	●	●	●	D
cold start valve and ports for external boost circuit filter, (F_s and F_a)	–	●	●	●	●	●	●	–	K
filter built-on (supplied complete) [3]	–	●	●	●	●	●	●	–	F
filter built-on with visual contamination indicator [3]	–	●	●	●	●	●	●	–	P
filter built-on with electrical contamination indicator [3]	–	●	●	●	●	●	●	–	L
filter built-on with visual and electrical contamination indicator [3]	–	●	●	●	●	●	●	–	M
External supply (model without integral auxiliary pump - N00, K..)	●	●	●	●	●	●	●	●	E

[1] standard for combi.-pump - 1st pump: shaft Z
[2] standard for combi.-pump - 1st pump: shaft S
[3] with cold start valve

= preferred program (preferred types see page 43)
● = available
– = not available

Technical Data

Fluid

We request that before starting a poject detailed information about the choice of pressure fluids and application conditions are taken from our catalogue sheets RE 90220 (mineral oil), RE 90221 (environmentally acceptable hydraulic fluids) and RE 90223 (fire resistant hydraulic fluids, HF).

When using HF- or environmentally acceptable hydraulic fluids possible limitations for the technical data have to be taken into consideration. If necessary please consult our technical department (please indicate type of the hydraulic fluid used for your application on the order sheet). The operation with HFA-, HFB and HFC- hydraulic fluids requires additional special measures.

Operating viscosity range

In order to obtain optimum efficiency and service life, we recommend that the operating viscosity (at operating temperature) be selected from within the range:

v_{opt} = operating viscosity 16...36 mm²/s

referred to the circuit temperature (closed circuit).

Viscosity limits

The limiting values for viscosity are as follows:

v_{min} = 5 mm²/s

short term at a max. permissible temp. of t_{max} = 115°C.

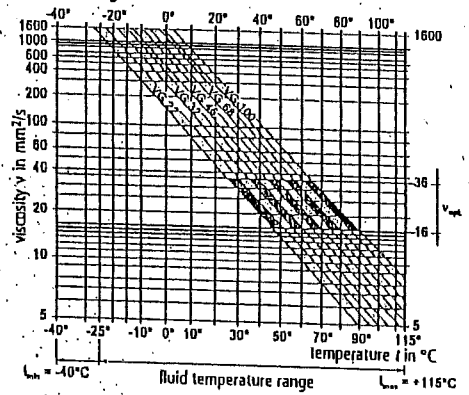
Please note that the max. fluid temperature is also not exceeded in certain areas (for instance bearing area).

v_{max} = 1600 mm²/s

short term on cold start ($n \leq 1000$ min⁻¹, t_{min} = -40°C).

At temperatures of -25°C up to -40°C special measures are required. Please contact us for further information.

Selection diagram



Notes on the selection of the hydraulic fluid

In order to select the correct fluid, it is necessary to know the operating temperature in the circuit (closed circuit) in relation to the ambient temperature.

The hydraulic fluid should be selected so that within the operating temperature range, the operating viscosity lies within the optimum range (v_{opt}) (see shaded section of the selection diagram). We recommend that the highest possible viscosity range should be chosen in each case.

Example: At an ambient temperature of X°C circuit temperature is 60°C. Within the operating viscosity range (v_{opt}; shaded area) this corresponds to viscosity ranges VG 46 or VG 68. VG 68 should be selected.

Important: The leakage oil (case drain oil) temperature is influenced by pressure and pump speed and is always higher than the circuit temperature. However, at no point in the circuit may the temperature exceed 115°C.

If it is not possible to comply with the above conditions because of extreme operating parameters or high ambient temperatures please consult us.

Temperature range of the radial shaft seal

The FPM shaft seal is admissible for a housing temperature range from -25°C to +115°C.

Note:
For applications below -25°C a NBR shaft seal is necessary (admissible temperature range -40°C to +90°C).
When ordering, please state in clear text: with NBR shaft seal

Operating pressure range - inlet

Variable pump (with external supply, E):

for control devices EP, EZ, HW and HD
boost pressure (when n = 2000 rpm) p_{sp} _____ 20 bar

for control devices DA, DG
boost pressure (when n = 2000 rpm) p_{sp} _____ 25 bar

Auxiliary pump:
suction pressure $p_{s\,min}$ ($v \leq 30$ mm²/s) _____ ≥ 0,8 bar absolute
for cold start _____ ≥ 0,5 bar absolute

Operating pressure range - outlet

Variable pump:
Pressure at port A or B
nominal pressure p_N _____ 400 bar
peak pressure p_{max} _____ 450 bar

Auxiliary pump:
peak pressure $p_{H\,max}$ _____ 40 bar
(pressure data to DIN 24312)

Case drain pressure

Permissible case drain pressure at ports T_1 and T_2
p_t _____ 4 bar abs.
short term (at start) _____ 6 bar abs.

Installation position

Optional. The housing must be filled with fluid prior the commissioning, and must remain full whenever it is operating.

For extensive information on installation position, please consult our data sheet RE 90 270 before completing your design work.

Note for installation position "drive shaft up" (only sizes 71-250): When ordering please state in clear text "installation position: drive shaft up". The pump will be delivered with an additional air bleed port R1 located at the flange area.

Technical Data

Table of values (theoretical values, without considering η_{mh} and η_v; values rounded)

Size					28	40	56	71	90	125	180	250
Displacement	variable pump		$V_{g\,max}$	cm³	28	40	56	71	90	125	180	250
	auxiliary pump (at p = 20 bar)		$V_{g\,H}$	cm³	6,1	8,6	11,6	19,6	19,6	28,3	39,8	52,5
Speed	max. speed with $V_{g\,max}$		$n_{max\,contin.}$	rpm	4250	4000	3600	3300	3050	2850	2500	2400
	limited max. speed [1]		$n_{max\,limited}$	rpm	4500	4200	3900	3600	3300	3250	2900	2600
	intermittent max. speed [2]		$n_{max\,interm.}$	rpm	5000	5000	4500	4100	3800	3450	3000	2700
	minimum speed		n_{min}	rpm	500	500	500	500	500	500	500	500
Flow	at $n_{max\,contin.}$ and $V_{g\,max}$		$q_{v\,max}$	L/min	119	160	202	234	275	356	450	600
Power	at $n_{max\,contin.}$	Δp = 400 bar	P_{max}	kW	79	107	134	156	183	237	300	400
Torque	at $V_{g\,max}$	Δp = 400 bar	T_{max}	Nm	178	255	356	451	572	795	1144	1590
(variable pump without aux. pump)		Δp = 100 bar	T	Nm	44,5	63,5	89	112,8	143	198,8	286	398
Moment of inertia (about drive axis)			J	kgm²	0,0017	0,003	0,0051	0,0072	0,0106	0,0164	0,0323	0,0879
Weight (standard model without through drive) approx.			m	kg	29	31	38	50	60	80	101	156

[1] Limited maximum speed: – at half corner power (e.g. at $V_{g\,max}$ and p_N /2)

[2] Intermittent maximum speed: – at high idling speed
– at engine overspeed: Δp = 70...150 bar and $V_{g\,max}$
– with reversing heads: Δp < 300 bar and t ≤ 5 sec.

Calculation of size

Output flow $q_v = \frac{V_g \cdot n \cdot \eta_v}{1000}$ in L/min

Torque $T = \frac{1{,}59 \cdot V_g \cdot \Delta p}{100 \cdot \eta_{mh}} = \frac{V_g \cdot \Delta p}{20 \cdot \pi \cdot \eta_{mh}}$ in Nm

Power $P = \frac{T \cdot n}{9549} = \frac{2 \pi \cdot T \cdot n}{60000} = \frac{q_v \cdot \Delta p}{600 \cdot \eta_t}$ in kW

V_g = displacement per revolution in cm³
Δp = differential pressure in bar
n = speed in rpm
η_v = volumetric efficiency
η_{mh} = mechanical-hydraulic efficiency
η_t = overall efficiency

Input drive

Permissible axial and radial loading on drive shaft

Size				28	40	56	71	90	125	180	250
Distance of F_q (from shaft collar)	a	mm		17,5	17,5	17,5	20	20	22,5	25	29
	b	mm		30	30	30	35	35	40	45	50
	c	mm		42,5	42,5	42,5	50	50	57,5	60	71
max. permissible radial load at distance	a	$F_{q\,max}$	N	2500	3600	5000	6300	8000	11000	16000	22000
	b	$F_{q\,max}$	N	2000	2891	4046	4950	6334	8594	12375	16809
	c	$F_{q\,max}$	N	1700	2416	3398	4077	5242	7051	10150	13600
max. permissible axial load		$-F_{ax\,max}$	N	1557	2120	2910	4242	4330	5743	7053	4150
		$+F_{ax\,max}$	N	417	880	1490	2758	2670	3857	4947	4150

Filtration

The finer the filtration the better the achieved purity grade of the pressure fluid and the longer the life of the axial piston unit.

To ensure the functioning of the axial piston unit a minimum purity grade of

9 to NAS 1638

18/15 to ISO/DIS 4406 is necessary.

At very high temperatures of the hydraulic fluid (90°C to max. 115°C) at least cleanless class

8 to NAS 1638

17/14 to ISO/DIS 4406 necessary.

If above mentioned grades cannot be maintained please consult supplier.

Standard: Filtration in the suction line of the auxiliary pump, S

Standard model (preferred)

Filter type: _____ filter without bypass

Recommendation: _____ with contamination indicator

Through flow resistance at the filter element:

at ν = 30 mm²/s, n = n_{max} _____ Δp ≤ 0,1 bar

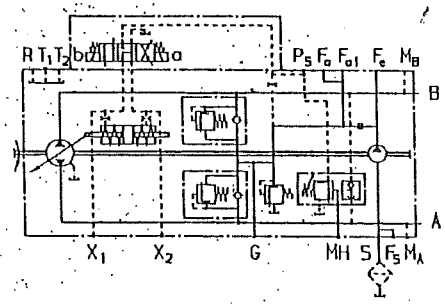
at ν = 1000 mm²/s, n = n_{max} _____ Δp ≤ 0,3 bar

Pressure at port S of the auxiliary pump:

at ν = 30 mm²/s _____ p ≥ 0,8 bar

at cold start (ν = 1600 mm²/s, n ≤ 1000 min⁻¹) _____ p ≥ 0,5 bar

Circuit diagram standard S



Variation: external supply, E

This variation is to be applied with models without integral auxiliary pump (N00 or K..).

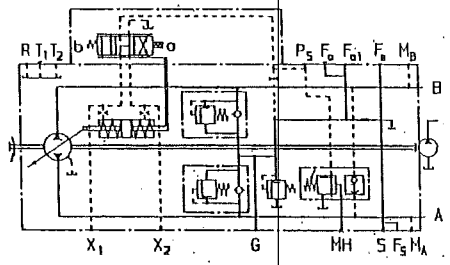
Connection S is closed.

Supply comes from connection F_e.

Filter arrangement: _____ separately

To ensure functioning the above mentioned purity grade for the boost pressure fluids at connection F_e has to be ensured.

Circuit diagram variation E (external supply)



Variation: Filtration in the pressure line of the auxiliary pump, ports for external boost circuit filter, D

Port F_e: Filter inlet

Port F_a: Filter outlet

Filter type: Filter with bypass are not recommended, when applying with bypass please consult supplier.

Recommendation: with contamination indicator

Please note:
for type with DG-displacement (with control pressure not from the supply circuit) the following filter type has to be used:

filter with bypass and with contamination indicator

Filter arrangement: __ separately in the pressure line (hose filter)

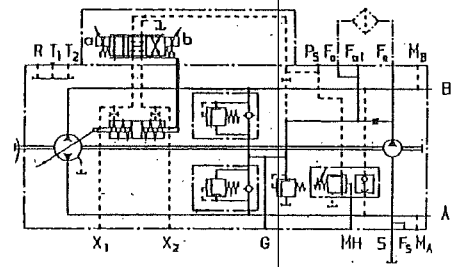
Through flow resistance at filter element:

at ν = 30 mm²/s _____ Δp ≤ 1 bar

at cold start _____ Δp_{max} = 3 bar

(valid for entire speed range $n_{min} - n_{max}$)

Circuit diagram variation D



Variation: Filtration in the pressure line of the auxiliary pump, with cold start valve and ports for external boost circuit filter, K

Design as variation D, however additionally with cold start valve:
– Filter is equipped with cold start valve and therefore protects the pump from damage. The valve opens at

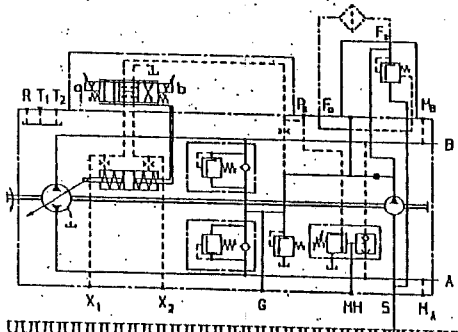
through flow resistance $\Delta p \geq 6$ bar.

Port F_e: Filter inlet (at th cold start valve)

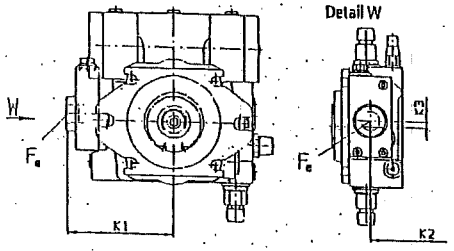
Port F_a: Filter outlet

Filter arrangement ___ separately in the pressure line (hose filter)

Circuit diagram variation K (with cold start valve)



Dimensions variation K (with cold start valve)



Size	K1	K2	K3	F_e
40	122,5	198,7	0	M18x1,5; 15 deep
56	125,5	215,4	0	M18x1,5; 15 deep
71	145,5	239,0	8	M26x1,5; 16 deep
90	139,5	248,5	24	M26x1,5; 16 deep
125	172,0	267,9	20	M33x2; 18 deep
180	173,0	311,9	3	M33x2; 18 deep

Variation: Filtration in pressure line of the auxiliary pump, filter built-on, supplied complete, F

Filter type: ___ Filter without bypass

Please note:
– Filter is equipped with cold start valve and therefore protects the pump from damage.
The valve opens at

through flow resistance $\Delta p \geq 6$ bar.

Recommendation: with contamination indicator (differential pressure $\Delta p = 5$ bar)

Filter arrangement connected to pump through flow resistance at filter element:

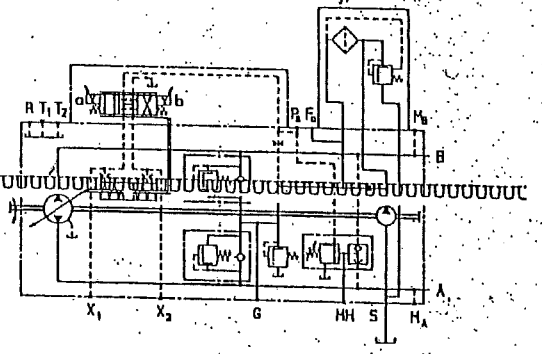
at $\nu = 30$ mm²/s ___ $\Delta p \leq 1$ bar

at cold start ___ $\Delta p_{max} = 3$ bar

(valid for entire speed range $n_{min} - n_{max}$)

To be considered for sizes 40, 56: max perm. boost pressure $p_{sp\,max} = 35$ bar

Circuit diagram variation F (with filter assembly)



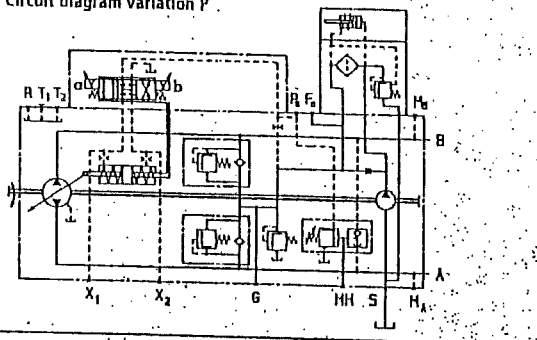
Variation: Filtration in pressure line of the auxiliary pump, filter built-on, supplied complete, with visual contamination indicator, P

Design as variation F, however additionally with visual contamination indicator.

Indication: green/red window

differential pressure (switching pressure) $\Delta p = 5$ bar

Circuit diagram variation P



Variation: Filtration in pressure line of the auxiliary pump, filter built-on, supplied complete, with electrical contamination indicator, L

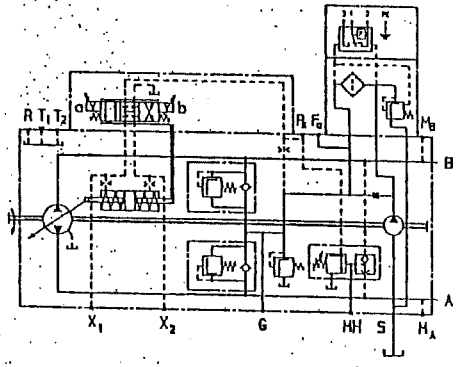
Design as variation F, however additionally with electrical contamination indicator.

Indication: electrical

differential pressure (switching pressure) $\Delta p = 5$ bar

Max. switching power at 24 V DC ___ 60 W

Circuit diagram variation L



Variation: Filtration in pressure line of the auxiliary pump, filter built-on, supplied complete, with visual and electr. contamination indicator, M

Design as variation F, however additionally with visual and electrical contamination indicator.

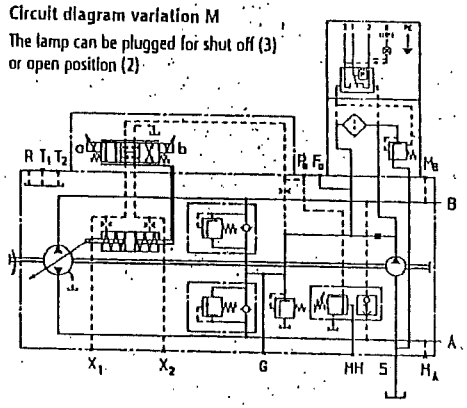
Indication: electrical and visual by lamp

differential pressure (switching pressure) $\Delta p = 5$ bar

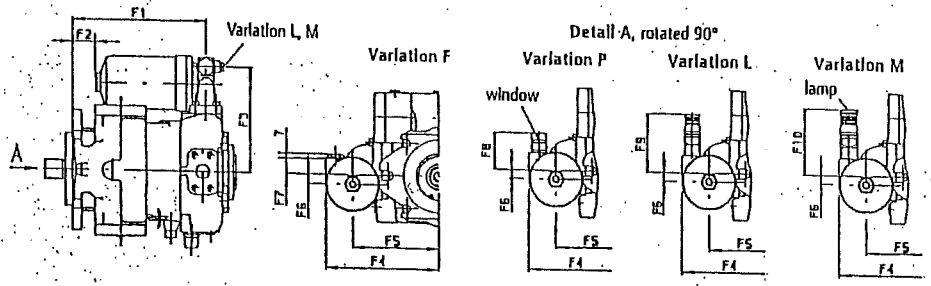
Max. switching power at 24 V DC ___ 60 W

Circuit diagram variation M

The lamp can be plugged for shut off (3) or open position (2)



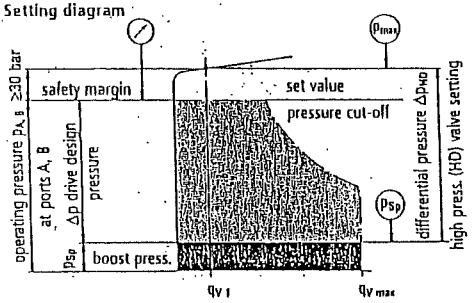
Dimensions variation F, P, L, M (with filter assembly)



Size	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
40	201,7	47,7	160	175	135	0	42	78,5	122	125
56	218,4	64,4	163	178	138	0	42	78,5	122	125
71	239	46,5	185	203,5	155	16	29	65,5	109	112
90	248,5	56	179	197,5	149	0	45	81,5	125	128
125	235,9	59,4	201	219,5	171	0	53	89,5	133	136
180	279,9	40,3	202	220,4	171,9	17	36	72,5	116	119

High Pressure Relief Valve

Setting diagram



Note: valve setting is done at
$n = 1000\ min^{-1}$ and $V_{g\,max}$ ($q_{V\,1}$)

Example: boost pressure 20 bar; operating pressure 410 bar

operating pres. $p_{A,B}$ − boost pres. p_{sp} + safety margin = differential pres. Δp_{HD}
410 bar − 20 bar + 30 bar = 420 bar

Setting range

High pressure relief valve, pilot controlled (sizes 71...250)	Differential pressure setting Δp_{HD}
Setting range valve 1 Δp 100 - 420 bar (see ordering code)	420 bar **400 bar** [1] 360 bar 340 bar 320 bar 300 bar 270 bar 250 bar 230 bar 200 bar 150 bar 100 bar

High pressure relief valve, direct controlled (sizes 28...56)	Differential pressure setting Δp_{HD}
Setting range valve 3, 5 Δp 250 - 420 bar (see ordering code)	420 bar **400 bar** [1] 360 bar 340 bar 320 bar 300 bar 270 bar
Setting range valve 4, 6 Δp 100 - 250 bar (see ordering code)	250 bar **230 bar** [1] 200 bar 150 bar 100 bar

[1]) Standard setting of differential pressure, valves set to this value if no details given on order.

Bypass function

Sizes 28...56: HD valves direct controlled (3), (4): without bypass
Sizes 28...56: HD valves direct controlled (5), (6): with bypass
Sizes 71...250: HD valves pilot controlled (1): with bypass

Simplification: The bypass function is not shown in the circuit diagrams.
The pilot controlled HD-valves (sizes 71..250) are not shown in the circuit diagrams.

Please state in clear text when ordering:
(possible are only the values Δp_{HD} shown in the table)

High pressure relief valve A
Differential pressure setting: Δp_{HD} = ... bar
Opening pressure of the HD-valve (at $q_{V\,1}$): p_{max} = ... bar.
($p_{max} = \Delta p_{HD} + p_{sp}$)

High pressure relief valve B
Differential pressure setting: Δp_{HD} = ... bar
Opening pressure of the HD-valve (at $q_{V\,1}$): p_{max} = ... bar
($p_{max} = \Delta p_{HD} + p_{sp}$)

Pressure Cut-Off, D

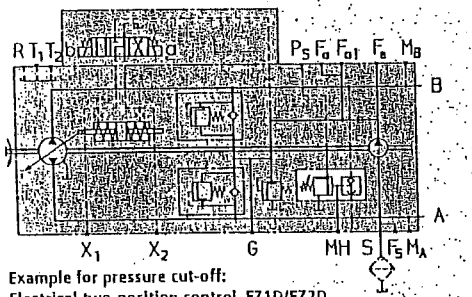
The pressure cut-off corresponds to a pressure regulation which, after reaching the set pressure, adjusts the pump volume of the pump to $V_{g\,0} = 0$.

This valve prevents the operation of the high pressure relief valves when accelerating or decelerating.

The pressure peaks occurring when the swashplate is swivelled rapidly and also the maximum pressure in the system are safeguarded by the high pressure limit valves.

The setting range of the pressure cut-off may be anywhere within the entire working pressure range. However, it must be set 30 bar lower than the setting of the high pressure safety relief valves (see setting diagram).

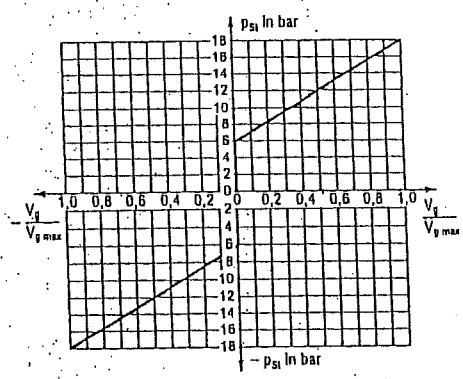
Please state the setting value of the pressure cut-off in clear text when ordering.



Example for pressure cut-off:
Electrical two-position control, EZ1D/EZ2D

HD - Hydraulic Control, Pilot Pressure Related

The positioning cylinder of the pump and therefore the swivel angle is varied in proportion to the difference in pilot pressure applied to the two control ports (Y_1 and Y_2). The pump displacement is therefore steplessly variable. One pilot line is assigned to each direction of flow.



V_g displacement at p_{St}
$V_{g\,max}$ displacement at p_{St} = 18 bar

Pilot pressure p_{St} = 6 - 18 bar (at ports Y_1, Y_2)
Start of control 6 bar
End of control 18 bar (max. displacement $V_{g\,max}$)

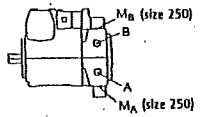
If the pump is also fitted with a DA control valve, e.g. for automotive control of the vehicle transmission is also possible. DA control valve see page 13.

For pressure cut-off, see page 9.

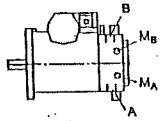
Graph
Direction of rotation - Control - Direction of through flow

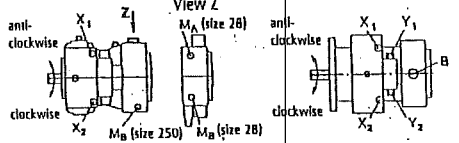
Direction of rotation	Size	Pilot pressure	Control pressure	Direction flow	Operating pressure
clockwise	28...56	Y_1	X_1	A to B	M_B
		Y_2	X_2	B to A	M_A
	71...250	Y_1	X_1	B to A	M_A
		Y_2	X_2	A to B	M_B
anti-clockwise	28...56	Y_1	X_1	B to A	M_A
		Y_2	X_2	A to B	M_B
	71...250	Y_1	X_1	A to B	M_B
		Y_2	X_2	B to A	M_A

Sizes 28, 250

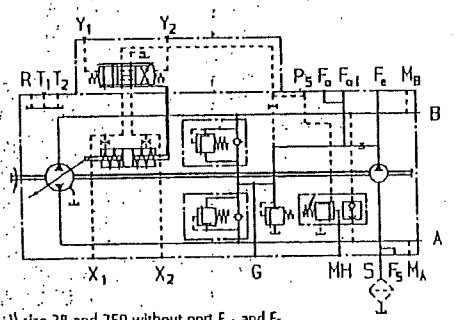


Sizes 40...180

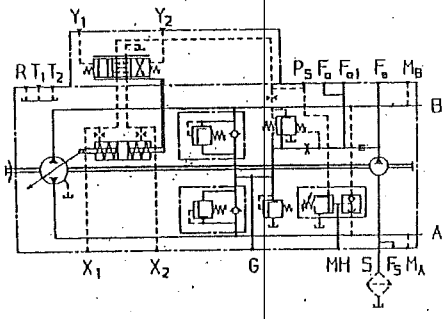




Standard model [1])



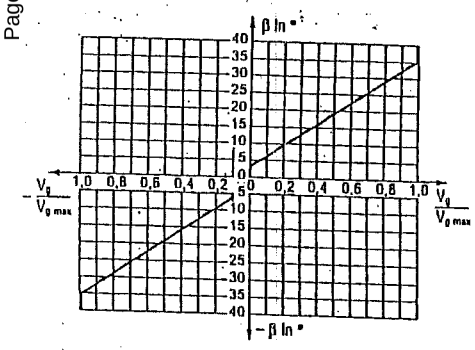
Model with DA control valve [1])



[1]) size 28 and 250 without port F_{a1} and F_5

HW Hy ... Control, Mechanical Servo

The positioning cylinder of the pump and therefore the swivel angle is varied in proportion to the movement of the control lever. The pump control is steplessly variable. Each direction of flow is assigned to one direction of lever movement.



Swivel angle of control lever:

from 0 bis $\pm V_{g\,max}$ ≙ $\beta = 0°$ to $\pm 35°$

mech. stop: sizes 28...71 ____ ± 40°

sizes 90...250 ____ ± 35°

Torque necessary at control lever is between 85 and 210 Ncm. The limitation of the operating range of the HW control lever must be fixed in the external control mechanism (required value setting).

If the pump is also fitted with a DA control valve, automotive control of the vehicle transmission is also possible. DA control valve see page 13.

For pressure cut-off, see page 9.

Variation: zero position switch, L

At zero positipn of the control lever of the HW control device the switch contact of the zero position switch is closed. In case of start-on of the control lever from the center position the contact is interrupted.

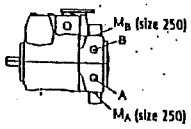
The zero position switch assures a safety function for drives which necessitate the zero position under certain operation conditions (for example start of the diesel engine).

Graph

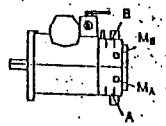
Direction of rotation - Control - Direction of through flow

Direction of rotation	Size	Lever direction	Control pressure	Direction flow	Operating pressure
clockwise	28...56	a	X_2	B to A	M_A
		b	X_1	A to B	M_B
	71...250	a	X_2	A to B	M_B
		b	X_1	B to A	M_A
anti-clockwise	28...56	a	X_2	A to B	M_B
		b	X_1	B to A	M_A
	71...250	a	X_2	B to A	M_A
		b	X_1	A to B	M_B

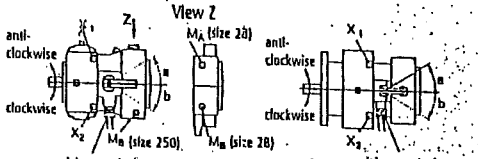
Sizes 28, 250



Sizes 40...180



View Z



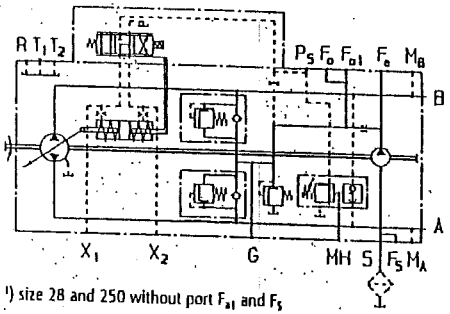
zero position switch

zero position switch

Technical data for zero position switch

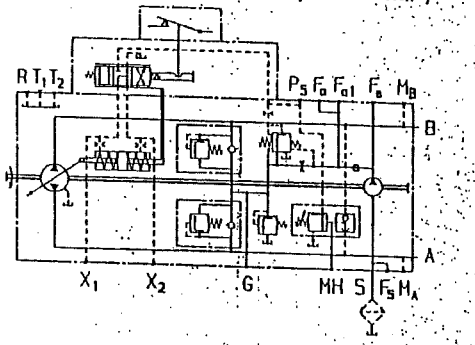
load performance	20 A (continuous)
switch performance	15A / 32V (DC)
	4A / 32V (AC - Inductive)

Standard model [1]



[1]) size 28 and 250 without port F_{o1} and F_S

Model with DA control valve and zero position switch [1]



DA Hydraulic Cont... Speed Related

In relation to the drive speed, control pressure is applied to the positioning cylinder of the pump by means of the DA control valve via a 4/3 way directional valve. Pump displacement is steplessly variable in each direction of flow. Each direction of flow is assigned to one of the two solenoids on the directional valve.

Increasing drive speed generates a higher control pressure through the DA valve.

Increasing control pressure increases the pump displacement.

Dependent upon the pump operating curve, pressure in the high pressure lines causes the pump to swivel back towards a smaller displacement.

Increasing operating pressure gives reduced displacement.

A constant torque input to the pump is achieved by this combination of de-stroking of the pump as the operating pressure increases and in response to the "pull-down" of the prime mover (leading to a reduced control pressure).

The least possible pull down leads to optimum usage of the drive power. This is achieved by "partial inching". In this form of the control, the DA valve is mechanically coupled to the accelerator pedal. This means that on reaching a certain speed (movement of the accelerator pedal), the control curve is offset parallel to the engine speed curve.

Any additional power requirements, e.g. the service hydraulics, may lead to engine pull down occuring. This leads to a reduction in control pressure and therefore pump displacement. The power thus released is then available to supply that demanded. Automatic power division and full utilisation of power available is thus achieved for both the vehicle transmission and the service hydraulics.

In an automative transmission, the DA control valve is used in conjunction with the directly controlled hydraulic "DA control".

However, pumps with EP, HW or HD control devices can also be equipped with a DA control valve. In this way, the automatic transmission function (speed related high pressure/flow increase with load limiting control) may be overridden.

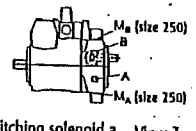
The maximum flow will then be determined by the setting of the relevant control module fitted.

Graph

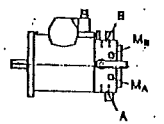
Direction of rotation - Control - Direction of through flow

Direction of rotation	Size	Solenoid	Control pressure	Direction flow	Operating pressure
clockwise	28...56	a	X_2	B to A	M_A
		b	X_1	A to B	M_B
	71...250	a	X_2	A to B	M_B
		b	X_1	B to A	M_A
anti-clockwise	28...56	a	X_2	A to B	M_B
		b	X_1	B to A	M_A
	71...250	a	X_2	B to A	M_A
		b	X_1	A to B	M_B

Sizes 28, 250

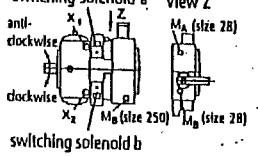


Sizes 40...180



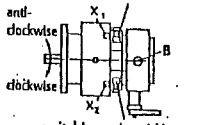
switching solenoid a

View Z



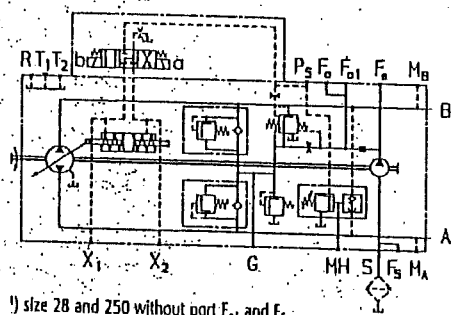
switching solenoid b

switching solenoid a



switching solenoid b

Hydraulic control, speed related,
DA-control valve, fixed setting, DA1D2/DA2D2 [1]



[1]) size 28 and 250 without port F_{o1} and F_S

Function and Control of DA Valves

(Unit dimensions see page 32...34)

DA control valve, fixed setting, (2)

Control pressure is generated in relation to drive speed. When ordering, please state in clear text: Start of control (set at factory).

DA control valve, mechanically adjustable with control lever (3)

Control pressure is generated in relation to drive speed. When ordering, please state in clear text: Start of control (set at factory).

Control pressure may be reduced (independently of drive speed) as required by operation of the control lever (inch function).

Max. adm. operating torque at the control lever ____ T_{max} = 4 Nm

Max. angle of lever operation 70°. The position of the lever is optional.

Variation 3L _ operation direction of the control lever anti-clockwise

Variation 3R ____ operation direction of the control lever clockwise

Hydraulic inch valve, (4, 5, 8, 9)

(only for pumps with DA control device)

- for inch function; for use in conjunction with DA control valve, fixed setting (4, 8) or mechanically adjustable (5, 9)
  Model with throttle valve sizes 28, 40, 56, 71
  Model with pressure reducing valve sizes 90, 125, 180, 250

Permits the control pressure to be reduced independently of the drive speed via hydraulic control (port Z).

Variation 4, 5:
The control at port Z by means of braking fluid from the vehicle braking system (hydraulically linked with the operation brake).

Variation 8, 9:
The control at port Z by means of mineral oil.

Master controller as inch valve, (7)

- for inch function; for use in conjuction with DA control valve, fixed setting

Any reduction of control pressure, independent from the input speed through the mechanical operation of the master controller.

The master controller is installed separately from the pump (for instance in the driver's cabin) connected with the pump by 2 hydraulic control lines at ports P_S and Y.

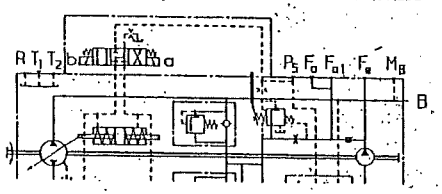
A suitable master controller is to be ordered separately and is not included in delivery volume.

Extensive information is available from our mobile sales department. Please make use of an opportunity to confirm your transmission design through our computer programme in BRUENINGHAUS HYDROMATIK. A DA control can only be approved by BRUENINGHAUS HYDROMATIK.

Note: rotary inch valve see page 41.

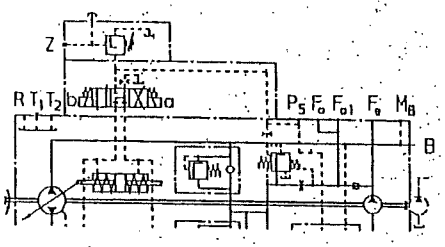
Circuit diagrams [1]:

Hydraulic control, speed related,
DA control valve, mech. adjustable with control lever DA1D3/DA2D3

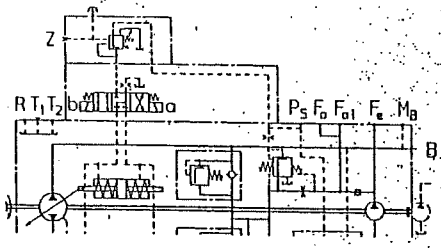


Hydraulic control, speed related,
DA control valve, fixed setting,
with hydraulic inch valve, DA1D4/DA2D4

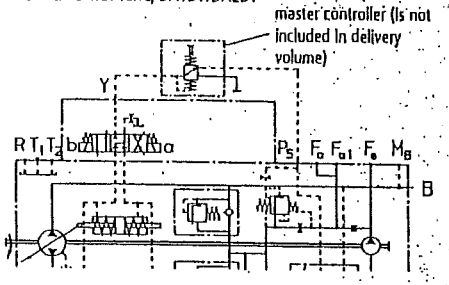
with throttle valve,
sizes 28...71



with pressure reducing valve,
sizes 90...250



Hydraulic control, speed related, DA,
DA control valve, fixed setting, with separately installed master controller as inch valve, DA1D7/DA2D7



[1]) size 28 and 250 without port F_{a1} and F_S

DG Hydraulic Control, Direct Operated

By switching the pilot pressure at the connections X_1 or X_2 the positioning cylinder of the pump is directly supplied with internal control pressure. Thus the swashplate and so the displacement is adjustable between $V_{g\,0}$ = 0 and $V_{g\,max}$. Each direction of flow is assigned to a connection.

solenoid de-energized = pilot pressure 0 bar = setting $V_{g\,0}$ = 0

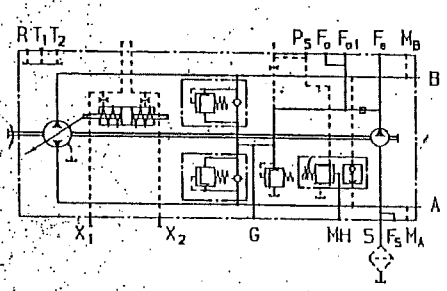
The necessary pilot pressure for the setting $V_{g\,max}$ depends upon the operation pressure and rotational speed.

Please contact us for further information.

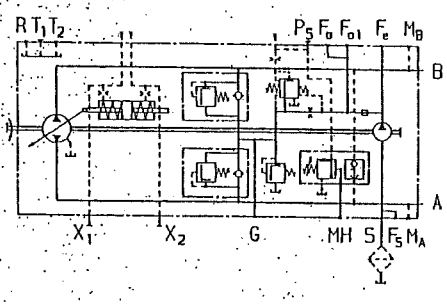
For pressure cut-off, see page 9.

Assignment direction of rotation – control – direction of flow HD control see page 10 (control pressure X_1; X_2).

Standard model [1]



Model with DA control valve [1]



[1]) size 28 and 250 without port F_{a1} and F_S

EZ Electrical Two-Position Control with Switching Solenoid

By energizing either solenoid a or b, the positioning cylinder of the pump is directly supplied with internal control pressure, and the pump swivels to maximum displacement. In this way, the swashplate and thus the displacement is switchable from $V_{g\,0}$ = 0 to $V_{g\,max}$. Each direction of flow is assigned to a solenoid.

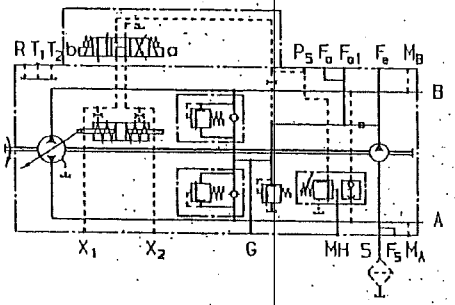
solenoid de-energized = setting $V_{g\,0}$ = 0
solenoid energized = setting $V_{g\,max}$

EZ1 _____ solenoid 12 V
EZ2 _____ solenoid 24 V

For pressure cut-off, see page 9.

Assignment direction of rotation – control – direction of flow DA control see page 12.

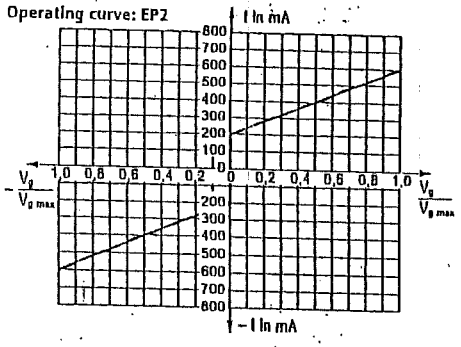
Standard model [1]



EP El… …l Control, with Proportional Solenoids

In relation to the preselected current, control pressure is applied to the positioning cylinder of the pump via two proportional solenoids on control device EP. The displacement of the pump is thus steplessly variable. One solenoid is assigned to each direction of flow.

Operating curve: EP2



model	control voltage (DC)	control current I start of control – end of control at $V_{g\,0}$	at $V_{g\,max}$
EP1	12 V	400 mA –	1200 mA
EP2	24 V	200 mA –	600 mA

To control the proportional solenoids the following electronic amplifiers and microcontroller are available:

proportional amplifiers PVR and PVRS (see RE 95022), chopper amplifier CV (see RE 95029), open loop control electronics RVR (see RE 95031), open loop control electronics CSD (see RE 95075), closed loop control electronics RVE (see RE 95033), universal closed loop control electronics RVU (see RE 95048) and microcontroller MC with software solutions related to the field of application (see RE 95050).

If the pump is also fitted with a DA control valve, automotive control of the vehicle transmission is also possible.

DA control valve, see page 13.

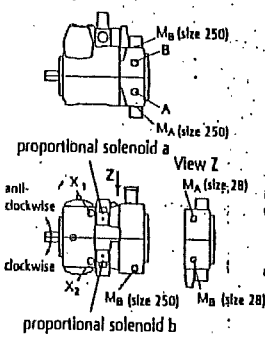
For pressure cut-off, see page 9.

Standard: proportional solenoid with manual emergency (without spring return)

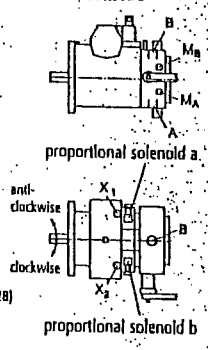
Graph
Direction of rotation - Control - Direction of through flow

Direction of rotation	Size	Solenoid	Control pressure	Direction flow	Operating pressure
clockwise	28...56	a	X_1	A to B	M_B
		b	X_2	B to A	M_A
	71...250	a	X_1	B to A	M_A
		b	X_2	A to B	M_B
anti-clockwise	28...56	a	X_1	B to A	M_A
		b	X_2	A to B	M_B
	71...250	a	X_1	A to B	M_B
		b	X_2	B to A	M_A

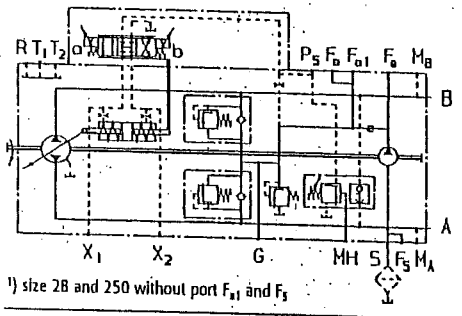
Sizes 28, 250



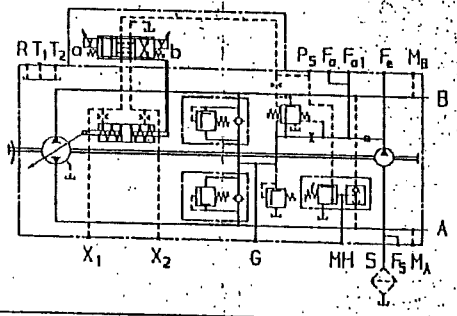
Sizes 40...180



Standard model [1]



Model with DA control valve [1]

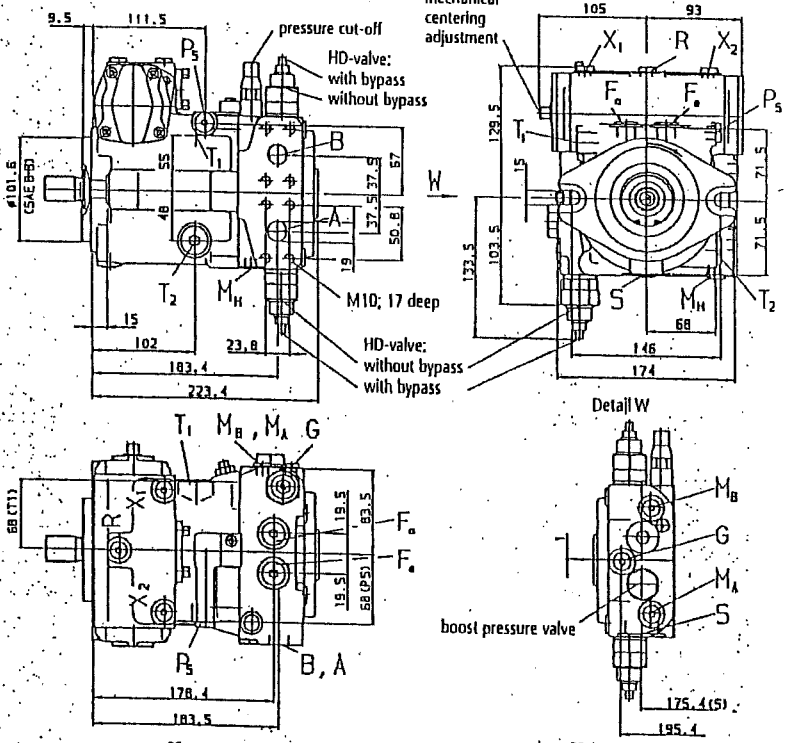


[1]) size 28 and 250 without port F_{a1} and F_S

Unit Dimensions, Si… …8

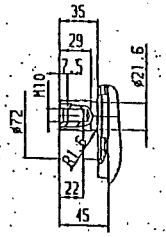
Before finalising your design, please request a certified drawing.

Pump configuration without control module, NV

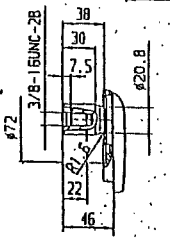


Shaft ends

Z
Splined shaft
W 25x1,25x30x18x9g
DIN 5480



S
Splined shaft SAE 1",
pressure angle 30°,
15 teeth, 16/32 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



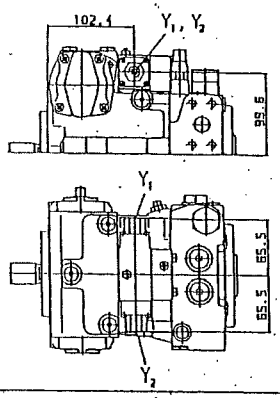
Connections

A, B	Service line ports SAE ¾", high pressure series 420 bar (6000 psi)	
T_1	Case drain or filling port	M22x1,5; 14 deep
T_2	Case drain	M22x1,5; 14 deep
M_A, M_B	Pressure gauge - operating pressure A, B	M12x1,5; 12 deep
R	Air bleed	M12x1,5; 12 deep
S	Boost suction port	M33x2; 18 deep
X_1, X_2	Control pressure ports (before the orifice)	M12x1,5; 12 deep
G	Pressure port for auxiliary circuit	M12x1,5; 12 deep
P_S	Control pressure supply	M14x1,5; 12 deep
F_a	Filter outlet	M18x1,5; 12 deep
F_e	Filter inlet	M18x1,5; 12 deep
M_H	Port for balanced high pressure	M12x1,5; 12 deep
Y_1, Y_2	Remote control ports (only for HD control)	M14x1,5; 12 deep

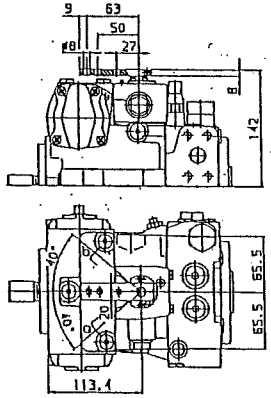
Unit Dimensions, Size 28

Before finalising your design, please request a certified drawing.

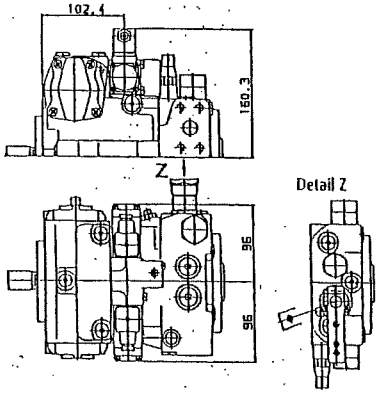
Hydraulic control, pilot pressure related, HD



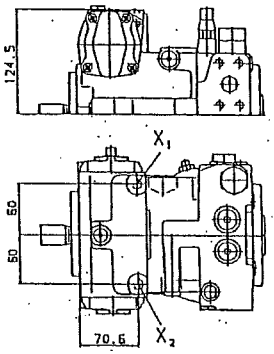
Hydraulic control, mechanical servo, HW



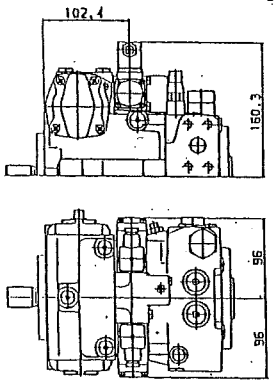
Hydraulic control, speed related, DA
(dimensions of the DA control valve see pages 32, 33)



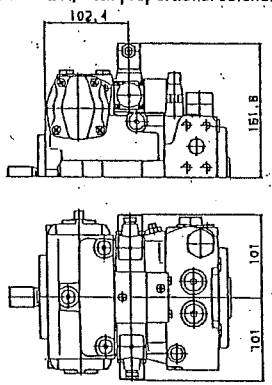
Hydraulic control, direct operated, DG



Electrical two-position control, with switching solenoid, EZ



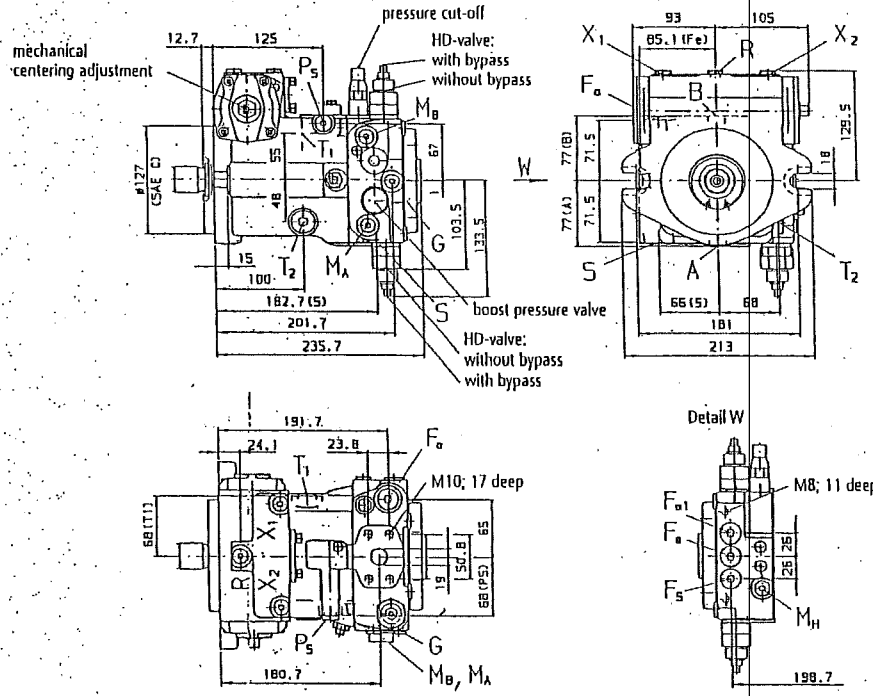
Electrical control, with proportional solenoid, EP



Unit Dimensions, Size 40

Before finalising your design, please request a certified drawing.

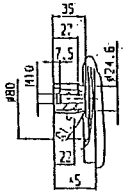
Pump configuration without control module, NV



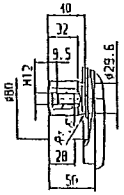
Detail W

Shaft ends

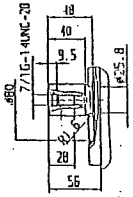
Z
Splined shaft
W 30x2x30x14x9g
DIN 5480



A
Splined shaft
W 35x2x30x16x9g
DIN 5480



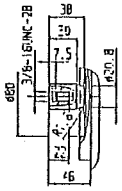
S
Splined shaft SAE 1¼"
pressure angle 30°,
14 teeth, 12/24 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



Connections

A, B	Service line ports SAE ¾", high pressure series 420 bar (6000 psi)	
T_1	Case drain or filling port	M22x1,5; 14 deep
T_2	Case drain	M22x1,5; 14 deep
M_A, M_B	Pressure gauge - operating pressure A, B	M12x1,5; 12 deep
R	Air bleed	M12x1,5; 12 deep
S	Boost suction port	M33x2; 18 deep
X_1, X_2	Control pressure ports (before the orifice)	M12x1,5; 12 deep
G	Pressure port for auxiliary circuit	M12x1,5; 12 deep
P_S	Control pressure supply	M14x1,5; 12 deep
F_a	Filter outlet	M18x1,5; 12 deep
F_{a1}	Filter outlet (filter assembly)	M18x1,5; 12 deep
F_s	Filter inlet	M18x1,5; 12 deep
F_S	Port from filter to suction line (cold start)	M18x1,5; 12 deep
M_H	Port for balanced high pressure	M12x1,5; 12 deep
Y_1, Y_2	Remote control ports (only for HD control)	M14x1,5; 12 deep

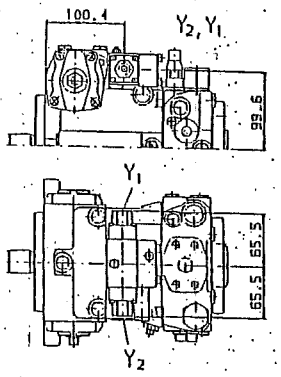
U
Splined shaft SAE 1"
pressure angle 30°,
15 teeth, 16/32 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



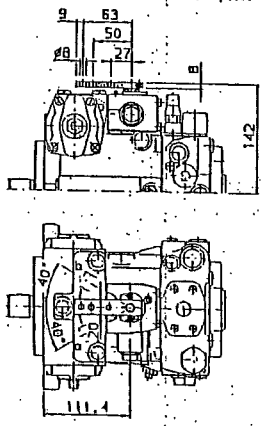
Page 747

Before finalising your design, please request a certified drawing.

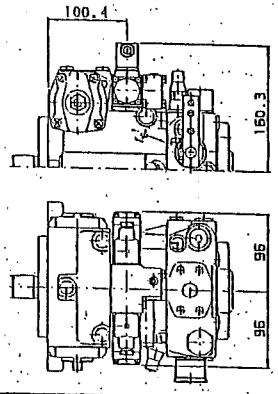
Hydraulic control, pilot pressure related, HD



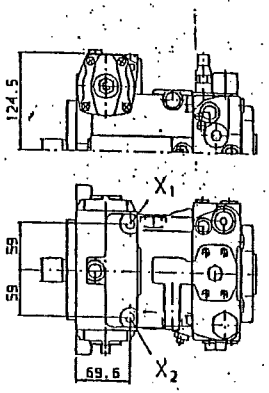
Hydraulic control, mechanical servo, HW



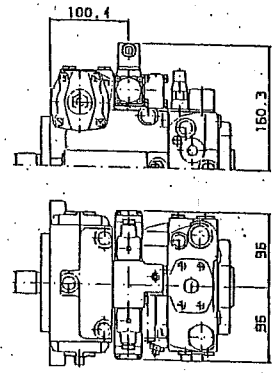
Hydraulic control, speed related, DA
(dimensions of the DA control valve see pages 32, 33)



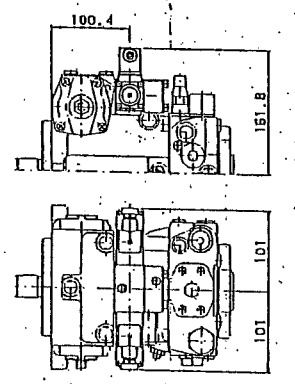
Hydraulic control, direct operated, DG



Electrical two-position control, with switching solenoid, EZ

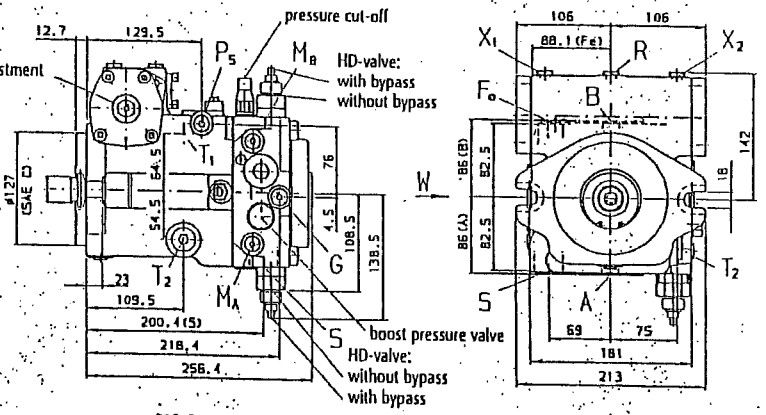


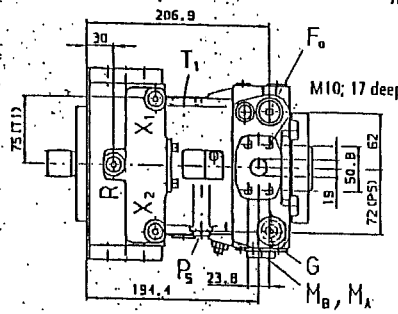
Electrical control, with proportional solenoid, EP



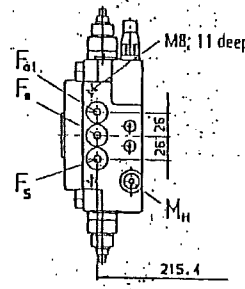
Before finalising your design, please request a certified drawing.

Pump configuration without control module, NV



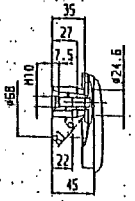


Detail W

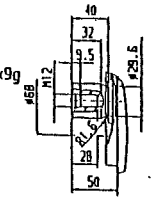


Shaft ends

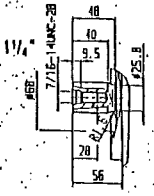
Z
Splined shaft
W 30x2x30x14x9g
DIN 5480



A
Splined shaft
W 35x2x30x16x9g
DIN 5480



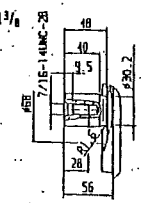
S
Splined shaft SAE 1¼"
pressure angle 30°,
14 teeth, 12/24 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



Connections

A, B	Service line ports SAE ¾", high pressure series 420 bar (6000 psi)	
T_1	Case drain or filling port	M22x1,5; 14 deep
T_2	Case drain	M22x1,5; 14 deep
M_A, M_B	Pressure gauge - operating pressure A, B	M12x1,5; 12 deep
R	Air bleed	M12x1,5; 12 deep
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X_1, X_2	Control pressure ports (before the orifice)	M12x1,5; 12 deep
G	Pressure port for auxiliary circuit	M14x1,5; 12 deep
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F_s	Port from filter to suction line (cold start)	M18x1,5; 12 deep
M_H	Port for balanced high pressure	M12x1,5; 12 deep
Y_1, Y_2	Remote control ports (only for HD control)	M14x1,5; 12 deep

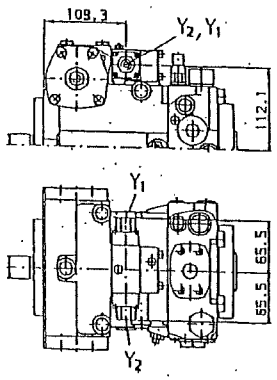
T
Splined shaft SAE 1⅜
pressure angle 30°,
21 teeth, 16/32 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



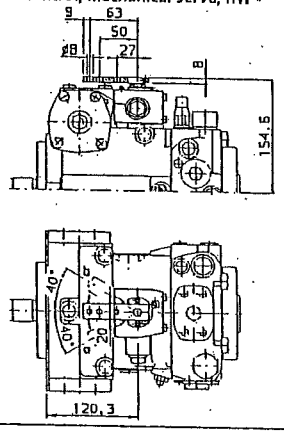
Unit Dimensions, Size 56

Before finalising your design, please request a certified drawing.

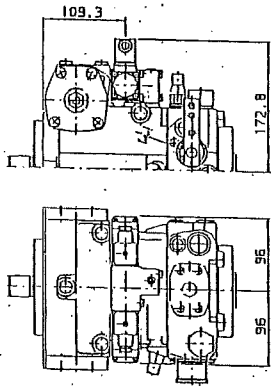
Hydraulic control, pilot pressure related, HD



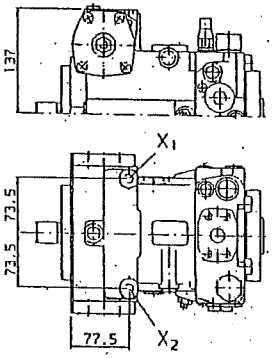
Hydraulic control, mechanical servo, HW



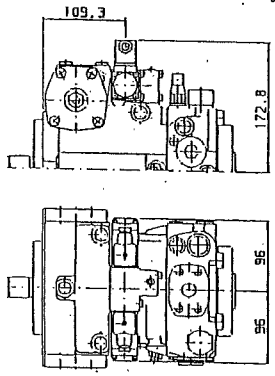
Hydraulic control, speed related, DA
(dimensions of the DA control valve see pages 32, 33)



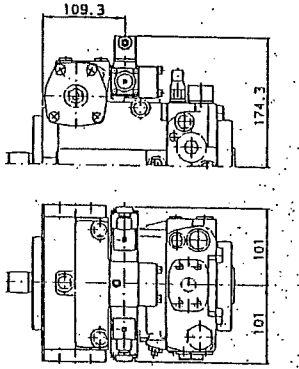
Hydraulic control, direct operated, DG



Electrical two-position control, with switching solenoid, EZ



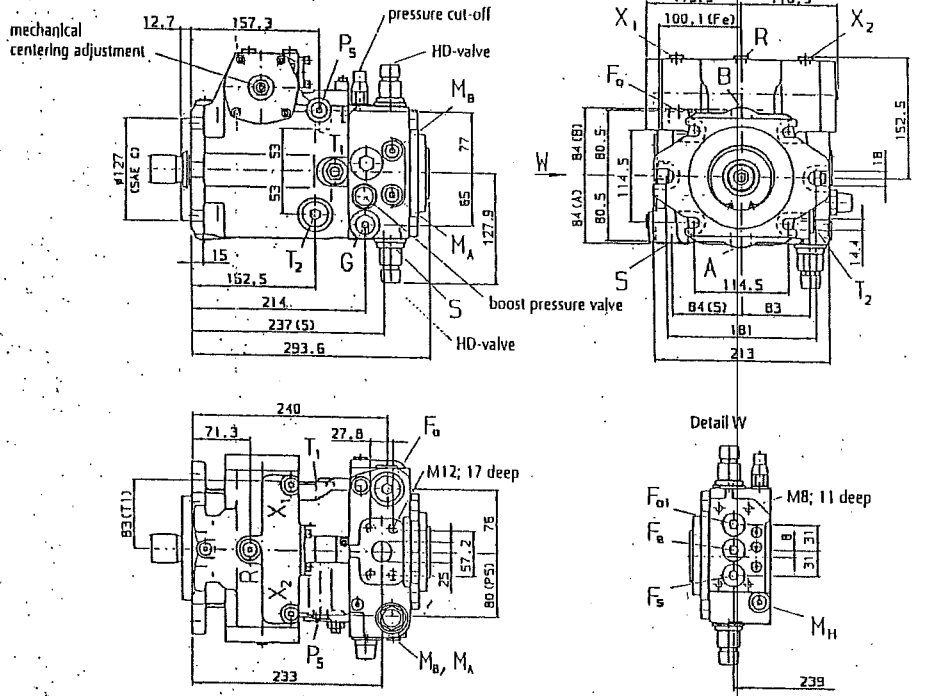
Electrical control, with proportional solenoid, EP



Unit Dimensions, Size 71

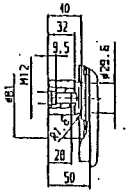
Before finalising your design, please request a certified drawing.

Pump configuration without control module, NV

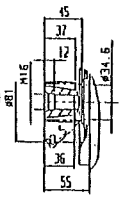


Shaft ends

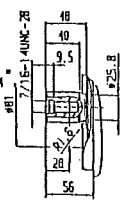
Z
Splined shaft
W 35x2x30x16x9g
DIN 5480



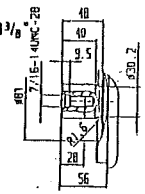
A
Splined shaft
W 40x2x30x18x9g
DIN 5480



S
Splined shaft SAE 1¼"
pressure angle 30°,
14 teeth, 12/24 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



T
Splined shaft SAE 1⅜"
pressure angle 30°,
21 teeth, 16/32 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



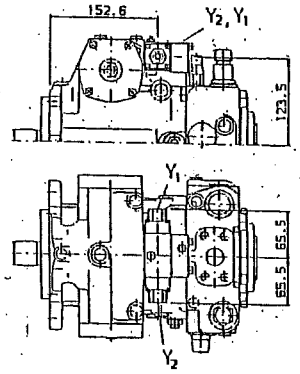
Connections

A, B	Service line ports SAE 1", high pressure series 420 bar (6000 psi)	
T_1	Case drain or filling port	M26x1,5; 16 deep
T_2	Case drain	M26x1,5; 16 deep
M_A, M_B	Pressure gauge - operating pressure A, B	M12x1,5; 12 deep
R	Air bleed	M12x1,5; 12 deep
S	Boost suction port	M42x2; 20 deep
X_1, X_2	Control pressure ports (before the orifice)	M12x1,5; 12 deep
G	Pressure port for auxiliary circuit	M18x1,5; 12 deep
P_S	Control pressure supply	M14x1,5; 12 deep
F_a	Filter outlet	M26x1,5; 16 deep
F_{a1}	Filter outlet (filter assembly)	M22x1,5; 14 deep
F_e	Filter inlet	M22x1,5; 14 deep
F_S	Port from filter to suction line (cold start)	M22x1,5; 14 deep
M_H	Port for balanced high pressure	M12x1,5; 12 deep
Y_1, Y_2	Remote control ports (only for HD control)	M14x1,5; 12 deep

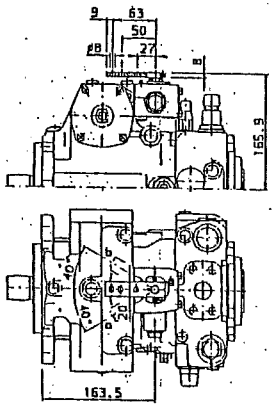
Before finalising your design, please request a certified drawing.

Page 749

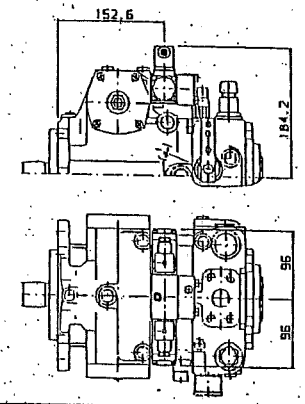
Hydraulic control, pilot pressure related, HD



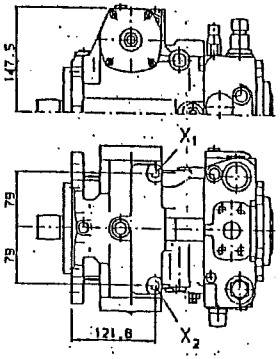
Hydraulic control, mechanical servo, HW



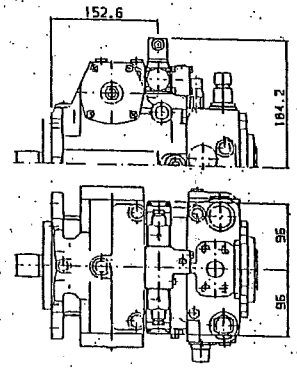
Hydraulic control, speed related, DA
(dimensions of the DA control valve see pages 32, 33)



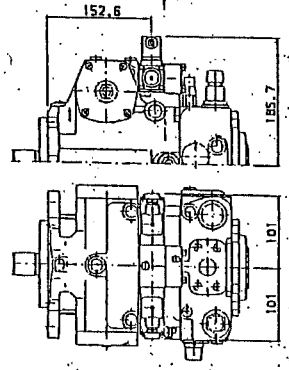
Hydraulic control, direct operated, DG



Electrical two-position control, with switching solenoid, EZ

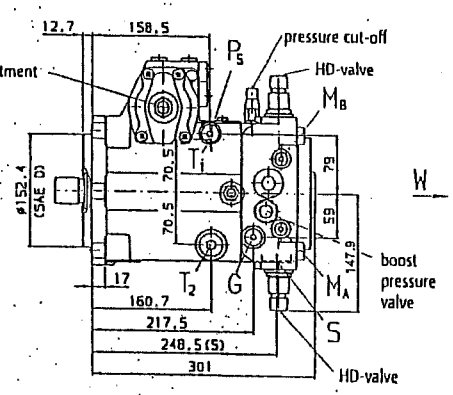


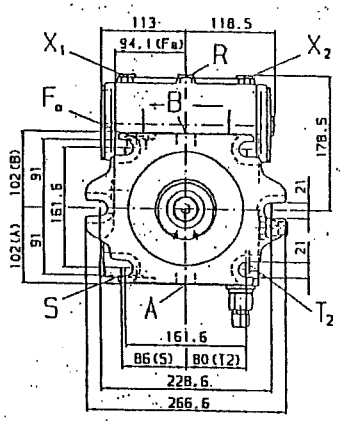
Electrical control, with proportional solenoid, EP

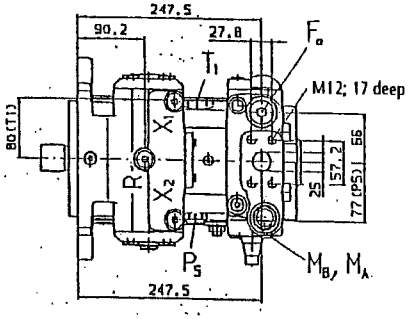


Before finalising your design, please request a certified drawing.

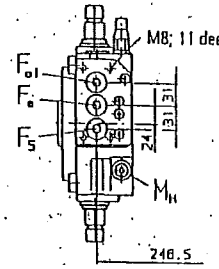
Pump configuration without control module, NV





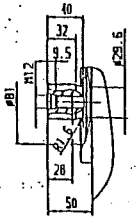


Detail W

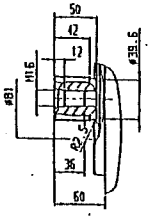


Shaft ends

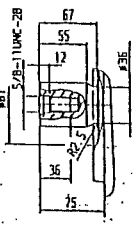
Z
Splined shaft
W 35x2x30x16x9g
DIN 5480



A
Splined shaft
W 45x2x30x21x9g
DIN 5480



S
Splined shaft SAE 1¾"
pressure angle 30°,
13 teeth, 8/16 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



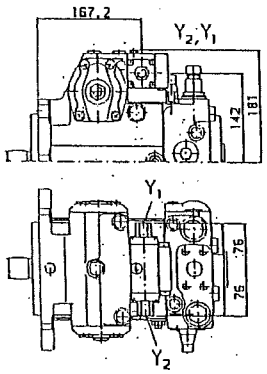
Connections

A, B	Service line ports SAE 1", high pressure series 420 bar (6000 psi)	
T_1	Case drain or filling port	M26x1,5; 16 deep
T_2	Case drain	M26x1,5; 16 deep
M_A, M_B	Pressure gauge - operating pressure A, B	M12x1,5; 12 deep
R	Air bleed	M16x1,5; 12 deep
S	Boost suction port	M42x2; 20 deep
X_1, X_2	Control pressure ports (before the orifice)	M16x1,5; 12 deep
G	Pressure port for auxiliary circuit	M18x1,5; 12 deep
P_S	Control pressure supply	M18x1,5; 12 deep
F_a	Filter outlet	M26x1,5; 16 deep
F_{a1}	Filter outlet (filter assembly)	M22x1,5; 14 deep
F_e	Filter inlet	M22x1,5; 14 deep
F_S	Port from filter to suction line (cold start)	M22x1,5; 14 deep
M_H	Port for balanced high pressure	M12x1,5; 12 deep
Y_1, Y_2	Remote control ports (only for HD control)	M14x1,5; 12 deep

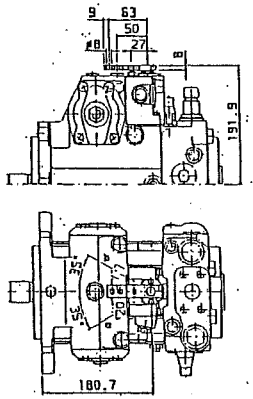
Unit Dimensions, Size 90

Before finalising your design, please request a certified drawing.

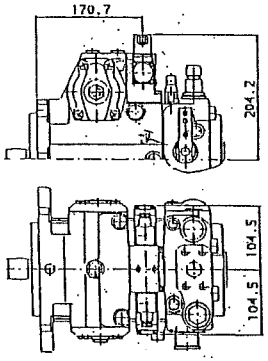
Hydraulic control, pilot pressure related, HD



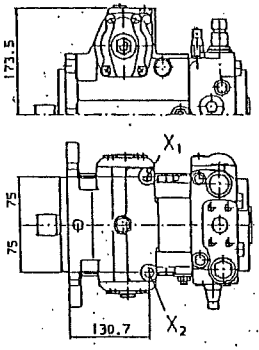
Hydraulic control, mechanical servo, HW



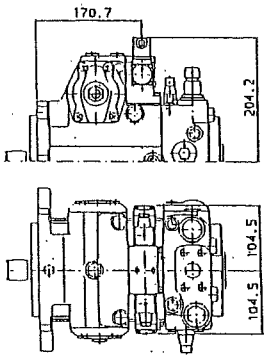
Hydraulic control, speed related, DA
(dimensions of the DA control valve see pages 32, 33)



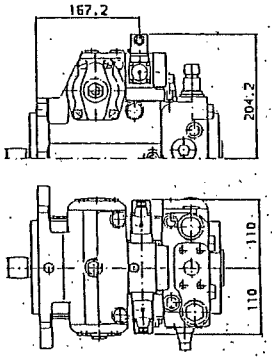
Hydraulic control, direct operated, DG



Electrical two-position control, with switching solenoid, EZ



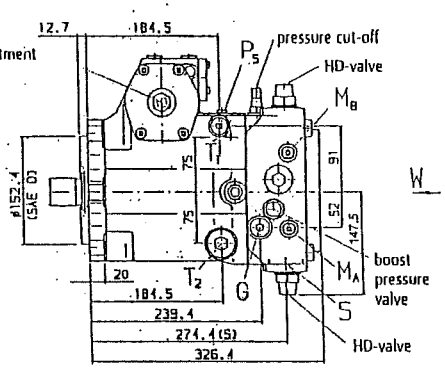
Electrical control, with proportional solenoid, EP

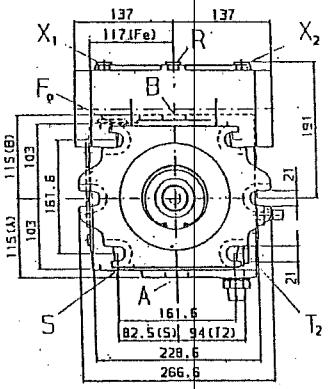


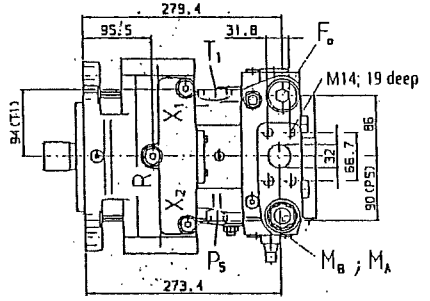
Unit Dimensions, Size 125

Before finalising your design, please request a certified drawing.

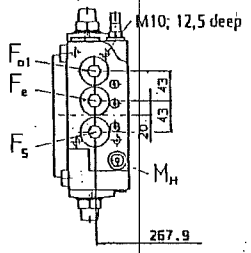
Pump configuration without control module, NV





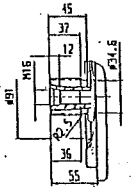


Detail W

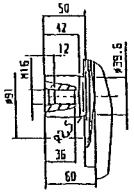


Shaft ends

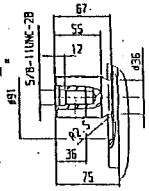
Z
Splined shaft
W 40x2x30x18x9g
DIN 5480



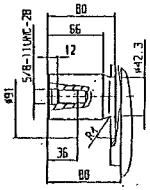
A
Splined shaft
W 45x2x30x21x9g
DIN 5480



S
Splined shaft SAE 1¾"
pressure angle 30°,
13 teeth, 8/16 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



T
Splined shaft SAE 2"
pressure angle 30°,
15 teeth, 8/16 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



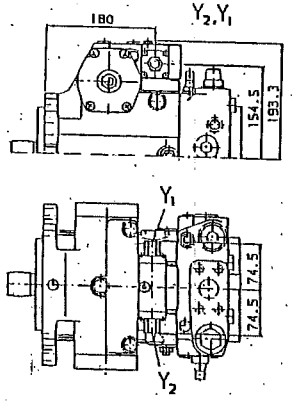
Connections

A, B	Service line ports SAE 1¼", high pressure series 420 bar (6000 psi)	
T_1	Case drain or filling port	M33x2; 18 deep
T_2	Case drain	M33x2; 18 deep
M_A, M_B	Pressure gauge - operating pressure A, B	M12x1,5; 12 deep
R	Air bleed	M16x1,5; 12 deep
S	Boost suction port	M48x2; 22 deep
X_1, X_2	Control pressure ports (before the orifice)	M16x1,5; 12 deep
G	Pressure port for auxiliary circuit	M22x1,5; 14 deep
P_S	Control pressure supply	M18x1,5; 12 deep
F_o	Filter outlet	M33x2; 18 deep
F_{o1}	Filter outlet (filter assembly)	M33x2; 18 deep
F_e	Filter inlet	M33x2; 18 deep
F_S	Port from filter to suction line (cold start)	M33x2; 18 deep
M_H	Port for balanced high pressure	M12x1,5; 12 deep
Y_1, Y_2	Remote control ports (only for HD control)	M14x1,5; 12 deep

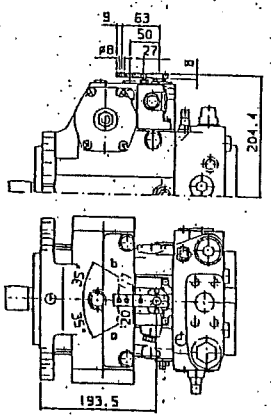
Before finalising your design, please request a certified drawing.

Page 751

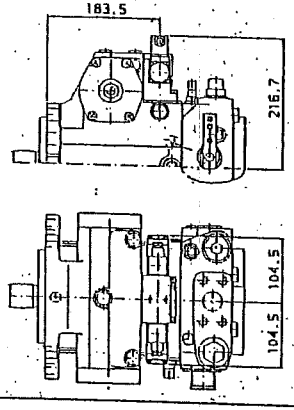
Hydraulic control, pilot pressure related, HD



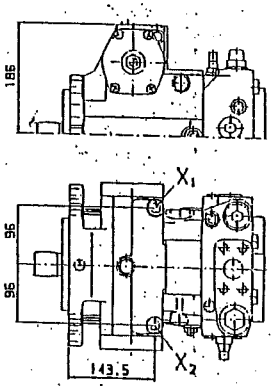
Hydraulic control, mechanical servo, HW



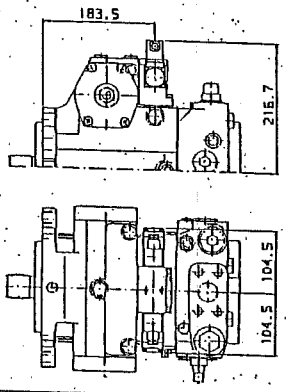
Hydraulic control, speed related, DA
(dimensions of the DA control valve see pages 32, 33)



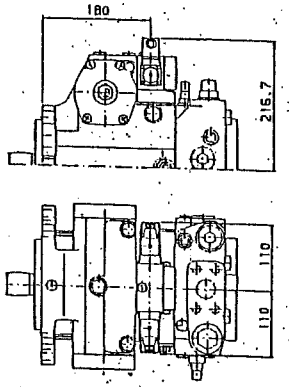
Hydraulic control, direct operated, DG



Electrical two-position control, with switching solenoid, EZ

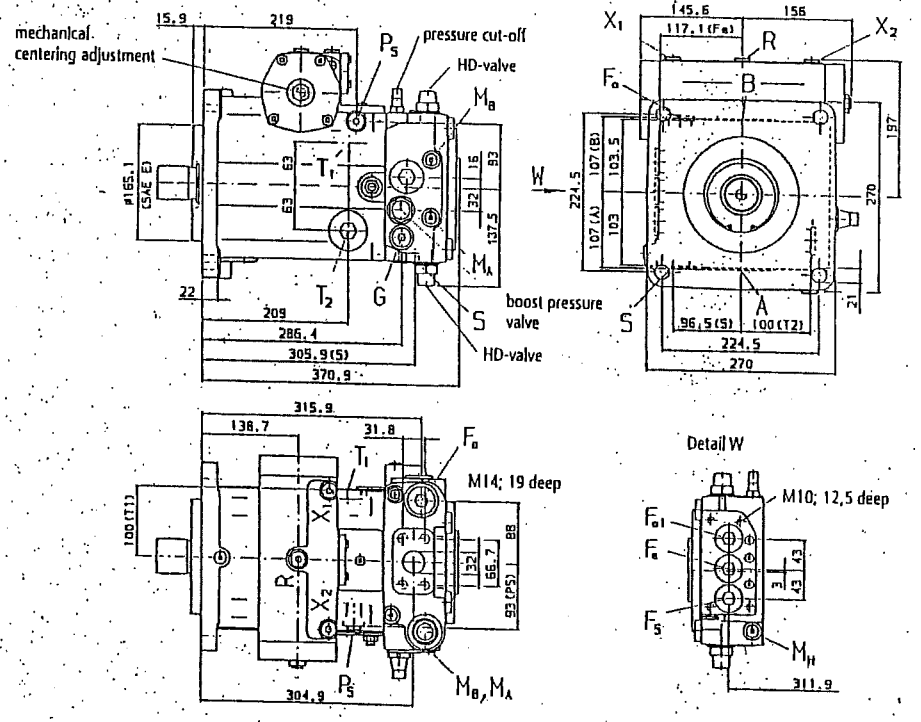


Electrical control, with proportional solenoid, EP



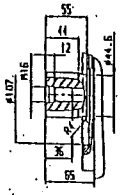
Before finalising your design, please request a certified drawing.

Pump configuration without control module, NV

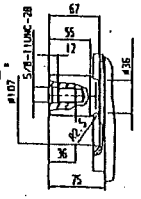


Shaft ends

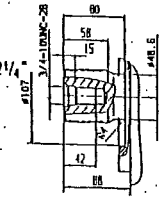
Z
Splined shaft
W 50x2x30x24x9g
DIN 5480



S
Splined shaft SAE 1¾"
pressure angle 30°,
13 teeth, 8/16 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



T
Splined shaft SAE 2¼"
pressure angle 30°,
17 teeth, 8/16 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



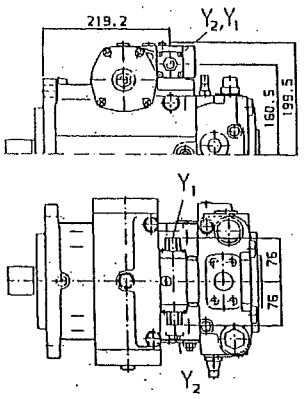
Connections

A, B	Service line ports SAE 1¼", high pressure series 420 bar (6000 psi)	
T_1	Case drain or filling port	M42x2; 20 deep
T_2	Case drain	M42x2; 20 deep
M_A, M_B	Pressure gauge - operating pressure A, B	M12x1,5; 12 deep
R	Air bleed	M16x1,5; 12 deep
S	Boost suction port	M48x2; 22 deep
X_1, X_2	Control pressure ports (before the orifice)	M16x1,5; 12 deep
G	Pressure port for auxiliary circuit	M22x1,5; 14 deep
P_S	Control pressure supply	M18x1,5; 12 deep
F_a	Filter outlet	M33x2; 18 deep
F_{a1}	Filter outlet (filter assembly)	M33x2; 18 deep
F_e	Filter inlet	M33x2; 18 deep
F_S	Port from filter to suction line (cold start)	M33x2; 18 deep
M_H	Port for balanced high pressure	M12x1,5; 12 deep
Y_1, Y_2	Remote control ports (only for HD control)	M14x1,5; 12 deep

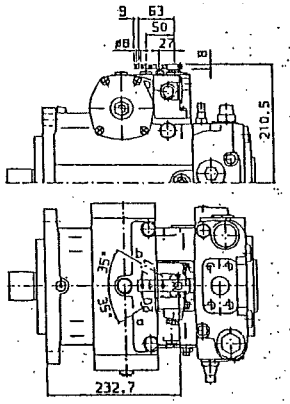
Unit Dimensions, Size 180

Before finalising your design, please request a certified drawing.

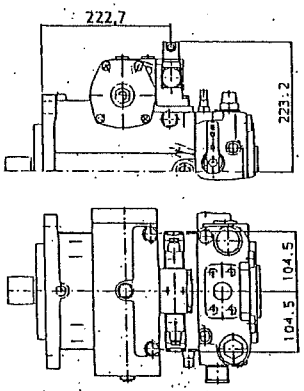
Hydraulic control, pilot pressure related, HD



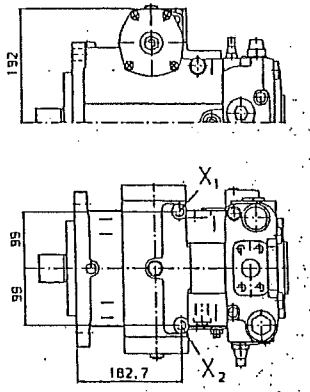
Hydraulic control, mechanical servo, HW



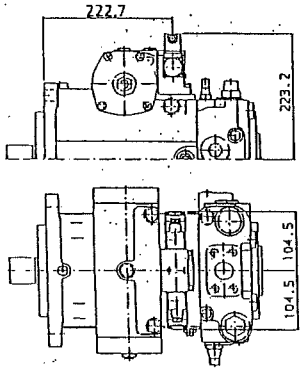
Hydraulic control, speed related, DA
(dimensions of the DA control valve see pages 32, 33)



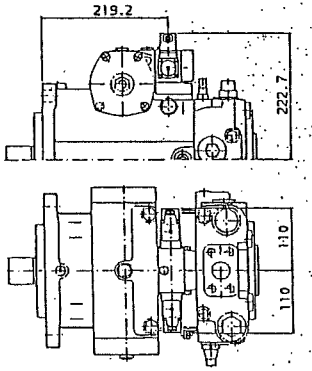
Hydraulic control, direct operated, DG



Electrical two-position control, with switching solenoid, EZ



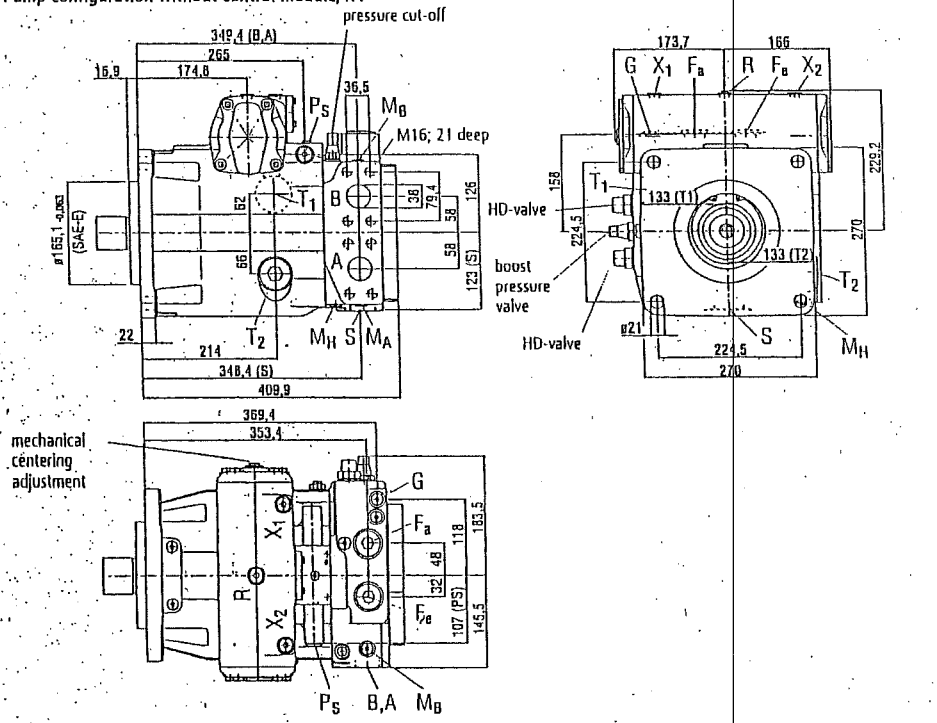
Electrical control, with proportional solenoid, EP



Unit Dimensions, Size 250

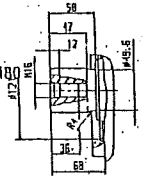
Before finalising your design, please request a certified drawing.

Pump configuration without control module, NV

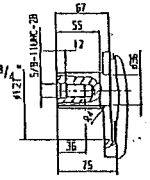


Shaft ends

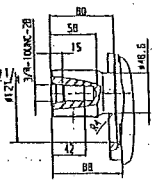
Z
Splined shaft, DIN 5480
W 55x2x30x26x9g



S
Splined shaft SAE 1¾"
pressure angle 30°,
13 teeth, 8/16 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



T
Splined shaft SAE 2½
pressure angle 30°,
17 teeth, 8/16 pitch,
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



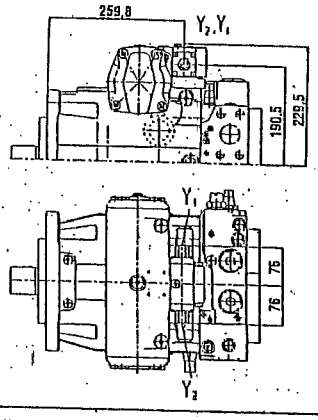
Connections

A, B	Service line ports SAE 1½", high pressure series 420 bar (6000 psi)	
T_1	Case drain or filling port	M42x2; 20 deep
T_2	Case drain	M42x2; 20 deep
M_A, M_B	Pressure gauge - operating pressure A/B	M14x1,5; 12 deep
R	Air bleed	M16x1,5; 12 deep
S	Boost suction port	M48x2; 22 deep
X_1, X_2	Control pressure ports (before the orifice)	M16x1,5; 12 deep
G	Pressure port for auxiliary circuit	M14x1,5; 12 deep
P_S	Control pressure supply	M18x1,5; 12 deep
F_a	Filter outlet	M33x2; 18 deep
F_e	Filter inlet	M33x2; 18 deep
M_H	Port for balanced high pressure	M14x1,5; 12 deep
Y_1, Y_2	Remote control ports (only for HD control)	M14x1,5; 12 deep

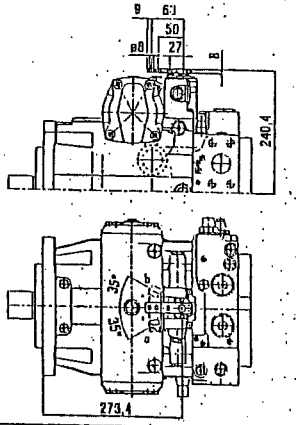
Before finalising your design, please request a certified drawing.

Page 753

Hydraulic control, pilot pressure related, HD

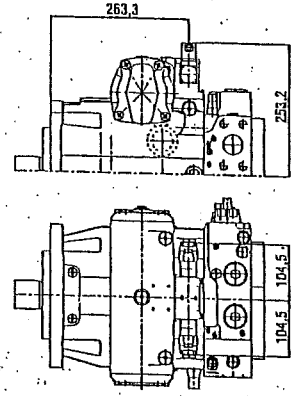


Hydraulic control, mechanical servo, HW

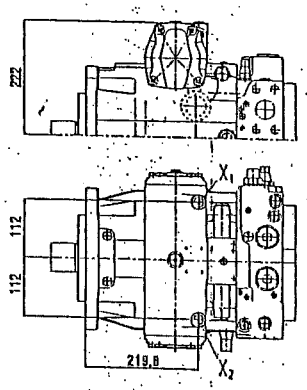


Hydraulic control, speed related, DA

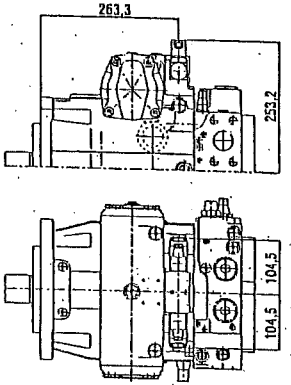
(dimensions of the DA control valve see pages 33, 34)



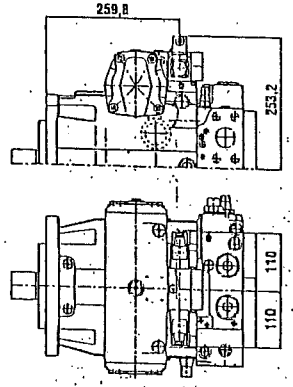
Hydraulic control, direct operated, DG



Electrical two-position control, with switching solenoid, EZ



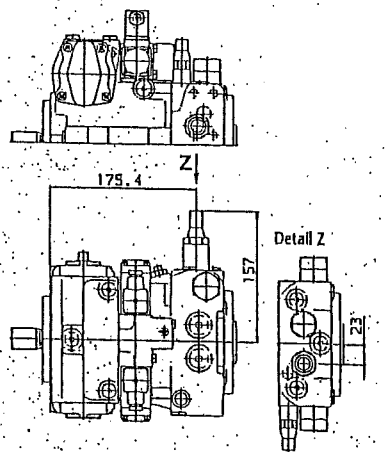
Electrical control, with proportional solenoid, EP



Unit Dimensions DA Control Valves

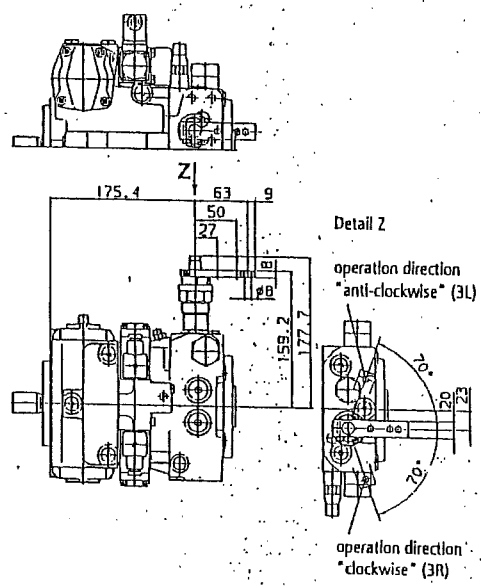
DA control valves, fixed setting, (2)

Size 28



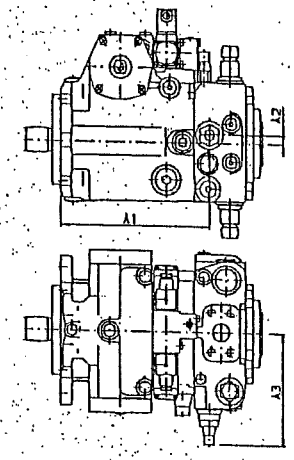
DA control valves, mech. adjustable with lever, (3)

Size 28



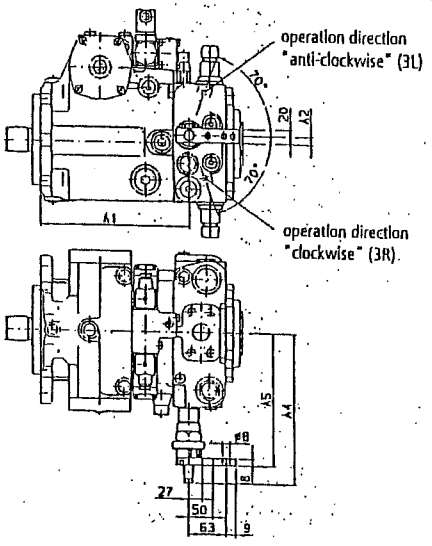
DA control valves, fixed setting, (2)

Sizes 40...180



DA control valves, mech. adjustable with lever, (3)

Sizes 40...180

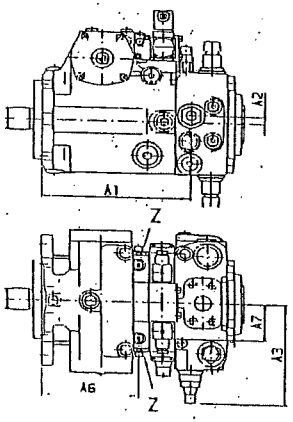


Unit Dimensions DA Control Valves

DA control valve, fixed setting and hydraulic inch valve built-on (only for pumps with DA control device), (4/8)

Z pilot pressure port M10x1; 8 deep
(plugged by supplier on delivery)

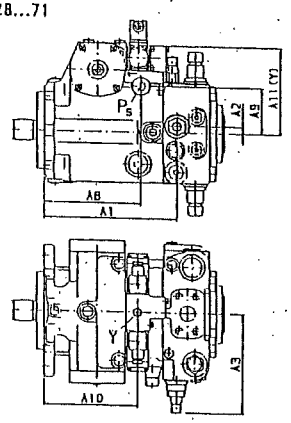
Sizes 28...250



DA control valve, fixed setting and connections for master controller, (7)

(order master controller separately)
P_S and Y pilot pressure ports for master controller

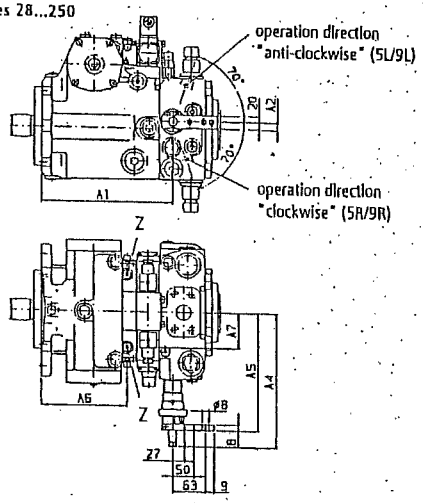
Sizes 28...71



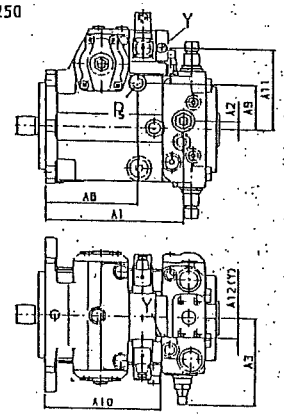
DA control valve, mechanically adjustable with lever and built-on hydraulic inch valve, (only for pumps with DA control device), (5/9)

Z pilot pressure port M10x1; 8 deep
(plugged by supplier on delivery)

Sizes 28...250



Sizes 90...250

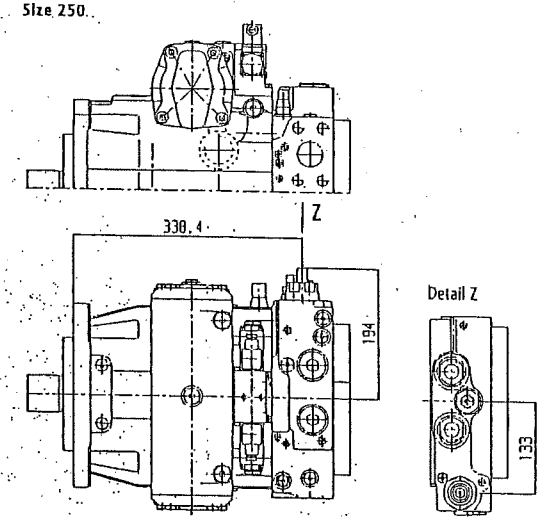


Size	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	Y
28	Variation 2 and 3, dimensions see page 32					90,9	59	111,5	67	93,9	119,6	–	M14x1,5; 12 deep
40	181,7	23	157	177,7	159,2	88,9	59	125	67	91,9	119,6	–	M14x1,5; 12 deep
56	197,4	24,5	149,5	172	153,5	97,8	59	129,5	76	100,8	132,1	–	M14x1,5; 12 deep
71	215,5	11	160	197	170	141	59	157,3	76	144,8	143,5	–	M14x1,5; 12 deep
90	237,5	14	145,5	182,5	154,5	185,6	66,5	159	79	201,6	122,5	48,5	M14x1,5; 12 deep
125	266,9	17	163,5	181	162,5	198,5	66,5	184,5	91	214,5	135	48,5	M14x1,5; 12 deep
180	292,9	16	164,5	187,5	169	237,7	66,5	219	93	253,7	141	48,5	M14x1,5; 12 deep
250	Variation 2 and 3, dimensions see page 34												

Unit Dimensions DA Control Valves

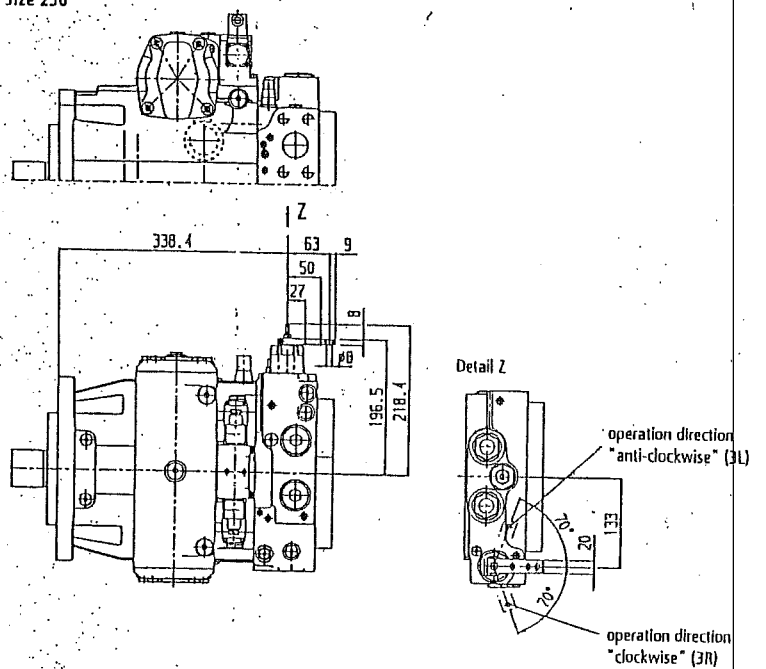
DA control valves, fixed setting, (2)

Size 250



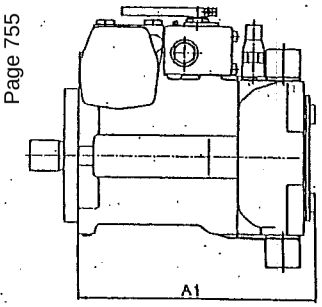
DA control valves, mech. adjustable with lever, (3)

Size 250



Dimens. ...r Through Drives

Without auxiliary pump, without through drive, (N00)

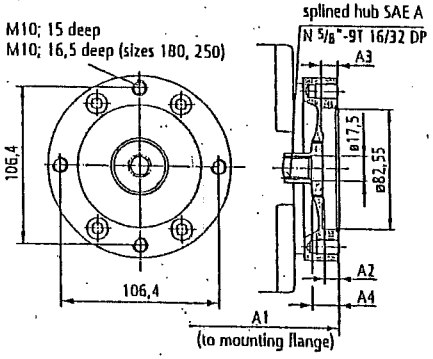


Size	A1
28	213,9
40	220,2
56	239,4
71	279,1
90	287
125	320,9
180	370,9
250	398,2

With auxiliary pump, without through drive, (F00)

standard model, see unit dimensions pages 16...31

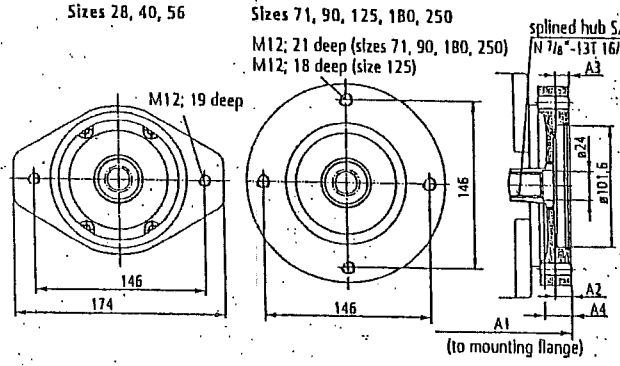
Through drive SAE A (F01/K01)



Size	A1 (F01)	A1 (K01)	A2	A3	A4
28	227,9	227,9	7,5	7,5	
40	239,7	234,2	9	10	18
56	261,4	254,9	10	11	19
71	297,6	297,6	9	10	17
90	304	304	9	8	
125	330,9	330,9	10,5	9	
180	378,4	378,4	7,5	7,5	15,5
250	426,9		11	11	18

suitable for connection of:
- gear pump G2 (RE 10030)
- variable pump A10VSO10 (RE 92713)
- variable pump A10VSO18 (RE 92712)

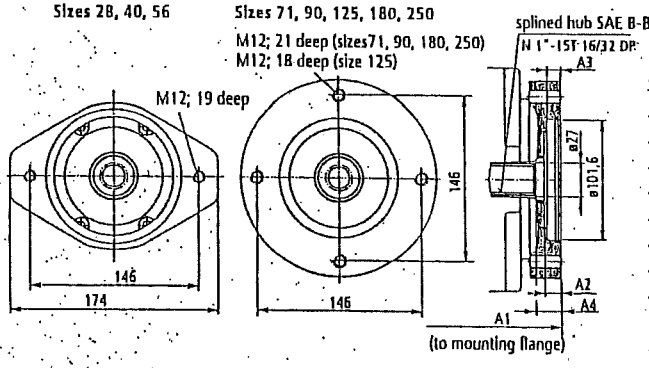
Through drive SAE B (F02/K02)



Size	A1	A2	A3	A4
28	230,4	9,7	9,7	
40	240,7	11	11	17
56	262,4	12	11	19,5
71	300,6	13	9,8	17
90	305	9	11	17
125	330,9	10	11	17
180	381,4	11	11	19
250	428,9	11	11	16

suitable for connection of:
- gear pump G3 (RE 10038)
- gear pump G4 (RE 10042)
- variable pump A10VG18 (RE 92750)
- variable pump A10VO28 (RE 92701/ RE 92703)

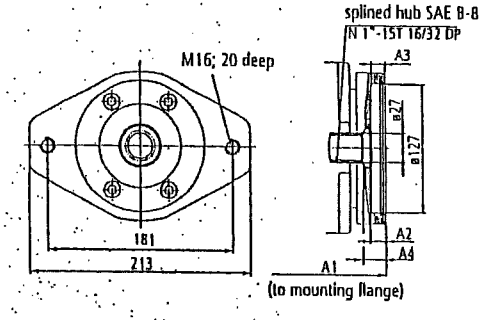
Through drive SAE B-B (F...K04)



Size	A1	A2	A3	A4
28	230,4	9,7	9,7	
40	240,7	11	9,7	16
56	262,4	13	11	18,5
71	300,6	13	9,8	15,5
90	305	9	11	15
125	330,9	10	11	16,5
180	381,4	11	11	18
250	428,9	11	11	15,5

suitable for connection of:
- variable pump A4VG28
- variable pump A10VG28 (RE 92750)
- variable pump A10VG45 (RE 92750)
- variable pump A10VO45 (RE 92701/ RE 92703)
- variable pump A11VO40 (RE 92500)

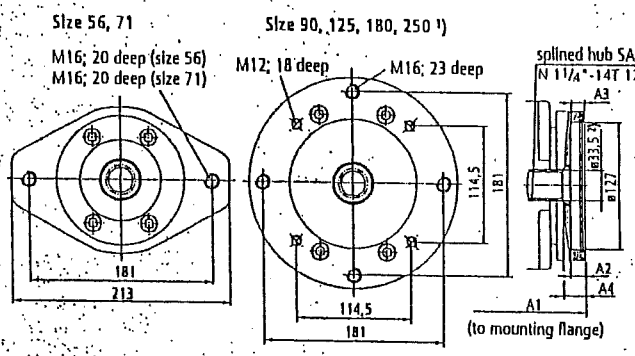
Through drive; flange SAE C, 2-hole; hub SAE B-B (F09/K09)



Size	A1	A2	A3	A4
40	244,7	11	11	

suitable for connection of:
- variable pump A4VG40

Through drive SAE C (F07/K07)

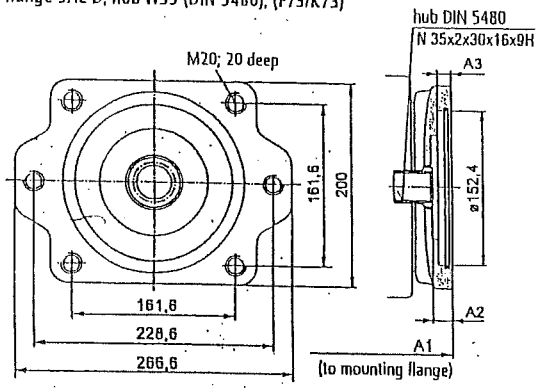


Size	A1	A2	A3	A4
56	266,4	15	14	
71	303,6	16	13,5	20
90	309	13	14	20,5
125	335,9	15	15,5	22,5
180	384,4	14	14	19
250	425,9	11	11	16

suitable for connection of:
- variable pump A4VG40
- variable pump A4VG56
- variable pump A4VG71
- variable pump A10VO71 (RE 92701)
- variable pump A11VO60 (RE 92500)

1) size 180 only with SAE 2-hole flange
2) size 56: ø32,7

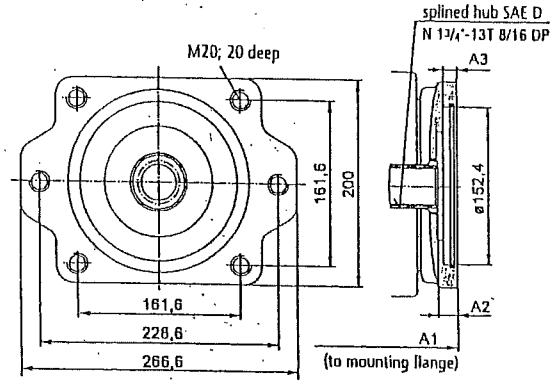
Through drive:
flange SAE D; hub W35 (DIN 5480); (F73/K73)



Size	A1	A2	A3
90	309	12	14

suitable for connection of:
– variable pump A4VG90

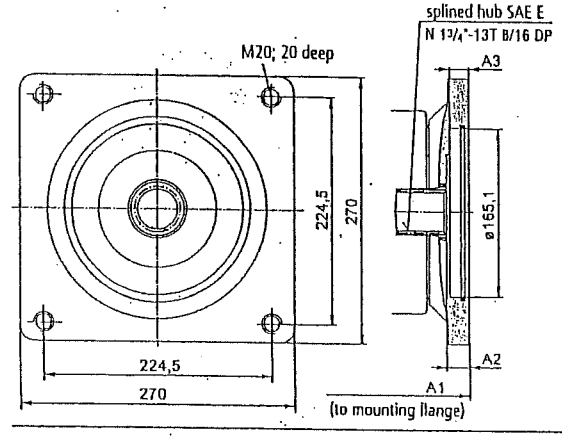
Through drive SAE D (F69/K69)



Size	A1	A2	A3
125	343,9	18	14
180	391,9	20,9	18
250	444,9		17

suitable for connection of:
– variable pump A4VG90
– variable pump A4VG125
– variable pump A10VO140 (RE 92701)
– variable pump A11VO95 (RE 92500)
– variable pump A11VO130 (RE 92500)

Through drive SAE E (F72/K72)



Size	A1	A2	A3
180	391,9	20,9	18
250	444,9		17

suitable for connection of:
– variable pump A4VG180
– variable pump A4VG250
– variable pump A11VO190 (RE 92500)
– variable pump A11VO260 (RE 92500)

RE 92 003/02.98

Permissible Input and Through Drive Rotation Torques

Size			28	40	56	71
Corner torque (when V_{gmax} a. Δp = 400 bar) [1]	T_{max}	Nm	178	254	356	451
Max. perm. through drive rotation torque	$T_{D\,perm.}$	Nm	231	314	521	660
Max. permissible input torque [2]						
at shaft end Z (DIN 5480)	$T_{E\,perm.}$	Nm	352 (W25x1,25x30x18x9g)	522 (W30x2x30x14x9g)	522 (W30x2x30x14x9g)	912 (W35x2x30x16x9g)
at shaft end A (DIN 5480)	$T_{E\,perm.}$	Nm	–	912 (W35x2x30x16x9g)	912 (W35x2x30x16x9g)	1460 (W40x2x30x18x9g)
at shaft end S SAE (ANSI B92.1a-1576)	$T_{E\,perm.}$	Nm	314 (SAE B-B) (W1"-15T 16/32DP)	602 (SAE C) (W1 1/4"-14T 12/24DP)	602 (SAE C) (W1 1/4"-14T 12/24DP)	602 (SAE C) (W1 1/4"-14T 12/24DP)
at shaft end T SAE (ANSI B92.1a-1976)	$T_{E\,perm.}$	Nm	–	–	970 (W1 3/8"-21T 16/32DP)	970 (W1 3/8"-21T 16/32DP)
at shaft end U [3] SAE (ANSI B92.1a-1976)	$T_{E\,perm.}$	Nm	–	314 (SAE B-B) (W1"-15T 16/32DP)	–	–

Size			90	125	180	250
Corner torque (when V_{gmax} a. Δp = 400 bar) [1]	T_{max}	Nm	572	795	1144	1590
Max. perm. through drive rotation torque	$T_{D\,perm.}$	Nm	822	1110	1760	2230
Max. permissible input torque [2]						
at shaft end Z (DIN 5480)	$T_{E\,perm.}$	Nm	912 (W35x2x30x16x9g)	1460 (W40x2x30x18x9g)	3140 (W50x2x30x24x9g)	4350 (W55x2x30x26x9g)
at shaft end A (DIN 5480)	$T_{E\,perm.}$	Nm	2190 (W45x2x30x21x9g)	2190 (W45x2x30x21x9g)	–	–
at shaft end S SAE (ANSI B92.1a-1976)	$T_{E\,perm.}$	Nm	1640 (SAE D) (W1 3/4"-13T 8/16DP)	1640 (SAE D) (W1 3/4"-13T 8/16DP)	1640 (SAE D) (W1 3/4"-13T 8/16DP)	1640 (SAE D) (W1 3/4"-13T 8/16DP)
at shaft end T SAE (ANSI B92.1a-1976)	$T_{E\,perm.}$	Nm	–	2670 (SAE F) (W2"-15T 8/16DP)	4070 (W2 1/4"-17T 8/16DP)	4070 (W2 1/4"-17T 8/16DP)

[1] efficiency not taken into consideration
[2] drive shaft without side load
[3] shaft „U" is only permissible as the shaft end in the 2nd pump of a combination pump of the same size

Code explanations

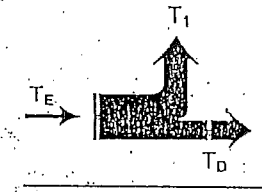
$T_{D\,perm.}$ = max. permissible through drive torque — in Nm
$T_{E\,perm.}$ = max. permissible input torque at the drive shaft — in Nm

T_1 = take off torque at 1st pump $= \dfrac{1{,}59 \cdot V_{g1} \cdot \Delta p_1}{100 \cdot \eta_{mh}}$ — in Nm

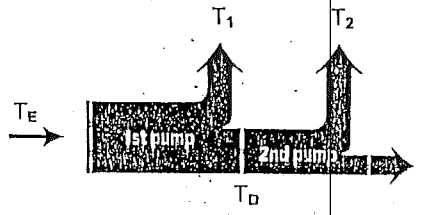
T_2 = take off torque at 2nd pump $= \dfrac{1{,}59 \cdot V_{g2} \cdot \Delta p_2}{100 \cdot \eta_{mh}}$ — in Nm

V_{g1} = pump displacement per rev. 1st pump — in cm³
V_{g2} = pump displacement per rev. 2nd pump — in cm³
Δp_1 = differential pressure 1st pump — in bar
Δp_2 = differential pressure 2nd pump — in bar
η_{mh} = mechanical-hydraulic efficiency

Single pump



Combination pump



Combir Pumps

Page 757

Combination pumps offer the facility of independent circuits without the need to fit splitter boxes.

When ordering combination pumps the model descriptions have to be connected by a „+" sign:

Code 1st pump (front pump) + Code 2nd pump (rear pump)

order example: A4VG56EP1D1/32R–PAC02F073S + A4VG56EP1D1/32R–P5C02F003S

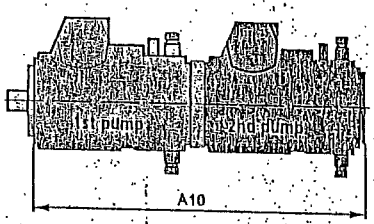
The series connection of two single pumps of the same size is permisssible without additional supports where the dynamic acceleration does not exceed 10 g (= 98,1 m/s²).

We recommend the use of 4-hole connection flanges from size 71 onwards.

Combination pump of the same size

(2nd pump without through drive and with auxiliary pump, F00)

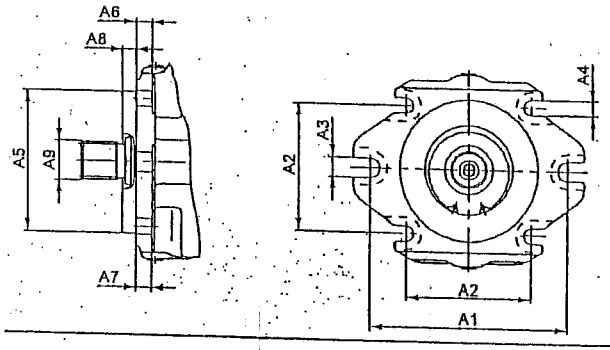
Size	28	40	56	71	90	125	180	250
A10	453,8	476,4	522,8	597,2	610,0	670,3	762,8	854,8



Mounting flange - shaft ends (of single and combination pumps)

Size	Mount. flange	A1	A2	A3	A4	A5	A6	A7	A8	Single pump	Combination pump of the same size 1st pump	2nd pump
28	SAE B-B, 2-hole	146	–	15	–	ø101,6	–	15	9,5	A9	A9	Through drive A9
										Z (W25)	Z (W25)	F04/K04 (SAE 1)
										S (SAE 1)	S (SAE 1)	F04/K04 (SAE 1)
40	SAE C, 2-hole	181	–	18	–	ø127	–	15	12,7	Z (W30)	A (W35)	F09/K09 (SAE 1)
										S (SAE 1)	S (SAE 1)	F09/K09 (SAE 1)
56	SAE C, 2-hole	181	–	18	–	ø127	–	18	12,7	Z (W30)	A (W35)	F07/K07 (SAE 1)
										S (SAE 1)	S (SAE 1)	F07/K07 (SAE 1)
71	SAE C, 2+4-hole	181	114,5	18	14,4	ø127	15	15	12,7	Z (W35)	A (W40)	F07/K07 (SAE 1)
										S (SAE 1)	W (SAE 1)	F07/K07 (SAE 1)
90	SAE D, 2+4-hole	228,6	161,5	21	21	ø152,4	17	20	12,7	Z (W35)	A (W45)	F73/K73 (SAE 1)
										S (SAE 1)	S (SAE 1)	F73/K73 (SAE 1)
125	SAE D, 2+4-hole	228,6	161,6	21	21	ø152,4	20	20	12,7	Z (W40)	A (W45)	F69/K69 (SAE 1)
										S (SAE 1)	T (SAE 2)	F69/K69 (SAE 1)
180	SAE E, 4-hole	–	224,5	–	21	ø165,1	22	–	15,9	Z (W50)	Z (W50)	F72/K72 (SAE 1)
										S (SAE 1)	T (SAE 2)	F72/K72 (SAE 1)
250	SAE E, 4-hole	–	224,5	–	21	ø165,1	22	–	15,9	Z (W55)	Z (W55)	F72/K72 (SAE 1)
										S (SAE 1)	T (SAE 2)	F72/K72 (SAE 1)

Mounting flange

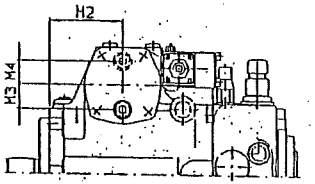


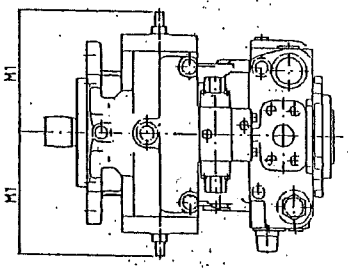
Mechanical Stroke L...er, M

Adjustment screws to both $V_{g\,max}$ – values

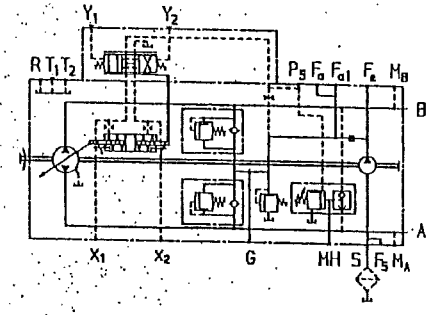
Dimensions

Size	M1	M2	M3	M4
28	110,6 max.	40,1	24	–
40	110,6 max.	38,1	24	–
56	130,5 max.	44	25,5	–
71	135,4 max.	86,3	–	28,5
90	147 max.	95,7	31,5	–
125	162 max.	104,5	–	35,5
180	181,6 max.	138,7	38	–
250	198,9 max.	174,8	39,5	–





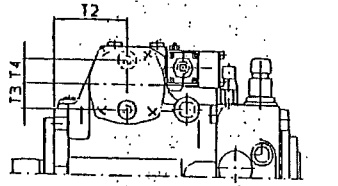
Circuit diagram [1]

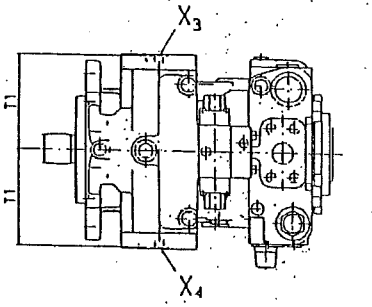


Ports X_3 and X_4 for Positioning Pressure, T

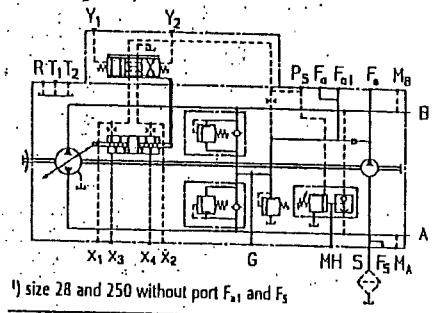
Dimensions

Size	T1	T2	T3	T4	X_3, X_4
28	92	40,1	–	24	M12x1,5
40	92	38,1	–	24	M12x1,5
56	104,5	44	–	25	M12x1,5
71	113,5	86,3	28	–	M12x1,5
90	111,5	95,7	–	30	M12x1,5
125	136	104,5	34	–	M12x1,5
180	146,5	138,7	–	35	M12x1,5
250	164,5	174,8	–	38	M16x1,5





Circuit diagram [1]



[1] size 28 and 250 without port F_{a1} and F_s

Rotary Inch Valve

Permits the control pressure to be reduced independently of the drive speed controlled by the position of the inch lever. Maximum movement 90°. The lever my be fixed in any position.

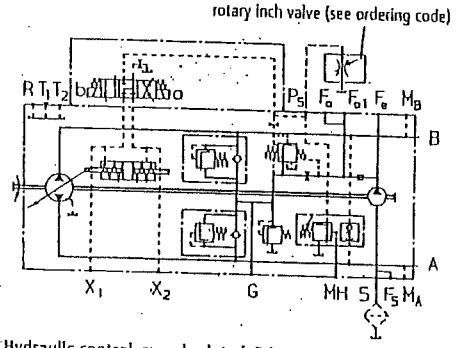
The valve is mounted separately from the pump and connected with the pump by the hydraulic control line at port P_S; (max. line length approximately 2 metres).

The rotary inch valve is to be ordered separately.

Size	Ordering code
28, 40, 56, 71, 90	438 553/470.05.31.01
125	438 554/470.05.31.02
180, 250	438 555/470.05.31.03

Please state your requirements in clear text: Inching, clockwise or anti-clockwise operation of the lever (This is determined on assembly).

Attention: The rotary inch valve can be use independently from the control device.



Hydraulic control, speed related, DA
with separately installed hydraulic inch valve

Installation Situation for Coupling Assembly

In order to assure that rotating parts (coupling hub) and fixed parts (housing, circlip) do not contact each other the installation situations are described in this leaflet have to be observed. The installation situation depend upon the sizes and the spline.

Size 28 and 40 (with free turning):

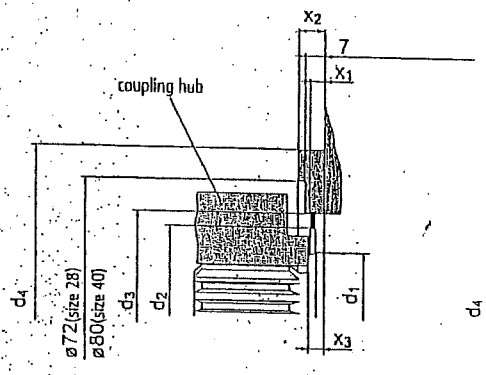
Please observe diameter of the free turning.

Size 56 to 250 (without free turning):

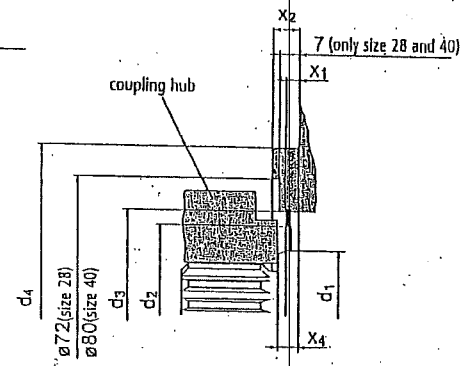
For *SAE spline* (shaft S or T) the outer diameter of the coupling hub must be smaller than the inner diameter of the circlip d_2 at the zone of the drive shaft collar (measure $x_2 - x_3$).

For *DIN spline* (shaft Z or A) the outer diameter of the coupling hub must be smaller than the housing diameter d_3 at the zone of the drive shaft collar (measure $x_2 - x_4$).

SAE spline
(to ANSI B92.1a-1976)



DIN spline
(to DIN 5480)



Size	ød1	ød2 min	ød3	ød4	x1	x2	x3	x4
28	35	43,4	$55_{\pm 0,1}$	101,6	$3,3^{+0,2}$	$9,5_{-0,5}$		
40	40	51,4	$63_{\pm 0,1}$	127	$4,3^{+0,2}$	$12,7_{-0,5}$		
56	40	54,4	$68_{\pm 0,1}$	127	$7,0^{+0,2}$	$12,7_{-0,5}$		
71	45	66,5	$81_{\pm 0,1}$	127	$7,0^{+0,2}$	$12,7_{-0,5}$	$8^{+0,9}_{+0,6}$	$10^{+0,9}_{-0,6}$
90	50	66,5	$81_{\pm 0,1}$	152,4	$6,8^{+0,2}$	$12,7_{-0,5}$		
125	55	76,3	$91_{\pm 0,1}$	152,4	$7,0^{+0,2}$	$12,7_{-0,5}$		
180	60	88	$107_{\pm 0,1}$	165,1	$7,4^{+0,2}$	$15,9_{-0,5}$		
250	75	104,6	121	165,1	$6,3^{+0,2}$	$15,9_{-0,5}$		

Prefe ypes

Type	Ident-No.
A4VG28DA1D2/32R-NZC10F005S	2036417
A4VG28DA1D2/32R-NZC10F015S	2019607
A4VG28DA2D2/32R-NZC10F005S	2019503
A4VG28DA2D2/32R-NZC10F015S	2036419
A4VG28DGD1/32R-NZC10F005S	2036421
A4VG28DGD1/32R-NZC10F015S	2036423
A4VG28DGD2/32R-NZC10F005S	2018984
A4VG28DGD2/32R-NZC10F015S	2036425
A4VG28EP1D1/32R-NZC10F005S	2034982
A4VG28EP1D1/32R-NZC10F015S	2019696
A4VG28EP1D2/32R-NZC10F005S	2036427
A4VG28EP1D2/32R-NZC10F015S	2036429
A4VG28EP2D1/32R-NZC10F005S	2036431
A4VG28EP2D1/32R-NZC10F015S	2019567
A4VG28EP2D2/32R-NZC10F005S	2036433
A4VG28EP2D2/32R-NZC10F015S	2026998
A4VG28HWD1/32R-NZC10F005S	2036434
A4VG28HWD1/32R-NZC10F015S	2036436
A4VG28HWD2/32R-NZC10F005S	2036438
A4VG28HWD2/32R-NZC10F015S	2036440
A4VG40DA1D2/32R-NZC02F005S	2020836
A4VG40DA1D2/32R-NZC02F015S	2020822
A4VG40DA2D2/32R-NZC02F005S	2036442
A4VG40DA2D2/32R-NZC02F015S	2036444
A4VG40DGD1/32R-NZC02F005S	2036446
A4VG40DGD1/32R-NZC02F015S	2036448
A4VG40DGD2/32R-NZC02F005S	2036450
A4VG40DGD2/32R-NZC02F015S	2031128
A4VG40EP1D1/32R-NZC02F005S	2036452
A4VG40EP1D1/32R-NZC02F015S	2036454
A4VG40EP1D2/32R-NZC02F005S	2036456
A4VG40EP1D2/32R-NZC02F015S	2031402
A4VG40EP2D1/32R-NZC02F005S	2026341
A4VG40EP2D1/32R-NZC02F015S	2017035
A4VG40EP2D2/32R-NZC02F005S	2036458
A4VG40EP2D2/32R-NZC02F015S	2020589
A4VG40HWD1/32R-NZC02F005S	2036460
A4VG40HWD1/32R-NZC02F015S	2016097
A4VG40HWD2/32R-NZC02F005S	2036462
A4VG40HWD2/32R-NZC02F015S	2036464
A4VG56DA2D2/32R-NZC02F005S	2036466
A4VG56DA2D2/32R-NZC02F015S	2021141
A4VG56DGD1/32R-NZC02F005S	2032204
A4VG56DGD1/32R-NZC02F015S	2019834
A4VG56DGD2/32R-NZC02F005S	2036468
A4VG56DGD2/32R-NZC02F015S	2036470
A4VG56EP2D1/32R-NZC02F005S	2036472
A4VG56EP2D1/32R-NZC02F015S	2031090
A4VG56EP2D2/32R-NZC02F005S	2036474
A4VG56EP2D2/32R-NZC02F015S	2019895
A4VG56HWD1/32R-NZC02F005S	2020855
A4VG56HWD1/32R-NZC02F015S	2028097
A4VG56HWD2/32R-NZC02F005S	2036476
A4VG56HWD2/32R-NZC02F015S	2021449

Type	Ident-No.
A4VG71DA2D2/32R-NZF02F001S	2022720
A4VG71DA2D2/32R-NZF02F011S	2022722
A4VG71DA2D2/32R-NZF02F021S	2022529
A4VG71DGD1/32R-NZF02F001S	2022052
A4VG71DGD1/32R-NZF02F011S	2036478
A4VG71DGD1/32R-NZF02F021S	2036480
A4VG71DGD2/32R-NZF02F001S	2036482
A4VG71DGD2/32R-NZF02F011S	2022084
A4VG71DGD2/32R-NZF02F021S	2022055
A4VG71EP2D1/32R-NZF02F001S	2022744
A4VG71EP2D1/32R-NZF02F011S	2022623
A4VG71EP2D1/32R-NZF02F021S	2022626
A4VG71EP2D2/32R-NZF02F001S	2036484
A4VG71EP2D2/32R-NZF02F011S	2036486
A4VG71EP2D2/32R-NZF02F021S	2036488
A4VG71HWD1/32R-NZF02F001S	2022645
A4VG71HWD1/32R-NZF02F01'S	2022651
A4VG71HWD1/32R-NZF02F021S	2022654
A4VG71HWD2/32R-NZF02F00'S	2036490
A4VG71HWD2/32R-NZF02F011S	2036492
A4VG71HWD2/32R-NZF02F02'S	2022660
A4VG90DA2D2/32R-NZF02F001S	2023606
A4VG90DA2D2/32R-NZF02F021S	2023608
A4VG90DGD1/32R-NZF02F001S	2023103
A4VG90DGD1/32R-NZF02F021S	2036494
A4VG90DGD2/32R-NZF02F001S	2036496
A4VG90DGD2/32R-NZF02F021S	2036498
A4VG90EP2D1/32R-NZF02F001S	2023536
A4VG90EP2D1/32R-NZF02F021S	2023542
A4VG90EP2D2/32R-NZF02F001S	2031211
A4VG90EP2D2/32R-NZF02F021S	2023552
A4VG90HWD1/32R-NZF02F001S	2023557
A4VG90HWD1/32R-NZF02F021S	2023561
A4VG90HWD2/32R-NZF02F001S	2023567
A4VG90HWD2/32R-NZF02F021S	2037000
A4VG125DA2D2/32R-NZF02F001S	2024184
A4VG125DA2D2/32R-NZF02F021S	2024170
A4VG125DGD2/32R-NZF02F001S	2037002
A4VG125DGD2/32R-NZF02F021S	2037004
A4VG125EP2D1/32R-NZF02F001S	2023999
A4VG125EP2D1/32R-NZF02F021S	2024241
A4VG125EP2D2/32R-NZF02F001S	2024246
A4VG125EP2D2/32R-NZF02F021S	2024247
A4VG180DA2D2/32R-NZD02F001S	2026204
A4VG180DA2D2/32R-NZD02F021S	2037006
A4VG180DGD1/32R-NZD02F001S	2037008
A4VG180DGD1/32R-NZD02F021S	2037672
A4VG180DGD2/32R-NZD02F001S	2037010
A4VG180DGD2/32R-NZD02F021S	2037637
A4VG180EP2D1/32R-NZD02F001S	2037012
A4VG180EP2D1/32R-NZD02F021S	2026225
A4VG180EP2D2/32R-NZD02F001S	2037014
A4VG180EP2D2/32R-NZD02F021S	2026235

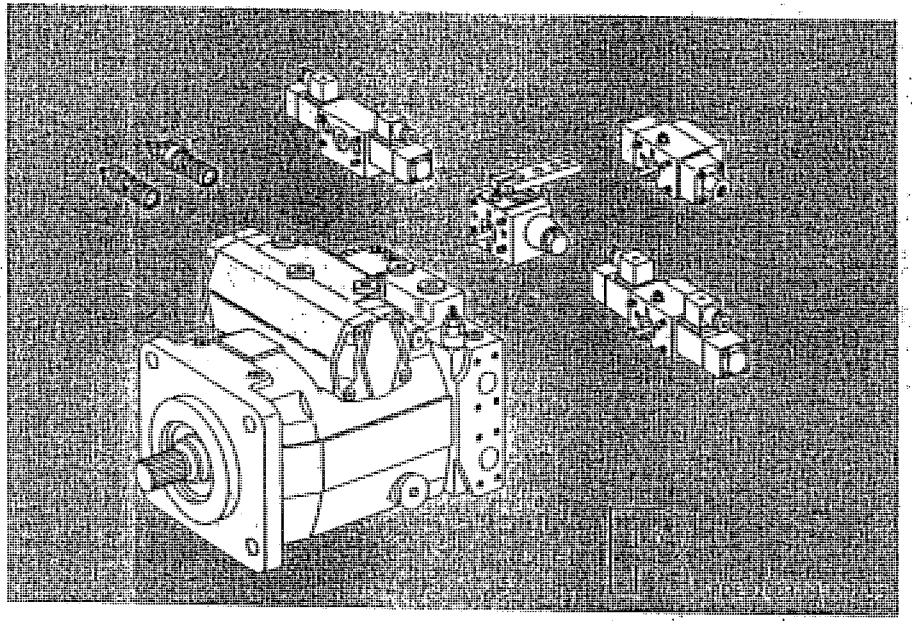
Bei Bestellung bitte Typ und Ident-Nr. angeben.

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The specified data is for product description purposes only and may not be deemed to be guaranteed unless expressly confirmed in the contract.

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engineering
Mannesmann Rexroth



Reparaturanleitung
Repair instructions

A4VG 250 / Baureihe 32

A4VG 250 / Series 32

Brueninghaus Hydromatik

HINWEIS

Bezeichnungen, Beschreibungen und Darstellungen entsprechen dem Informationsstand zum Zeitpunkt der Drucklegung dieser Unterlage.

Änderungen können den Service am Produkt beeinflussen, Verpflichtungen entstehen uns daraus nicht.

Methoden und Vorrichtungen sind Empfehlungen, für deren Resultat wir keine Haftung übernehmen können.

BRUENINGHAUS HYDROMATIK- Baugruppen, mit Angabe der Fabrik-Nr. bestellt, sind die Basis guter Reparaturen.

Einstell- und Prüfarbeiten sind bei Betriebstemperatur auf dem Teststand vorzunehmen.

Schutz von Personen und Eigentum ist durch Vorkehrungen sicherzustellen.

Sachkenntnis, die Voraussetzung für jede Service-arbeit, vermitteln wir in unseren Schulungskursen.

NOTICE

Specifications, descriptions and illustrative material shown herein were as accurate as known at the time this publication was approved for printing.

BRUENINGHAUS HYDROMATIK reserves the right to discontinue models or options at any time or to change speci-fications, materials, or design without notice and with-out incurring obligation.

Optional equipment and accessories may add cost to the basic unit, and some options are available only in combination with certain models or other options.

For the available combinations refer to the relevant data sheet for the basic unit and the desired option.

Adjustment and tests have to be carried out on the test bench under operating temperatures.

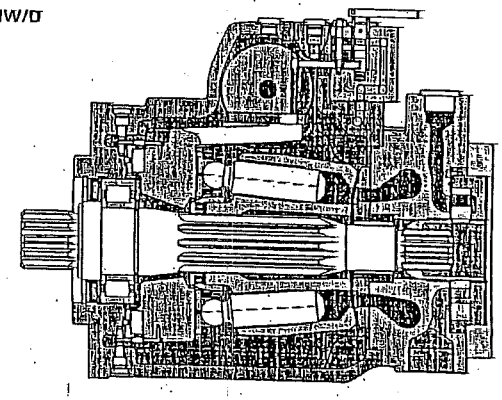
Protection of personnel and property has to be guaranteed by appropriate measures.

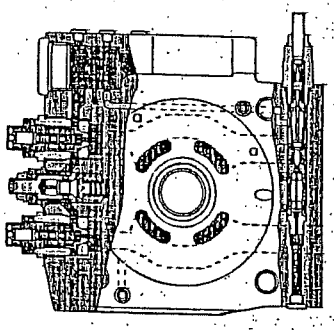
Expert knowledge, the precondition of any service work, can be obtained in our training courses.

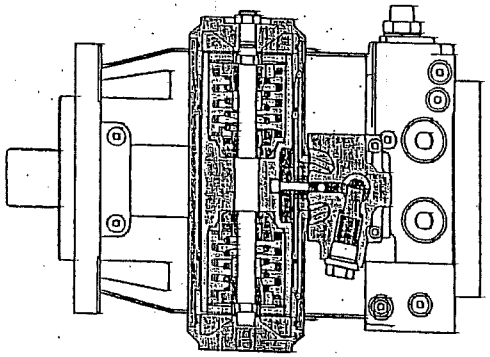
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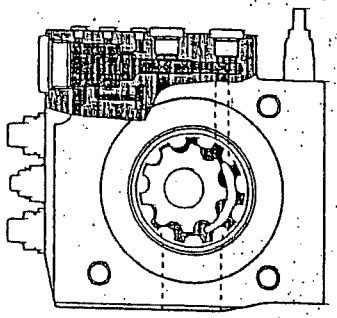
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HW/D

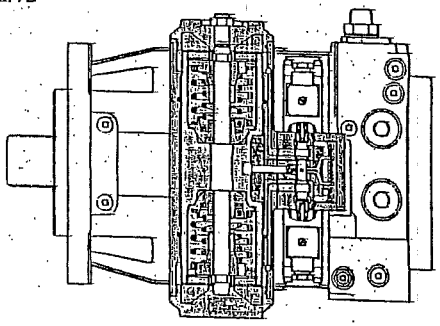




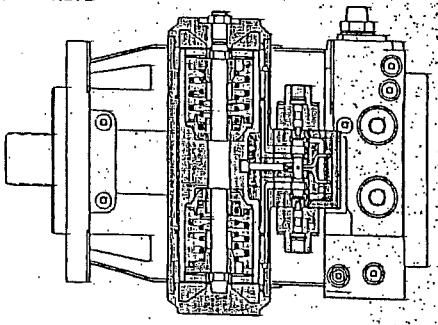




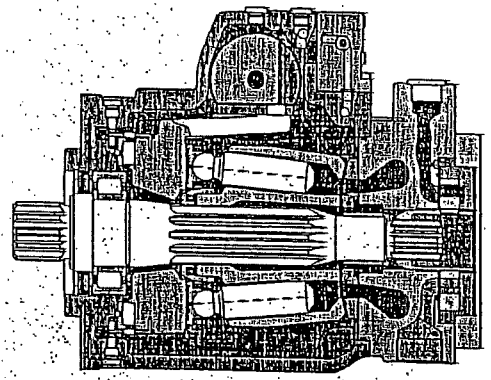
EP/D

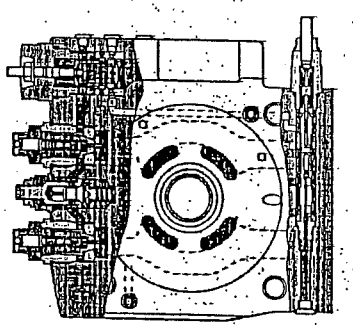


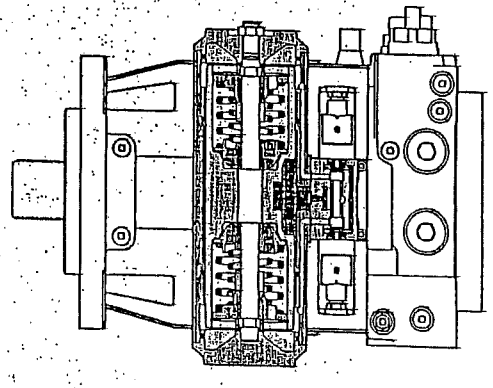
HD/D

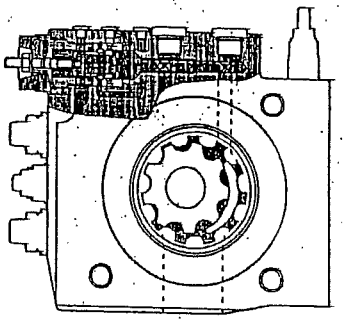


DA/D





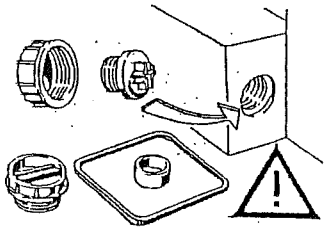






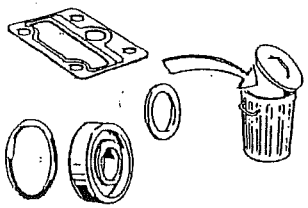
Achtung!
Nachfolgend Hinweise bei allen Reparaturarbeiten an Hydraulikaggregaten beachten!

Attention!
Observe the following notices when carrying out repair work at hydraulic units!



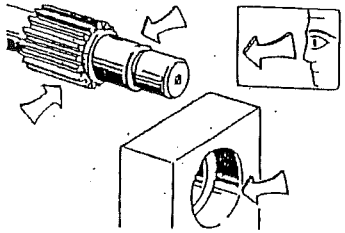
Alle Öffnungen der Hydraulikaggregate verschließen.

Close all of the hydraulic unit ports.



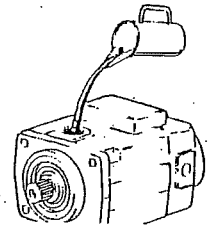
Alle Dichtungen erneuern.
Nur original BRUENINGHAUS HYDROMATIK-Ersatzteile verwenden.

Replace all seals.
Use only original BRUENINGHAUS HYDROMATIK spare parts.



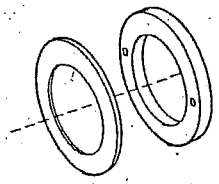
Alle Dicht- und Gleitflächen auf Verschleiß prüfen.
Achtung: Nacharbeiten an Dichtflächen z.B. durch Schleifpapier kann die Oberfläche beschädigen.

Check all sealing and sliding surfaces for wear.
Attention: Rework of sealing area for example with abrasive paper can damage the surface.



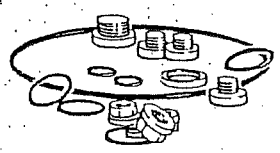
Hydraulikaggregate vor Inbetriebnahme mit Betriebsmedium befüllen.

Fill up the hydraulic units with the operating medium before start- up.



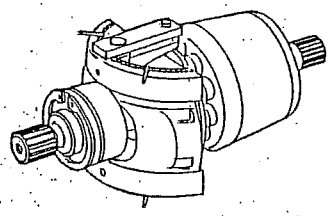
Dichtsatz für Triebwelle.

Seal kit for drive shaft.



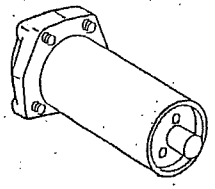
Äußerer Dichtsatz.

External seal kit.



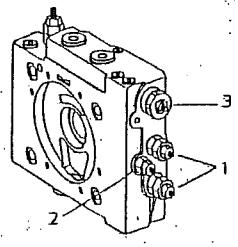
Triebwerk komplett.

Complete rotary group.



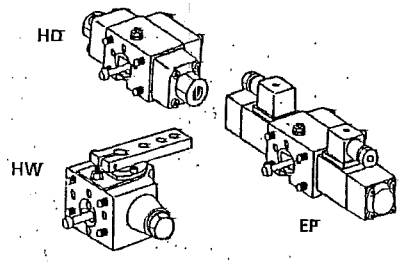
Stellkolben

Positioning piston



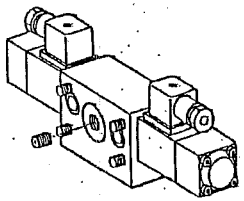
Anschlußplatte
1. HD-Ventile
2. Speisedruckventil
3. DA-Regelventil

Valve plate
1. HD valve
2. Boost pressure valve
3. DA control valve



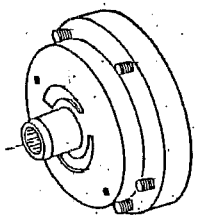
Ansteuergeräte HW, HD, EP

Control device HW, HD, EP



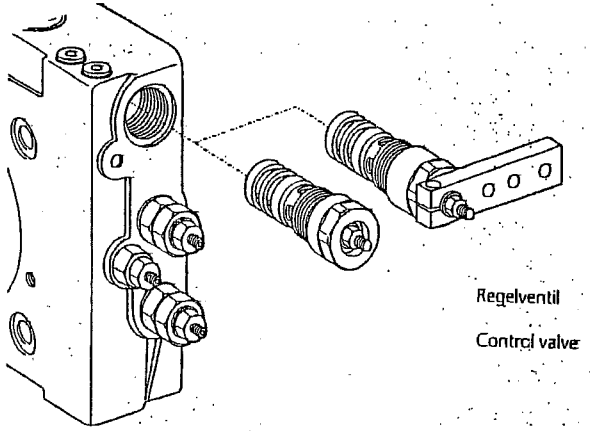
Ansteuergerät DA

Control device DA



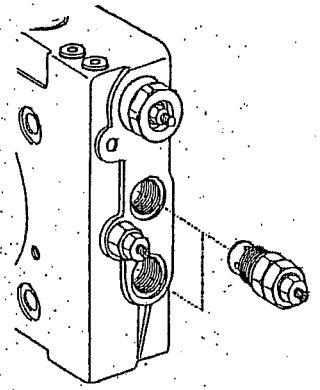
Hilfspumpe

Boost pump



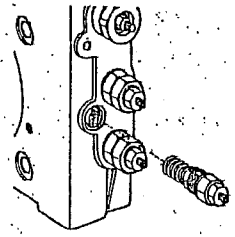
Regelventil

Control valve



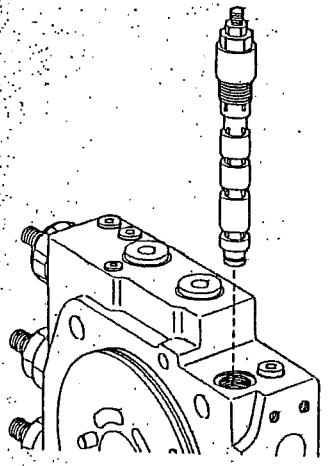
HD - Ventil

HD - High pressure valve



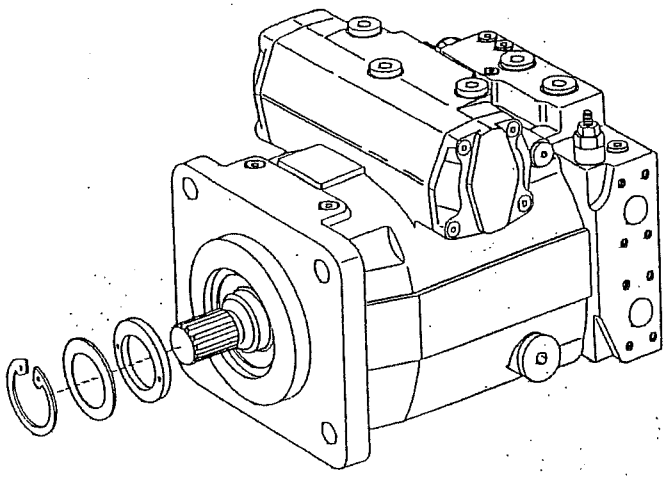
ND - Ventil

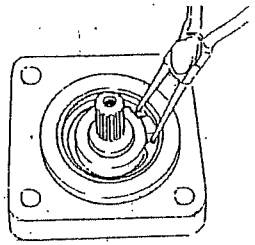
ND - Low pressure valve



Druckabschneidung

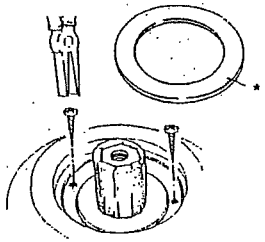
Pressure cut-off





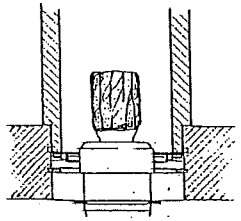
Triebwelle abkleben.
Sicherungsring ausbauen.

Protect the drive shaft.
Remove retaining ring.



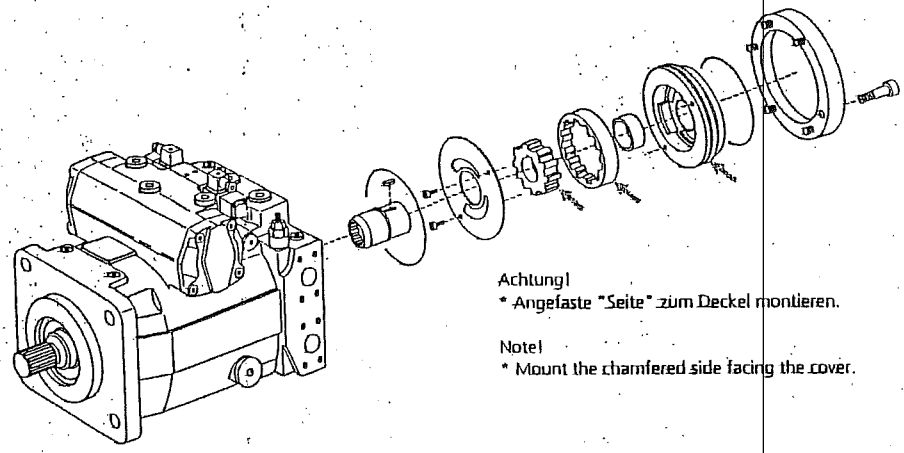
* Scheibe ausbauen.
Blechschraube in die mit Gummi gefüllten Löcher eindrehen.
Mit Zange WDR herausziehen.

* Remove disc.
Screw in sheet metal screw into the holes fitted with rubber.
Pull out shaft seal with pliers.



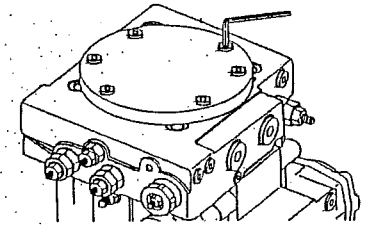
Wellendichtring mit Buchse auf Anschlag einpressen.
Sicherungsring einbauen.

Press-in shaft seal with bush to the end stop.
Assemble retaining ring.



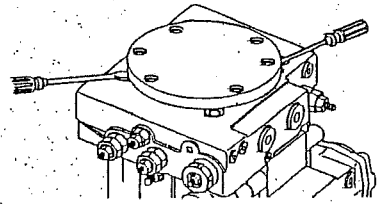
Achtung!
* Angefaste "Seite" zum Deckel montieren.

Note!
* Mount the chamfered side facing the cover.



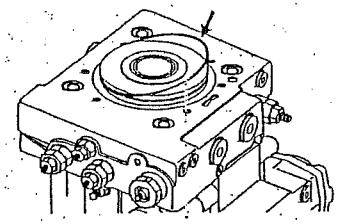
Befestigungsschrauben ausbauen.

Remove fixing screws.



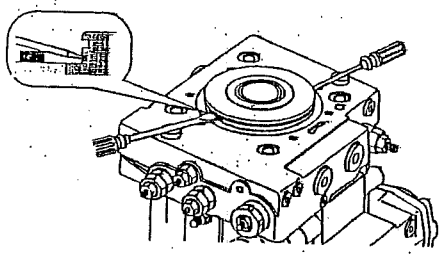
⚠ Deckel abdrücken.
Deckel nicht beschädigen.

⚠ Pry-off cover.
Do not damage the cover



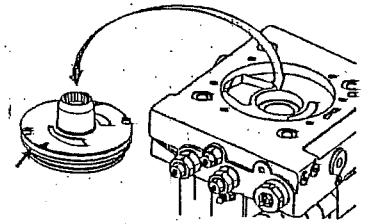
O-Ring ausbauen.

Remove O-ring.



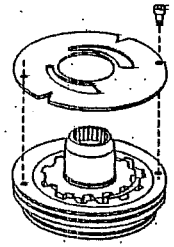
Hilfspumpe abdrücken.
Abdrückschlitz und Unterlage benutzen!

Pry off the boost pump.
Use protective support pads andthe pry-off slots!



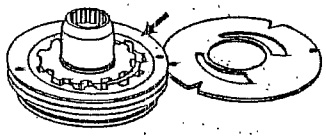
O-Ring ausbauen.

Remove O-ring.



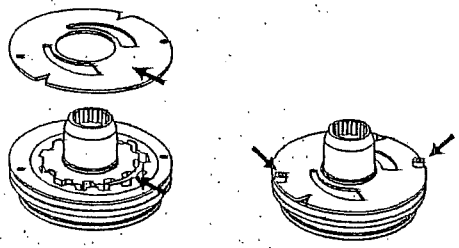
Verschleißplatte demontieren.

Remove the wear plate!



Hilfspumpe auf Verschleiß kontrollieren.

Check the boost pump for wear.

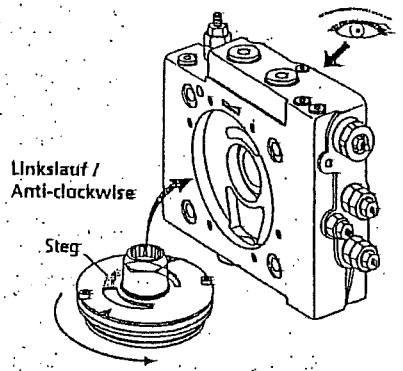


Verschleißplatte aufsetzen und verschrauben.

Breite Seite auf Steg.

Fit wear plate.

Wide side to the web.

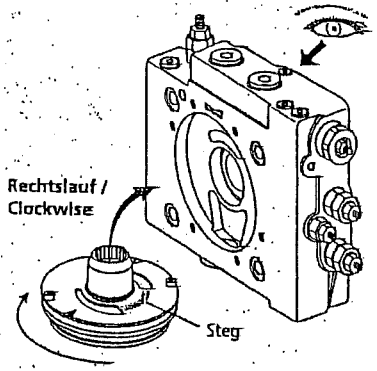


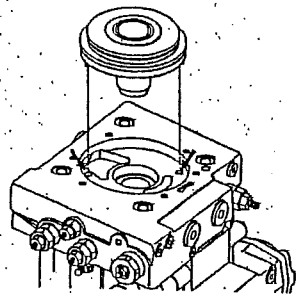
Drehrichtung

Einbaulage beachten!

Direction of rotation

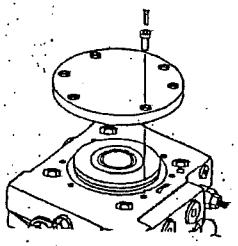
Take care over the installation position!





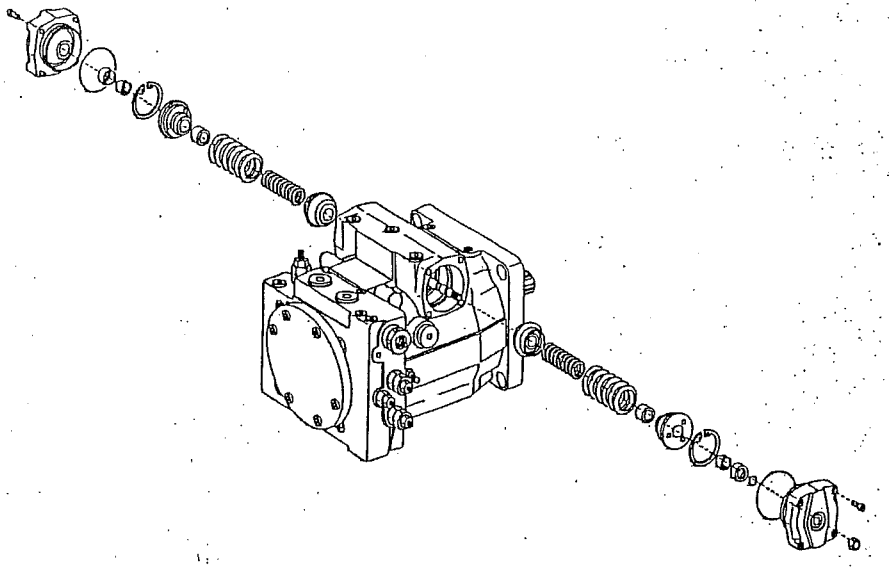
Hilfspumpe montieren.
Montagehilfe: Bohrung

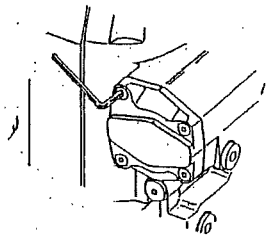
Fit boost pump.
Assembly aid: drilling



O-Ring und Deckel montieren.

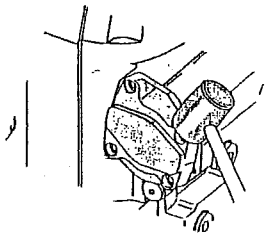
Fit O-ring and cover plate.





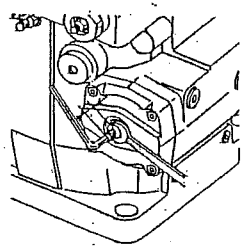
Lage kennzeichnen.

Mark position.



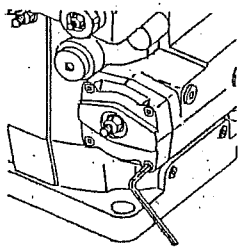
Deckel verdrehen und mit leichten Hammerschlägen lösen.

Rotate cover and release by tapping gently with a hammer.



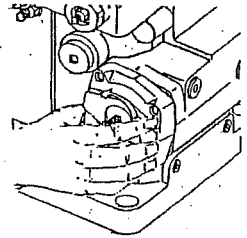
Deckel kennzeichnen. Maß festhalten,
Kontermutter lösen,
Stellschraube gegenhalten.

Mark cover, dimension must be held,
loosen lock nut, hold adjustment screw.



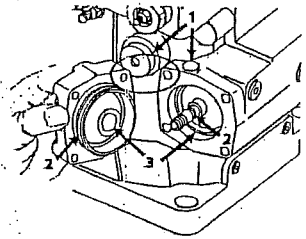
Befestigungsschrauben ausbauen.

Remove fixing screws.



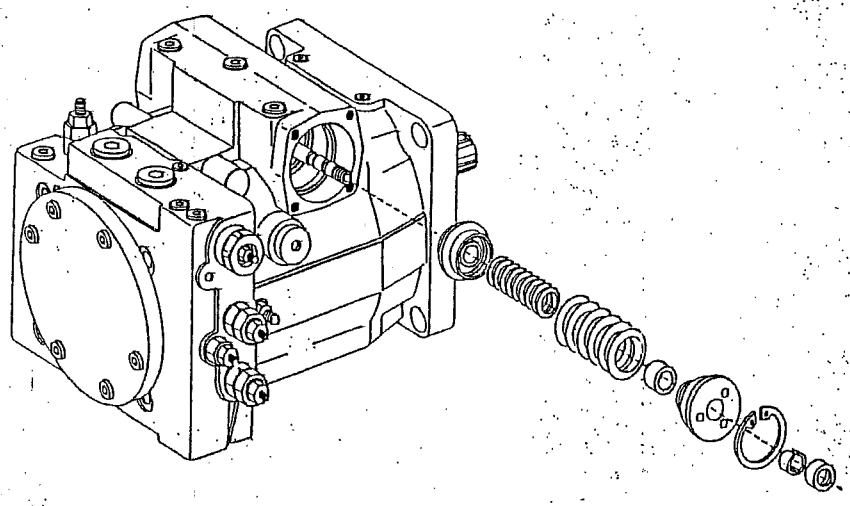
Deckel mit Stellschraube "abdrehen".

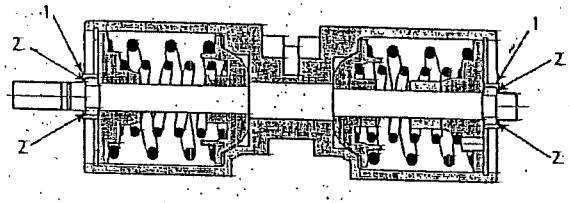
Lift off by turning the setting screw.



Kontrolle!
O-Ring (1), Nut (2), Gehäuse (3).
Achtung!
Korrekte mechanische 0-Lageneinstellung
überprüfen!

Check!
O-ring (1), groove (2), housing (3).
Attention!
Check correct mechanical 0-position.



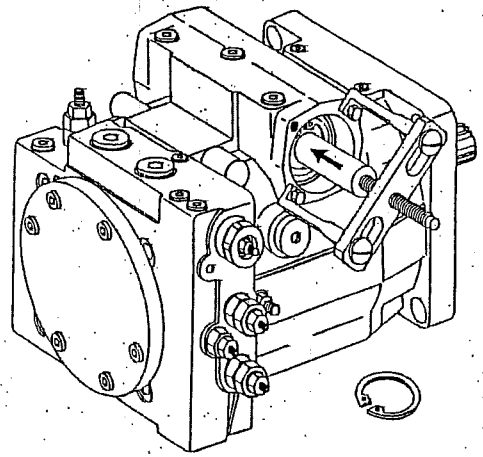


1. Sicherungskappe abbauen.
2. Geteilte Ringe ausbauen.

⚠ Ringe nicht vertauschen.

1. Remove safety cap.
2. Remove the split rings.

⚠ Do not exchange the rings

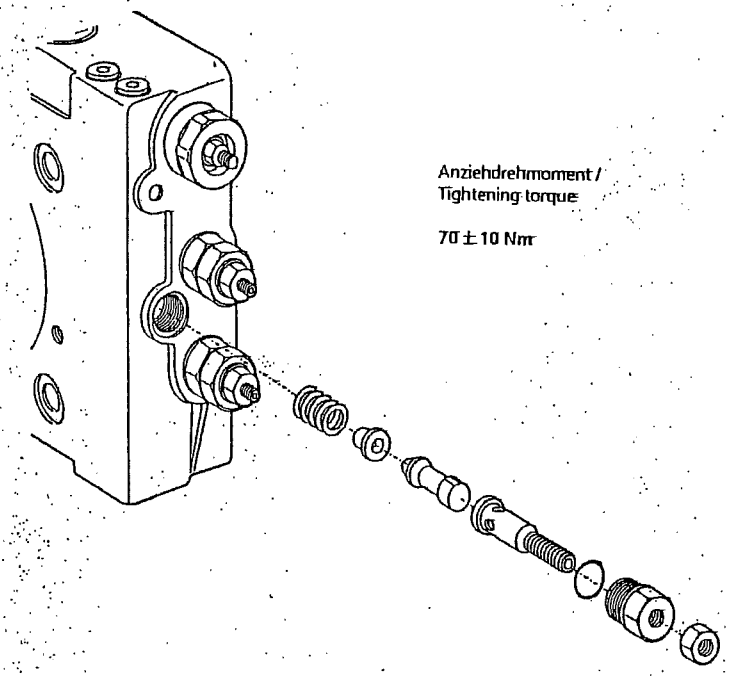


3. Mit Vorrichtung Federteller gegen Feder vorspannen.
4. Sicherungsring ausbauen.
5. Federteller mit Feder entspannen und ausbauen.

+ Montage in umgekehrter Reihenfolge.

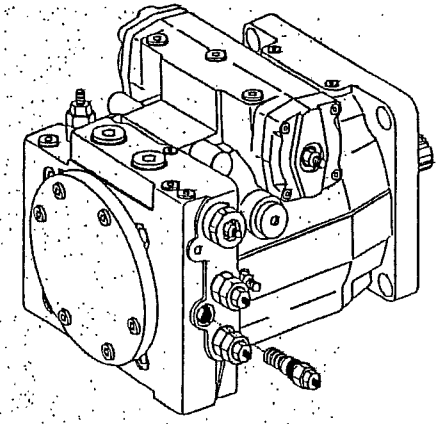
3. Using an aid pre-tension the spring plates against the spring.
4. Remove circlip.
5. Untension the spring plates and spring - then remove.

+ Re-assemble in revers order.



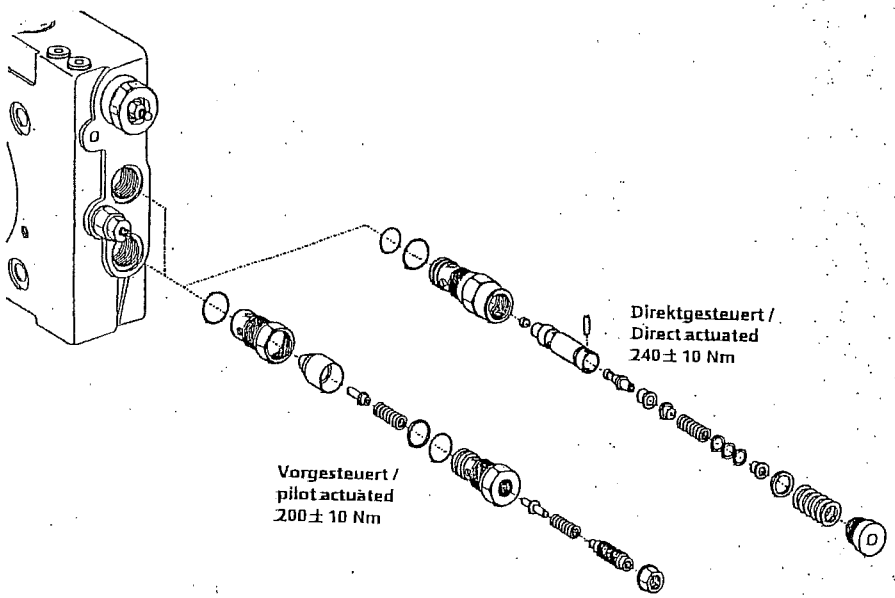
Anziehdrehmoment /
Tightening torque

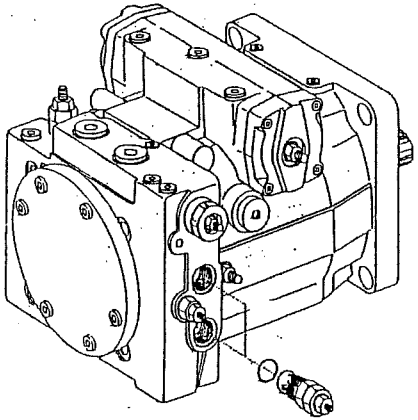
70 ± 10 Nm

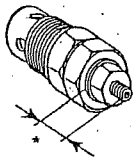


Ventil komplett ausbauen.
Hinweis:
Einstellschraube nicht verändern.
Achtung!
Nach Einbau Ventileinstellung überprüfen!

Remove valve completely:
Note:
Do not change adjustment screw.
Attention!
Check valve setting after installation.





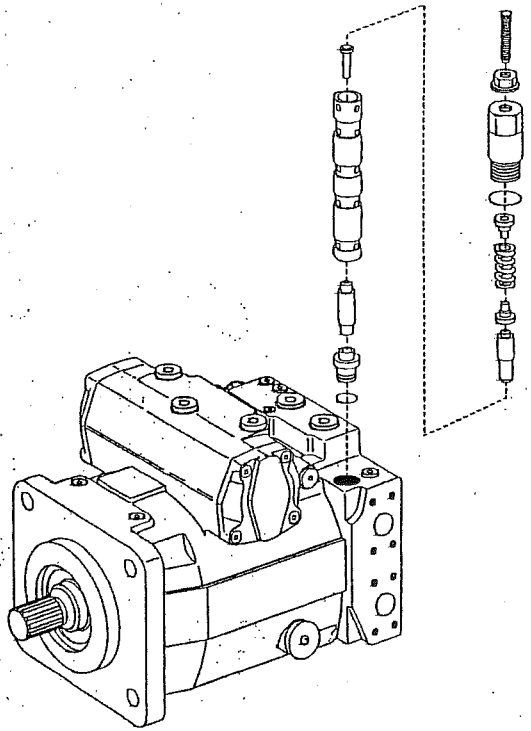


Ventil komplett ausbauen.
Kontrolle: O-Ring, Gehäuse.
Wechsel der Dichtmutter - Einstellmaß (*) festhalten.
Achtung!
Nach Einbau "Ventileinstellung" überprüfen.

Remove valve completely.
Check: O-ring, housing.
Replacement of the sealing nut, record dimension (*).
Attention!
After assembly check "valve setting".

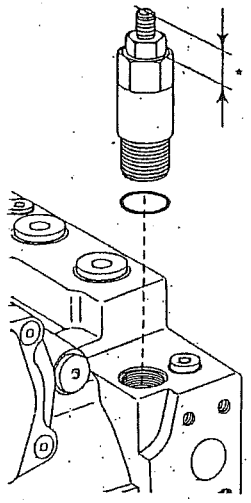
Anziehdrehmoment vorgesteuert /
Tightening torque pilot operated
200 ± 10 Nm

Anziehdrehmoment direktgesteuert /
Tightening torque direct operated
240 ± 10 Nm



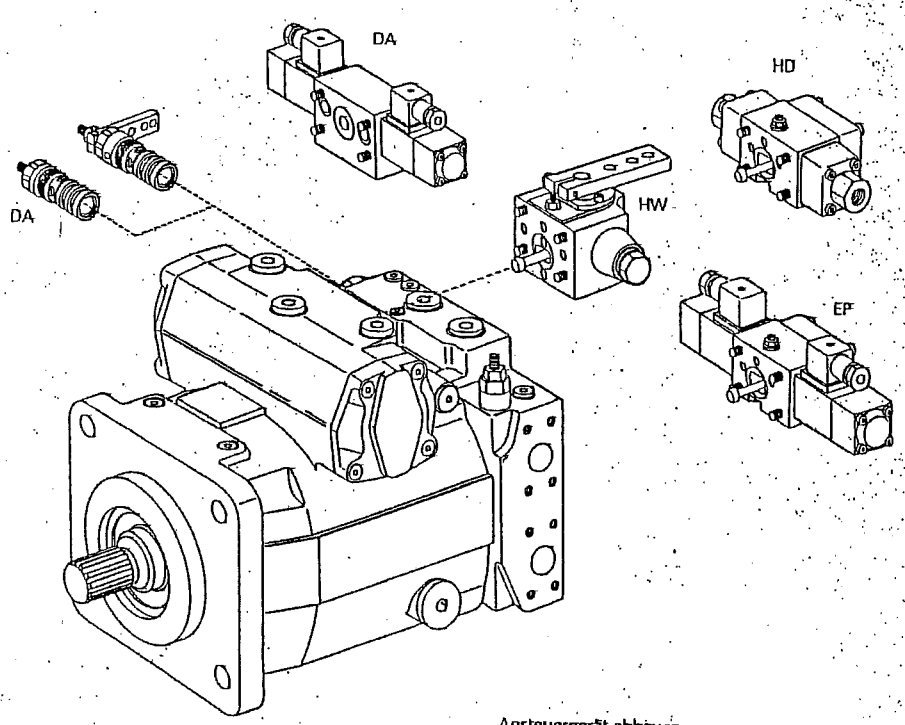
Anziehdrehmoment /
Tightening torque

50 ± 10 Nm



Einstellteil komplett ausschrauben.
Kontrolle: O-Ring, Gehäuse.
Wechsel der Dichtmutter - Einstellmaß (*) festhalten.
Achtung!
Nach Einbau "Ventileinstellung" überprüfen.

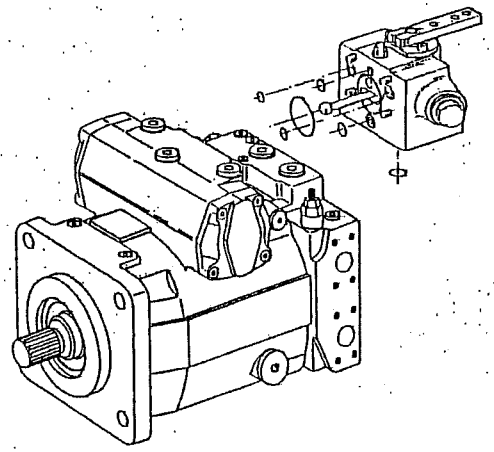
Unscrew setting cartridge completely.
Check: O-ring, housing.
Replacement of the sealing nut, record dimension (*).
Attention!
After assembly check "valve setting".

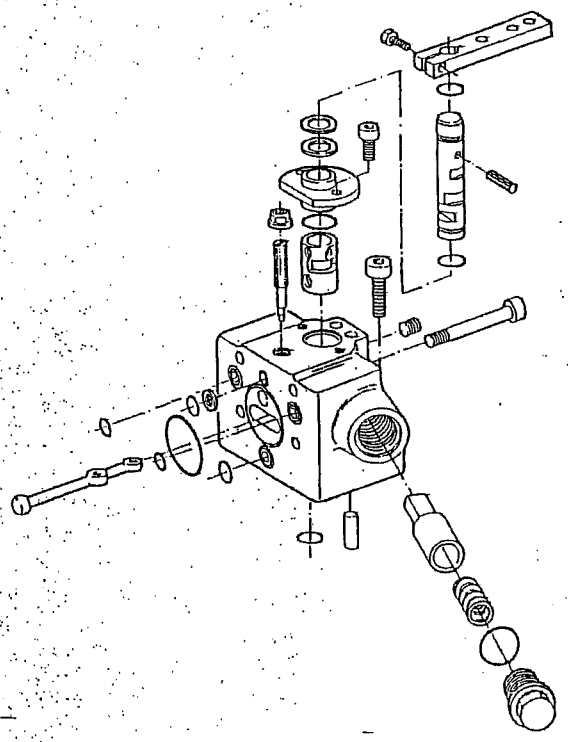


NG 250

Ansteuergerät abbauen.

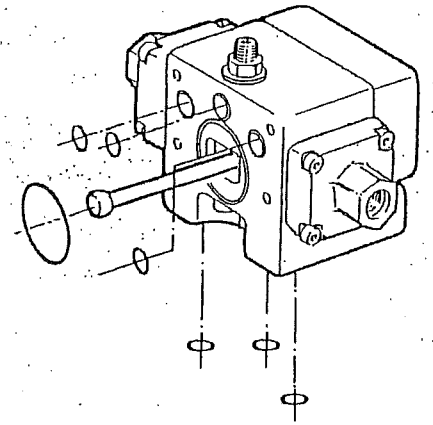
Remove control device.





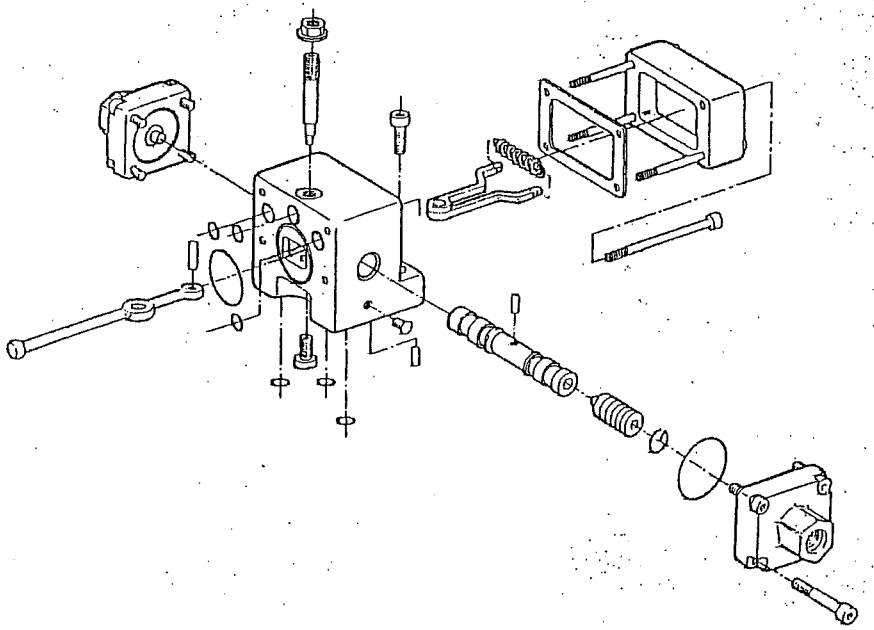
Kontrolle:
O-Ringe und Dichtung.

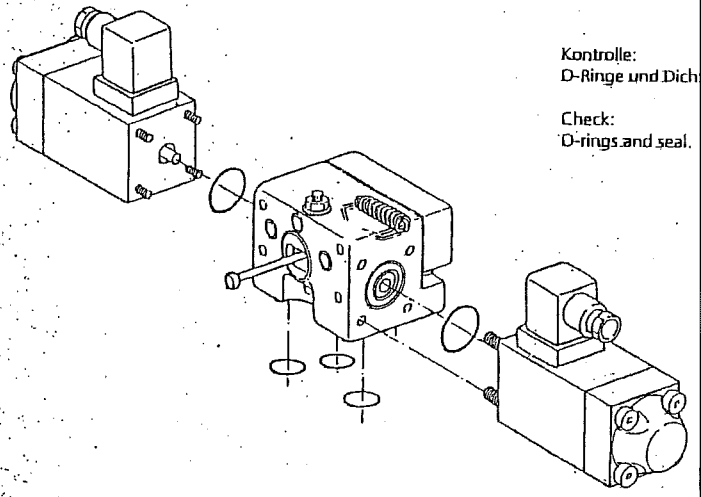
Check:
O-rings and seal.



Kontrolle:
O-Ringe

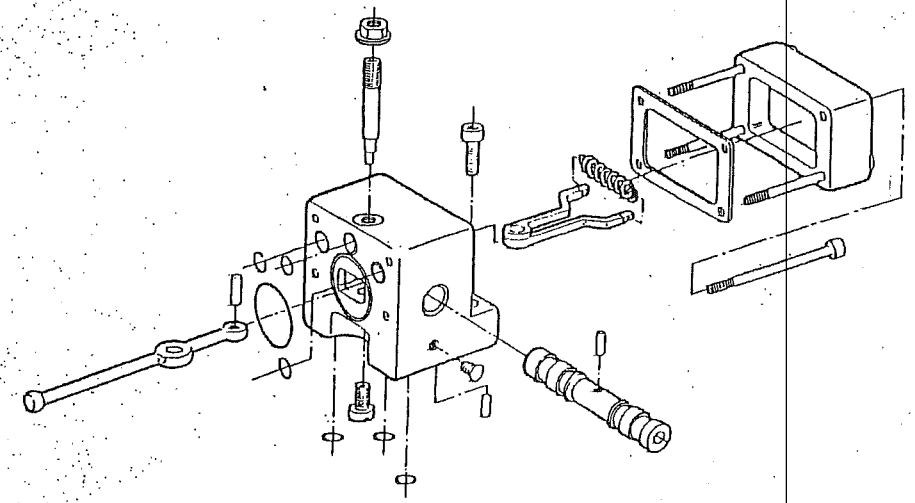
Check:
O-rings

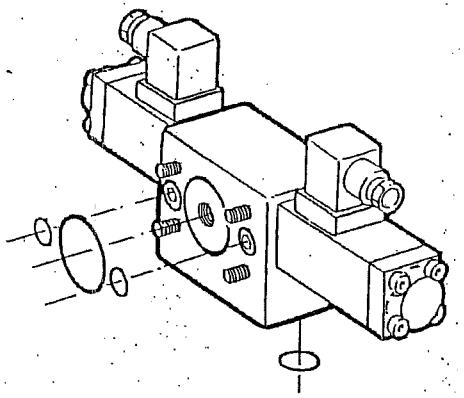




Kontrolle:
O-Ringe und Dichtung.

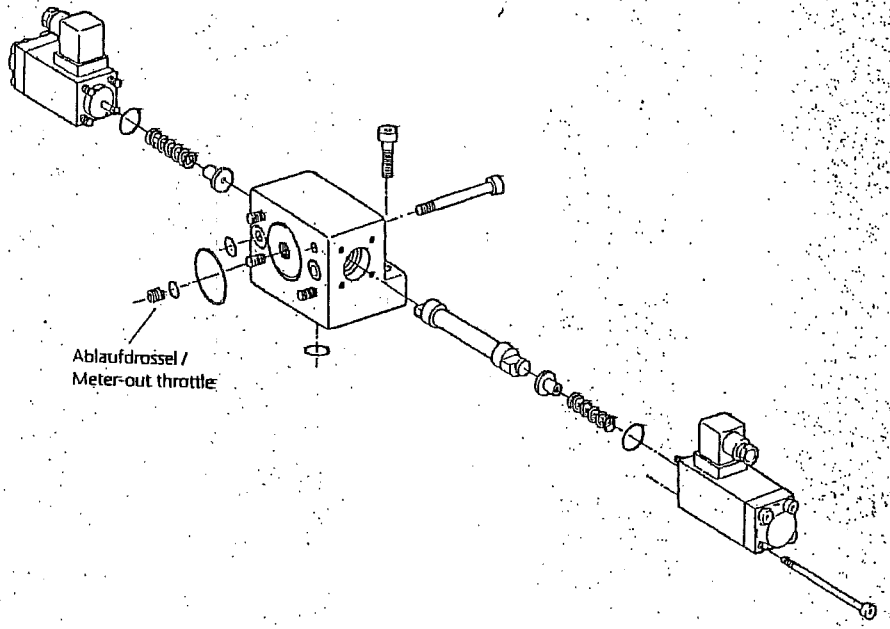
Check:
O-rings and seal.

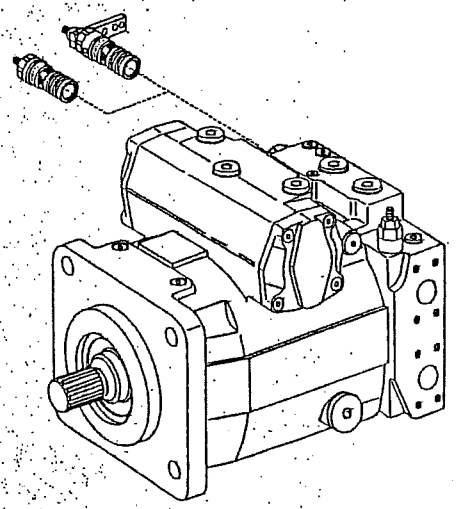




Kontrolle:
O-Ringe

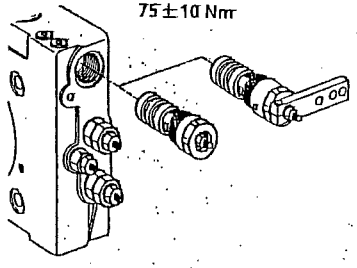
Check:
O-rings

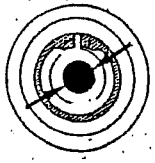




Anziehdrehmoment /
Tightening torque

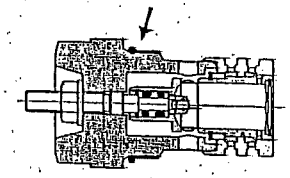
75±10 Nm





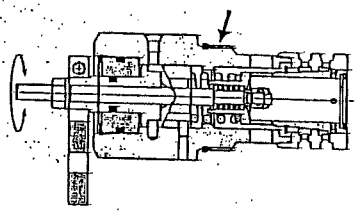
Blende überprüfen.
Keine Beschädigung.

Inspect orifice.
No damage.



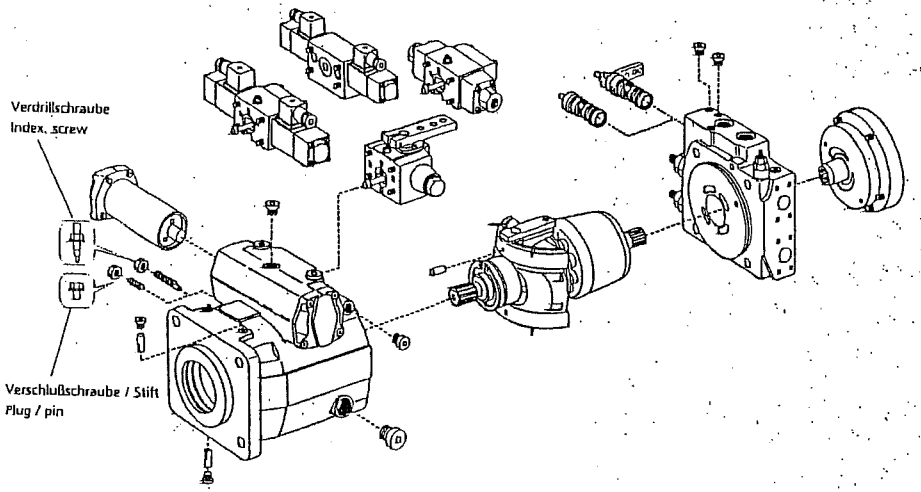
DA-Ventil ohne Hebel
Gewinde abkleben.
O-Ring einsetzen.

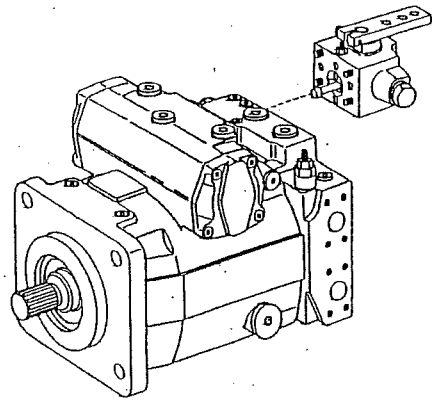
DA valve without lever.
Tape up thread.
Fit O-ring.



DA-Ventil mit Hebel.
Gewinde abkleben.
O-Ring einsetzen.
(Umbau Drehrichtung siehe Serviceinfo).

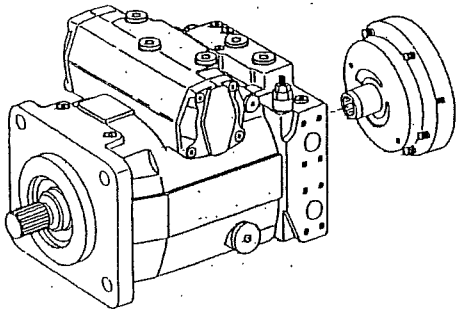
DA valve with lever.
Tape up thread.
Fit O-ring.
(Direction of rotation see service info).





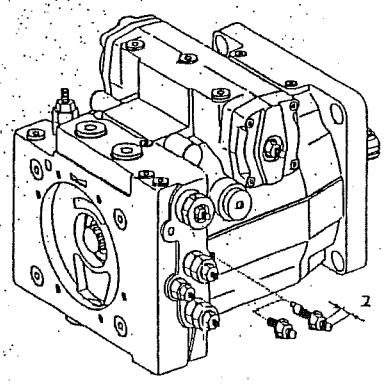
Ansteuergerät abbauen.

Remove control device.



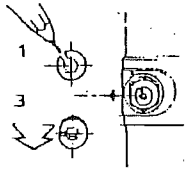
Hilfspumpe ausbauen.
Hinweis:
Einbaulage kennzeichnen.

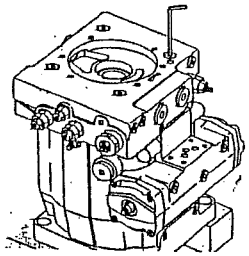
Remove boost pump.
Note:
Mark assembly location.



Lage der Verdrillschraube markieren (1).
Einstellmaß festhalten (2).
Verdrillschraube auf Demontageposition stellen (3).

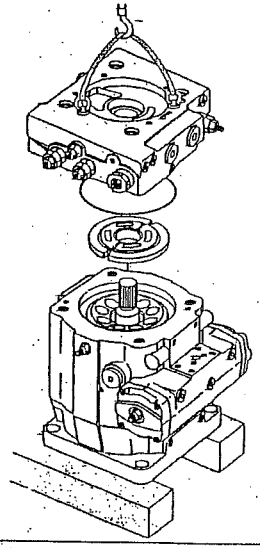
Mark the position of the indexing screw (1).
Record setting dimension (2).
Set the indexing screw to disassembly position (3).





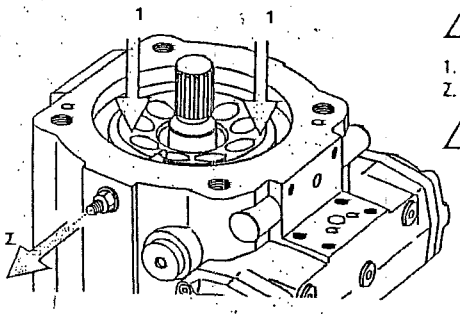
Lage der Hilfspumpe und Anschlußplatte markieren.
Anschlußplattenbefestigung lösen.

Mark position of the boost pump and connection plate.
Loosen connection plate bolts.



Anschlußplatte und Steuerplatte abheben.

Lift off port plate and control plate.

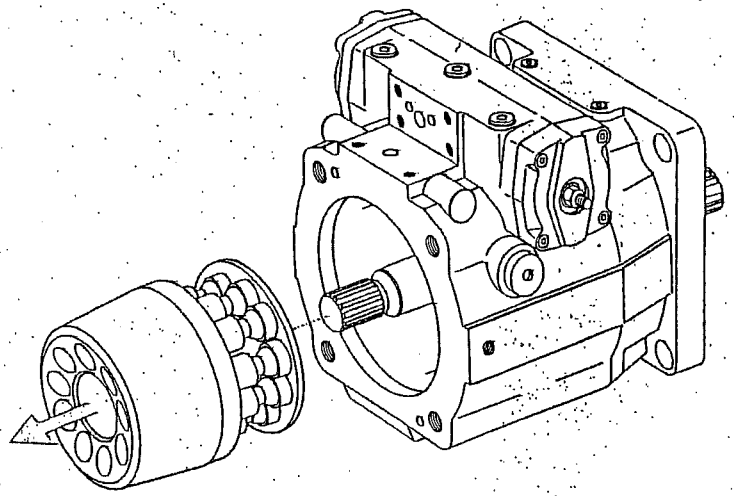


1. Zylinder nach unten drücken.
2. Verdrillschraube herausdrehen.

⚠ Zylinderfläche nicht beschädigen!

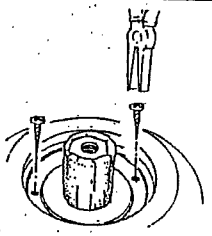
1. Press the cylinder downwards.
2. Remove fixing indexing screw.

⚠ Do not damage the cylinder surface!



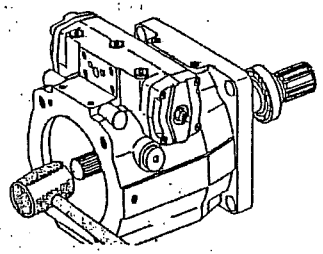
Zylinder komplett mit Kolben und Rückzugeinrichtung ausbauen.

Remove the cylinder with pistons and retaining system.



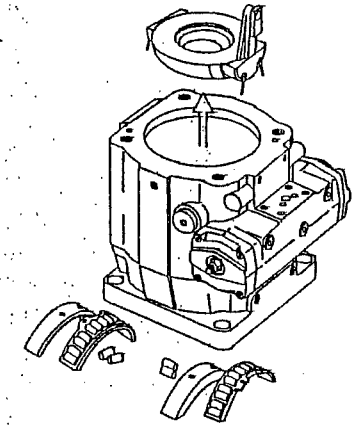
Seegerring / WDR ausbauen.

Remove Seeger-ring and shaft seal.



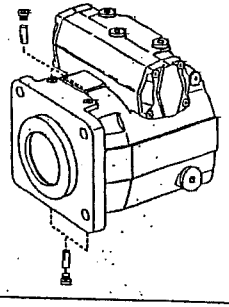
Triebwelle mit leichten Hammerschlägen austreiben.

Remove drive shaft with light hammer strokes.



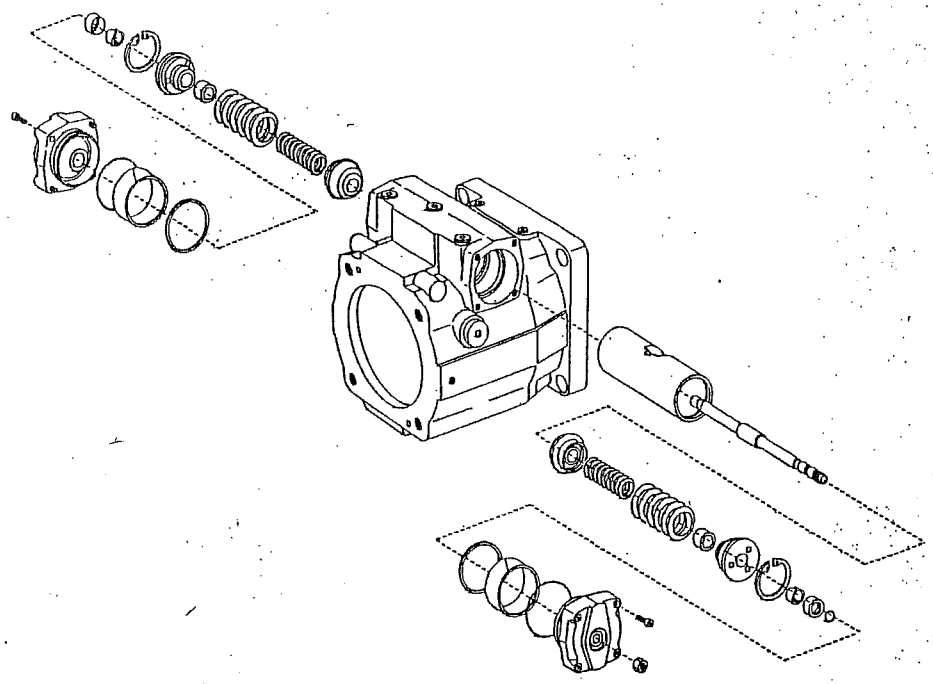
Schwenkwiege / Lager komplett ausbauen.

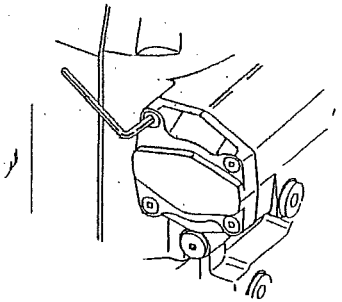
Remove swash plate / bearings.



Gelenkstifte ausbauen.

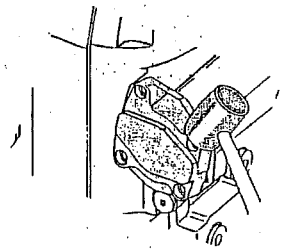
Remove the swivel.





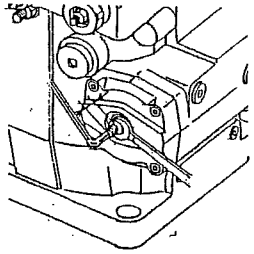
Befestigungsschrauben lösen.

Loosen fixing screws.



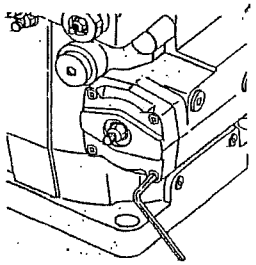
Deckel verdrehen und mit leichten Hammerschlägen lösen.

Rotate cover and release by tapping gently with hammer.



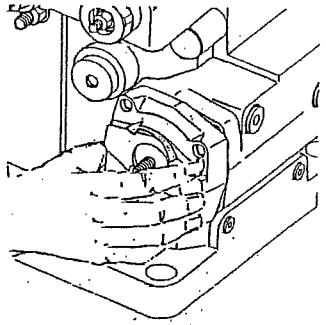
Deckel kennzeichnen. Maß festhalten, Kontermutter lösen, Stellschraube gegenhalten.

Mark cover. Dimension must be held, loosen lock nut, hold adjustment screw.



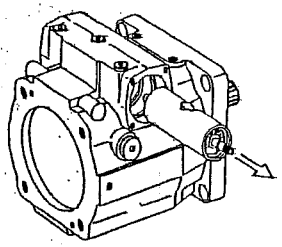
Befestigungsschrauben ausbauen.

Remove fixing screws.



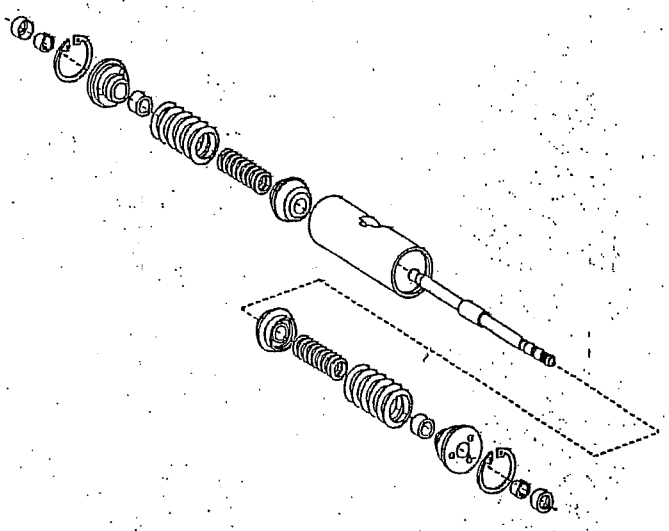
Deckel mit Stellschraube "abdrehen".

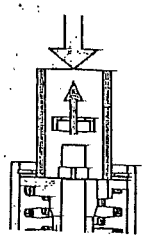
Lift off by turning the setting screw.



Stellzylinder ausbauen.

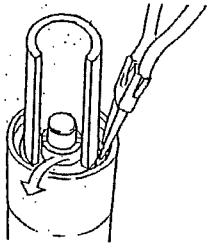
Remove positioning cylinder.





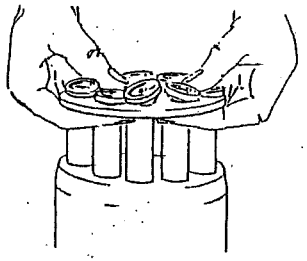
Vorrichtung aufsetzen und Feder vorspannen.
Sicherungskappe ausbauen.

Fit tool device and preload spring.
Remove safety cap.



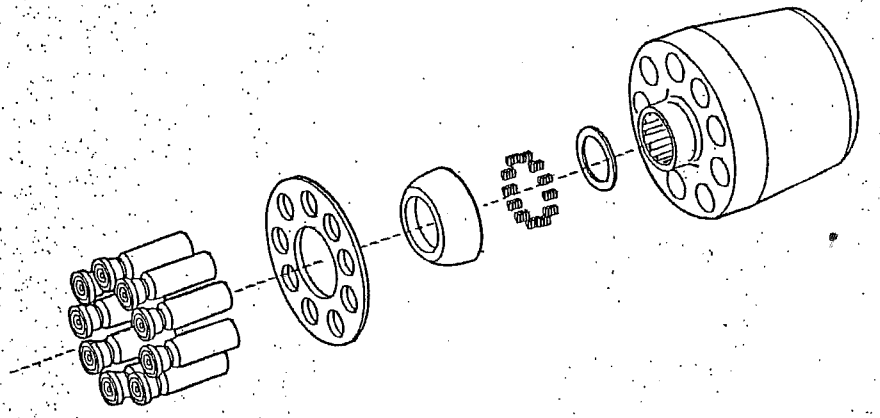
Ringe ausbauen.
Sicherungsring ausbauen.
Achtung: Teile stehen unter Federvorspannung.

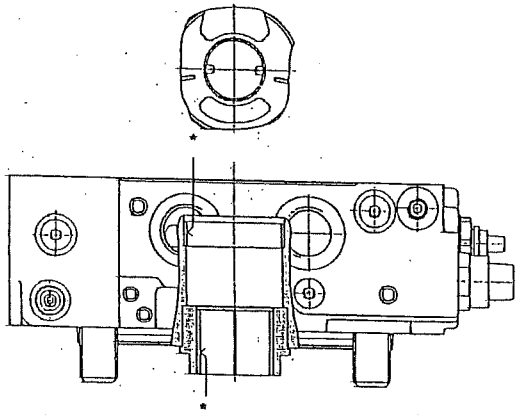
Remove rings.
Remove circlip.
Attention: Parts are under spring load.



Kolben mit Rückzugeinrichtung ausbauen.
Rückzugkugel mit Druckfedern abheben.

Remove piston with retaining plate.
Remove retaining ball complete with the compression springs.





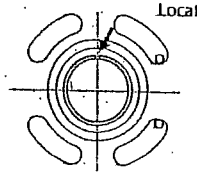
* Lagerbuchse kontrollieren.

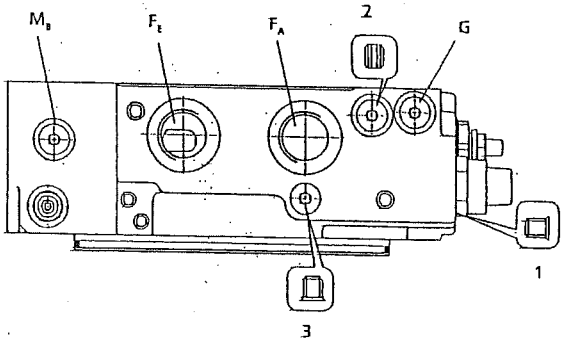
Bei Austausch der Lagerbuchsen Einbaulage beachten!

* Check bearing bush.

Take the installation attitude into account when changing the bearing bushes.

Lage der Trennfuge /
Location of the dividing groove

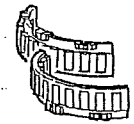




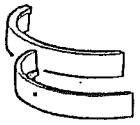
G: Meßstelle Speisedruck / Boost pressure test point
F_A: Filterausgang / Filter outlet
F_E: Filtereingang / Filter inlet
M_A: Meßstelle / Test point
M_A: Meßstelle HD / Test point HD

1 Verschlußstopfen bei Druckfilterung / Plug with pressure filtration
2 Düse für Vorsteuerung / Orifice for pilot control
3 Bei DA-Steuerung kein Verschlußstopfen / With DA control, plug is not fitted.

Lager
Bearing

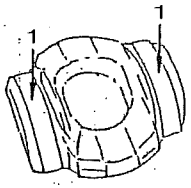


Lagerschalen
Bearing cup



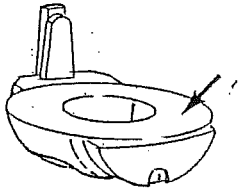
Kontrolle!
Käfig-Paar (1),
Lagerschalenpaar (2).

Check!
Cage set (1),
Bearing cup set (2).



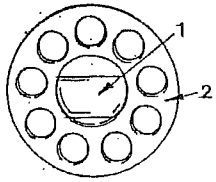
Kontrolle!
Lagerbahnen (1)

Check!
Bearing surfaces (1)



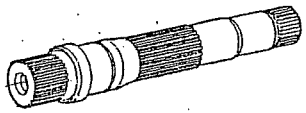
Kontrolle!
Gleitfläche riefenfrei.

Check!
Sliding surface free from scoring.



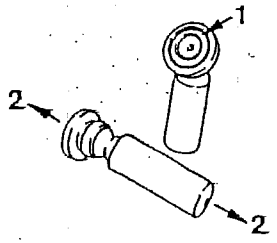
Kontrolle!
Rückzugeinrichtung riefenfrei.

Check!
Check that return device is free of scoring.



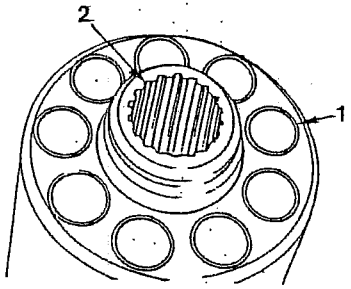
Kontrolle!
1. Verzahnung "ausgeschlagen", Passungsrost.
2. Laufflächen.
3. Lauffläche - Wellendichtring.

Check!
1. Splines for damage or fretting.
2. Running surfaces.
3. Running surface - shaft seal.



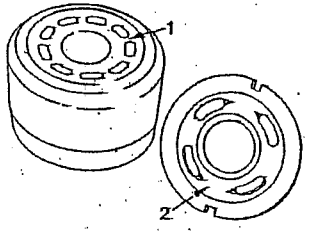
Kontrolle!
Lauffläche (1) keine Kratzer, keine Metalleinlagerungen,
kein Axialspiel (2), (Kolben nur satzweise tauschen).

Check!
Check that there are no scratches or metal deposits on the sliding surface (1), and there is no axial play (2), (otherwise: pistons must only be replaced in sets).



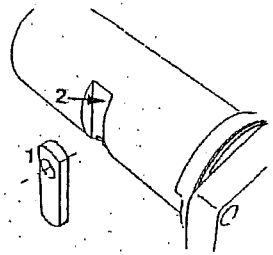
Kontrolle!
Zylinderbohrungen (1), Verzahnungen (2).

Check!
Cylinder bores (1), splines (2).



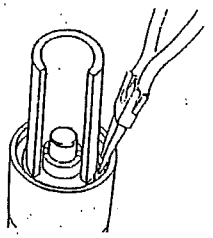
Kontrolle!
Zylindergleitfläche (1) riefenfrei.
Steuerplatte (2) nicht riefig.

Check!
Cylinder sliding surface (1) free of scoring.
Control plate (2) without scoring.



Kontrolle!
Stellkolben - Schwenkwiegenverbindung
Gleitstein (1), Nut im Stellkolben (2), Stellkolben.

Check!
Positioning piston - swivel linkage connection
Gliding stone (1), groove in the positioning piston (2).
Positioning piston.



Stellkolben montieren.
Hinweis:
Auf korrekten Sitz der geteilten Ringe achten".

Assemble positioning piston.
Note:
Take care that the divided rings are correctly located.

Gehäuse - Turcon-Glyd-Ring montieren / Assemble housing - Turcon-Glyd-ring

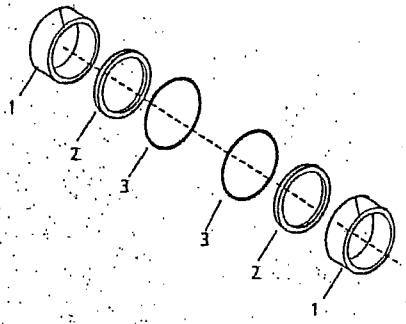
Hilfswerkzeuge / Auxiliary tools:

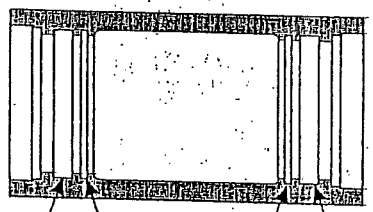
Montagezange / Assembly pliers: B+S x M22

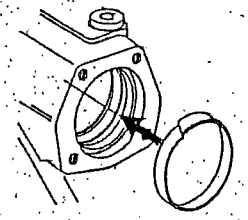
Führungsdorn / Guide pin:

A4VG28	I: 277 4 347
A4VG40	I: 277 4 049
A4VG56	I: 277 4 050
A4VG71	I: 277 4 051
A4VG90	I: 277 4 052
A4VG125	I: 277 4 053
A4VG180	I: 277 4 054
A4VG250	I: 277 4 072

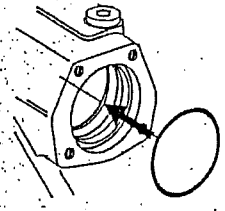
Montage / Assembly A4VG





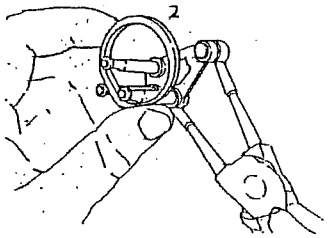


Pos. / Item 1: Stangenführungsring montieren.
Fit rod guide ring.



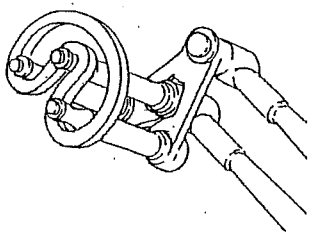
Pos. / Item 3: O-Ring montieren.
Install O-ring.

Gehäuse - Turcon-Glyd-Ring montieren / Assemble housing - Turcon-Glyd-ring



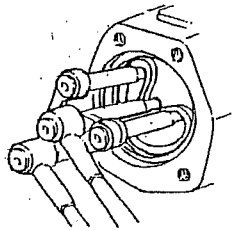
Dichtring (Pos. 2) in die Montagezange einlegen.

Fit the seal ring (Item 2) into the assembly tool.



Dichtring mit Zangenschenkel nierenförmig zusammendrücken. Die Verformung von Turcon-Dichtungen ist sorgfältig vorzunehmen, damit die Dichtkanten nicht beschädigt werden.

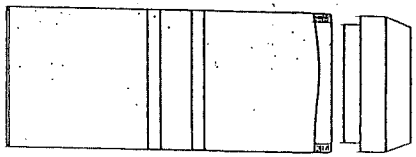
Press the seal ring into the kidney shape using the assembly tool. The deformation of the Turcon seal has to be done with care so as not to damage the sealing edges.



Dichtring ins Gehäuse einführen und in der Aufnahmenut plazieren. Dann Spannung lösen und Montagezange herausziehen.
Lage des Dichtringes prüfen - eventuell mit dem Finger egalisieren.

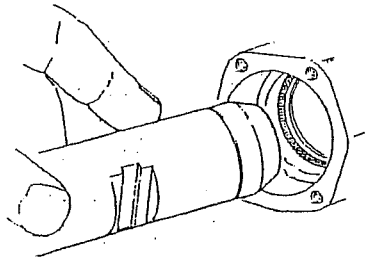
Position the seal ring into the housing and place it into the groove. Release the tension and withdraw the assembly tool.

Check the location of the seal ring, if necessary press into place.



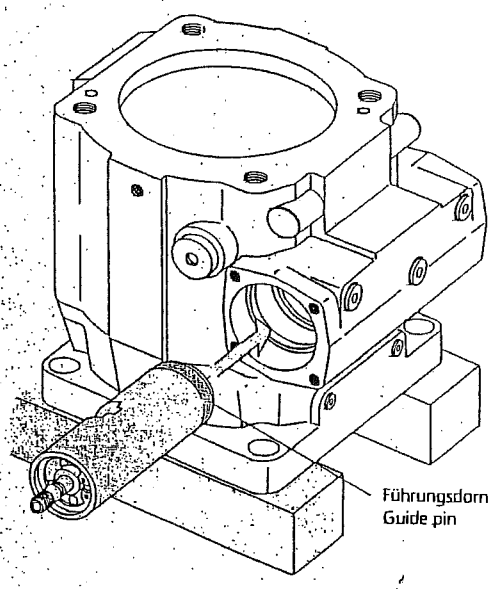
Führungsdorn in Stellkolben einbauen.

Insert guide pin into the positioning piston.



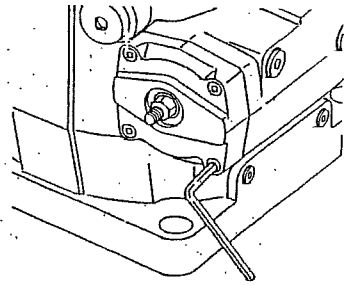
Führungsdorn leicht einfetten.
Stellkolben mit Führungsdorn einbauen.

Grease slightly guide pin.
Install positioning piston with guide pin.



Stellkolben mit Führungsdorn ins Gehäuse einsetzen.
Hinweis:
Stellkolben vor Einbau einölen.

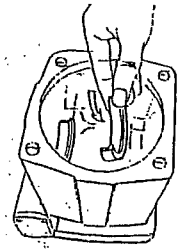
Insert positioning piston with guide pin into the housing.
Note:
Oil positioning piston before assembly.



1. Deckel montieren.
2. Nullage nach Maß einstellen.
Achtung!
Korrekte mechanische 0-Lageneinstellung überprüfen!

1. Assemble cover.
2. Adjust zero position to the recorded measurement.
Attention!
Check correct mechanical 0-position.

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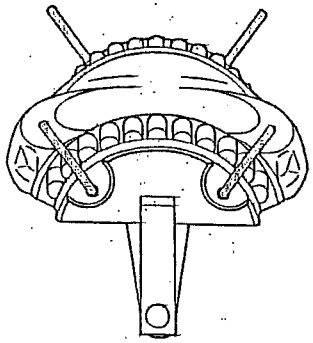


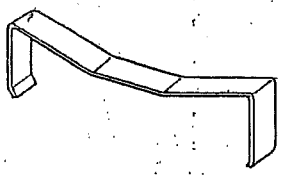
Lagerschalenpaar einsetzen.

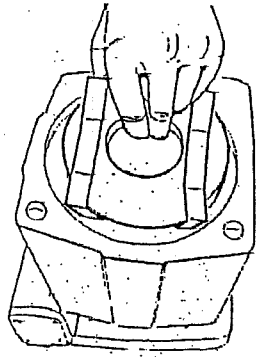
Insert bearing cup set.

Lager, Draht, Gleitstein und Gelenkstift montieren.
Montagehilfe: z.B. - Klammer

Assemble bearing, wire, glding stone and articulating pin.
Assistance: Devices e.g. - Clamp





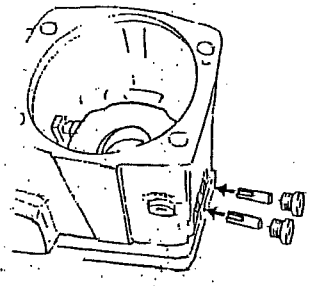


Schwenkwiege komplett ins Gehäuse einsetzen.
Auf korrekten Sitz der Schwenklager im Gehäuse achten".

⚠ Montagehilfe ausbauen.

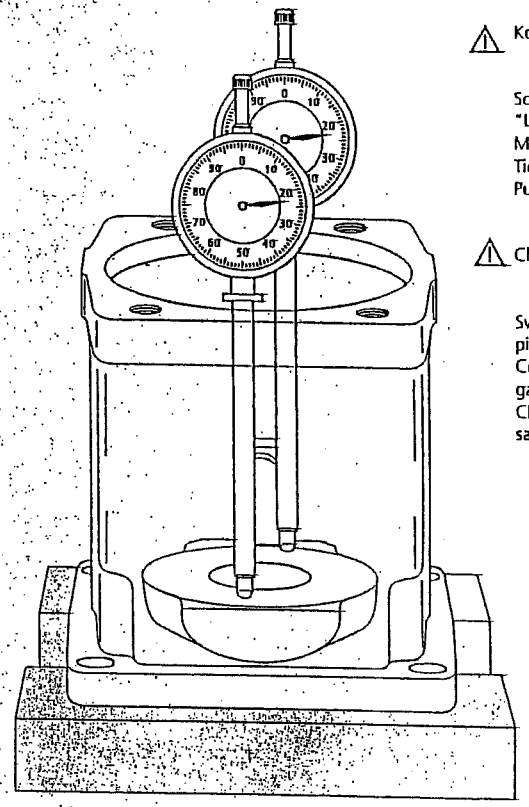
Insert completely swivel cradle into the housing.
Pay attention for correct seat of the swivel cradle in the housing.

⚠ Remove auxiliary device.



Gelenkstifte montieren.
Draht muß im Gelenkstift geführt sein.
⚠ Kontrolle: Mit Schraubendreher auf Verdrehwiderstand prüfen.

Fit swivel pins.
Wire must be fitted into the swivel pins.
⚠ Check: Use a screw driver to check the rotation resistance.

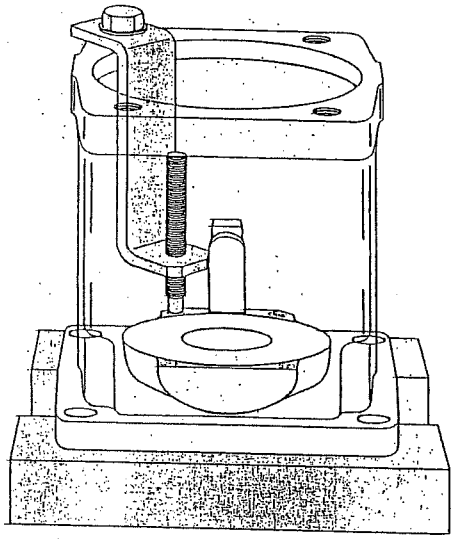


⚠ Kontrolle: Sitz der Schwenklager in der Lagerbahn.

Schwenkwiege mit Stellkolben verschwenken "Leichtgängig".
Mittig stellen mit Meßvorrichtung (Uhr oder Tiefenmaß)
Punkt 1 und 2 kontrollieren - gleiches Maß.

⚠ Check: Location of the swivel-bearing in the bearing.

Swivel the swivel bearing by using the control piston "it should move easily".
Centralise by using a measuring device (dial gauge or depth measurement).
Check points 1 and 2 - they should have the same dimension.



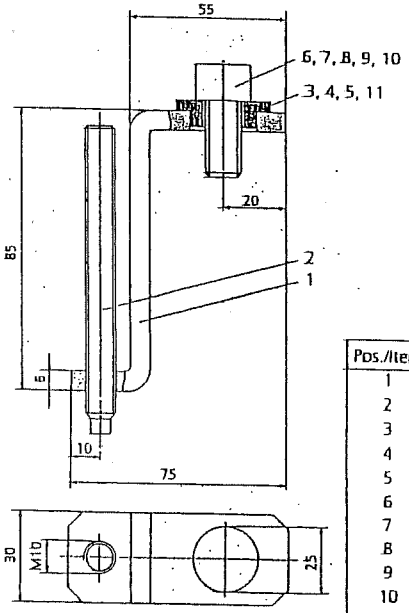
Haltevorrichtung montieren.
Mit Gewindestift Schwenkwiege festhalten.

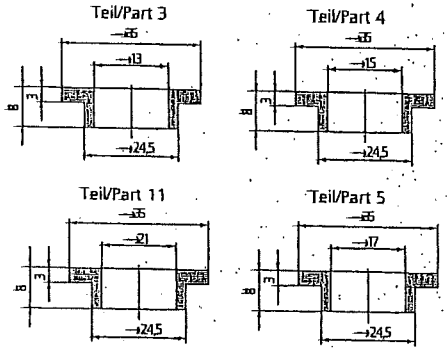
⚠ Keine Gewaltanwendung.

Fit holding device.
Hold swash plate in position utilising the set screw.

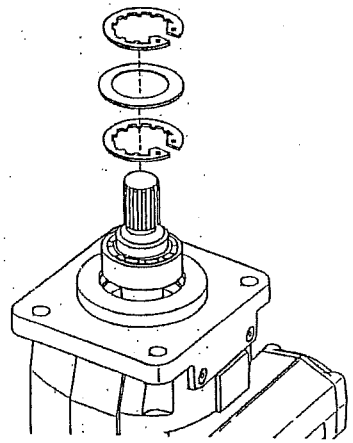
⚠ Do not use force.

Haltevorrichtung "Schwenkwiege" A4V
Holding device "swivel cradle" A4V



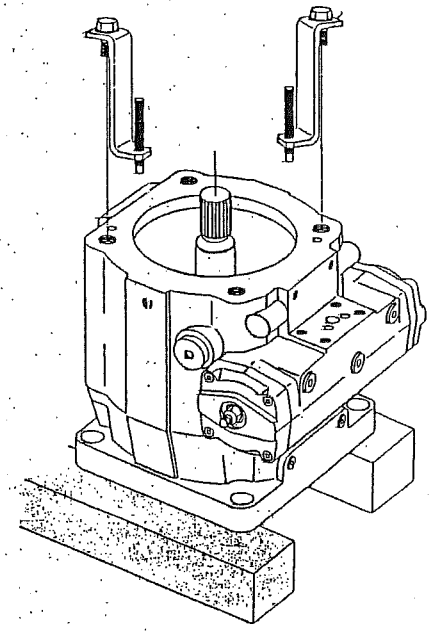


Pos./Item	Benennung/Designation	Stck./Qty.
1	Winkel/Angle	2
2	Gewindestift/Threaded pin	2
3	Scheibe/Shim	2
4	Scheibe/Shim	2
5	Scheibe/Shim	2
6	Zyl. Schraube/Cyl. screw M12 x 25 DIN 912	2
7	Zyl. Schraube/Cyl. screw M14 x 25 DIN 912	2
8	Zyl. Schraube/Cyl. screw M16 x 30 DIN 912	2
9	Zyl. Schraube/Cyl. screw M20 x 35 DIN 912	2
10	Zyl. Schraube/Cyl. screw M24 x 35 DIN 912	2
11	Scheibe/Shim	2



Neue Montageposition!
Triebwelle mit Lager und Wellendichtring einbauen.

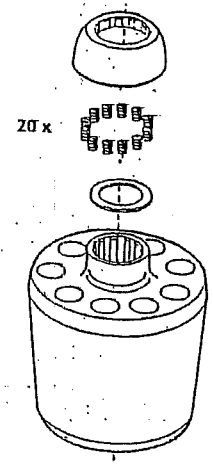
New assembly position!
Assemble drive shaft with bearings and shaft seal.



Vorrichtung ausbauen.
Zylinder mit Kolben und Rückzugseinrichtung einbauen.

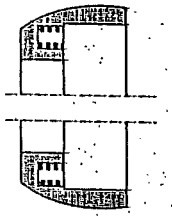
Remove holding device.
Fit cylinder complete with pistons and retaining device.

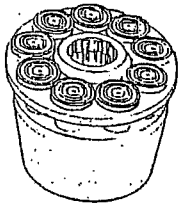
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Abstimmscheibe, Federn und Rückzugkugel montieren.
Hinweis: Richtige Einbaulage beachten*.
Federn mit Fett einsetzen
Triebwerksabstimmung siehe Service Info.

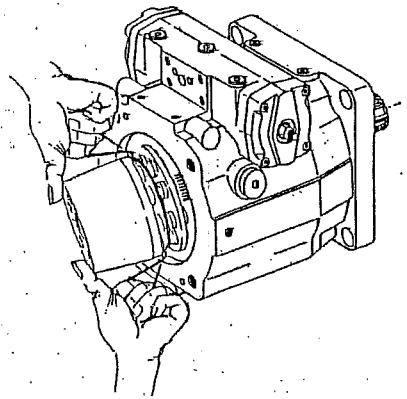
Fit shims, springs and retaining ball.
Note: Ensure that the orientation is correct *.
Hold the springs in place using grease.
For rotary group matching see Service information.





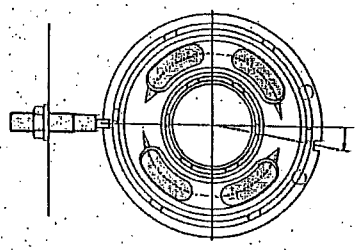
Rückzugeinrichtung mit Kolben in Zylinder montieren.
Verzahnung Rückzugkugel / Zylinder ausrichten.

Fit retaining unit with pistons into the cylinder.
Align the splines of retaining ball / cylinder.



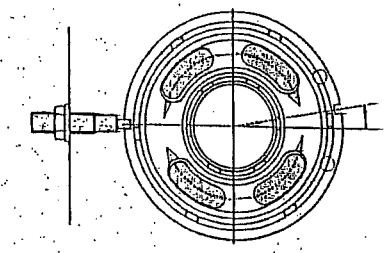
Montagehilfe:
Mit O-Ring über Kolben Rückzugeinrichtung festhalten.
Lauffläche Schwenkwiege leicht einölen.
Zylinder mit Kolben-Gleitschuh in waagrechter Position einsetzen.
Federn in der Rückzugkugel können ausrasten.

Assembly aid:
Hold retaining system in place using an O-ring over the pistons.
Lightly oil the swivel plate running surface.
Fit the cylinder with pistons - slipper pads in the horizontal position.
Springs in the retaining ball can jump out.



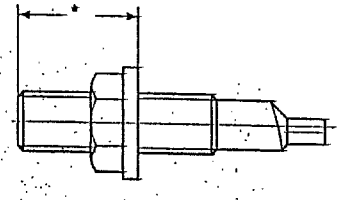
Steuerplatte Rechtslauf - in Drehrichtung verdreht.
Achtung!
Geräuschkerben sind drehrichtungsbezogen eingeschliffen.

Control plate clockwise rotation - indexed in the direction of rotation.
Note!
Noise grooves are machined - based on direction of rotation.



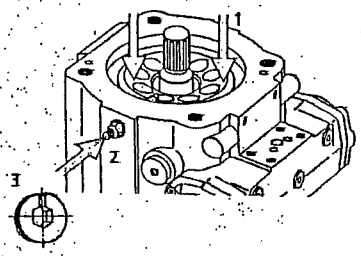
Steuerplatte Linkslauf - in Drehrichtung verdreht.
Achtung!
Geräuschkerben sind drehrichtungsbezogen eingeschliffen.

Control plate counter clockwise rotation - indexed in the direction of rotation.
Note!
Noise grooves are machined - based on direction of rotation.



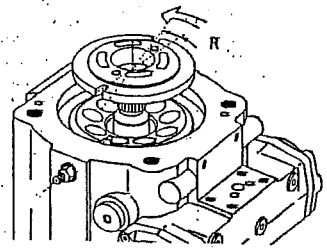
Grundeinstellung - Verdrillschraube
A4VG...250 * = 25 ± 0,75 mm

Basic setting - indexing screw
A4VG...250 * = 25 ± 0,75 mm



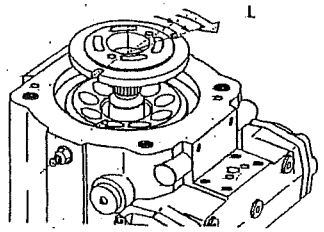
Zylinder nach unten drücken (1).
Verdrillschraube einbauen (2).
Kerbe in Montageposition.

Press the cylinder downwards (1).
Screw in the indexing screw (2).
Groove in assembly position.



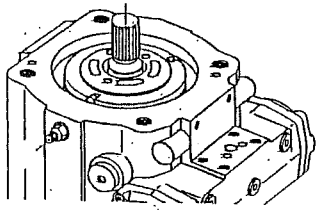
Steuerplatte einsetzen - Rechtslauf.

Insert the control plate - clockwise rotation.



Steuerplatte einsetzen - Linkslauf.

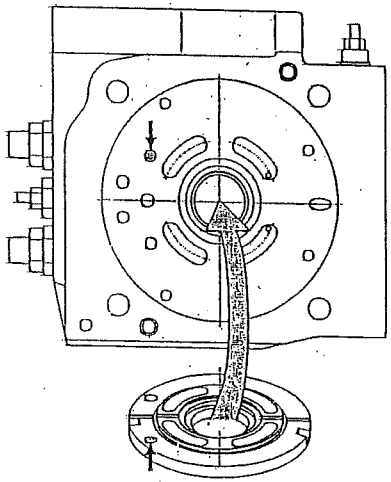
Insert the control plate - Anti-clockwise rotation.



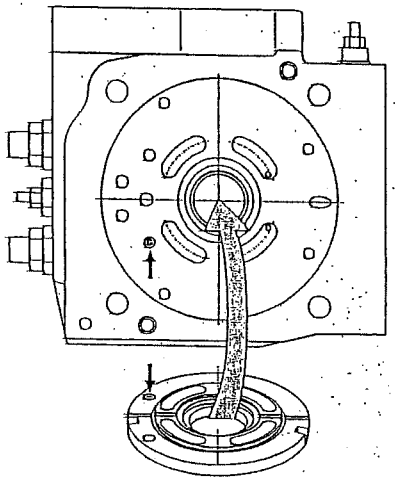
Beispiel: Linkslauf

Example: anti-clockwise rotation

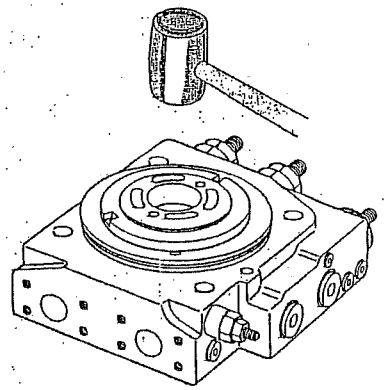
Steuerplatte EP, HD, HW usw.
Control plate EP, HD, HW etc.



Rechtslauf / Clockwise

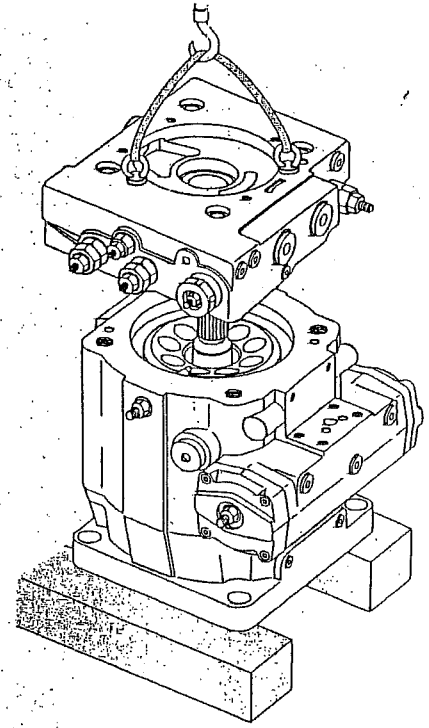


Linkslauf / Anti-clockwise



Steuerplatte mit Fett einsetzen.
Montagehilfe: Mit Softhammer Steuerplatte auf Anschlußplatte zentrieren.
⚠ Nut für Excenterschraube ausrichten

Fit the control plate using grease.
Assembly aid: Centralise the control plate on the connection plate by using a soft hammer.
⚠ Position the screw for the eccentric screw.

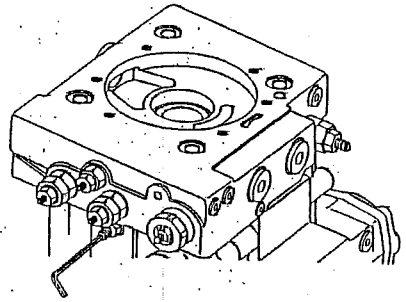


Neue Montageposition:
Vorsicht: Steuerplatte ist nur mit Fett angeklebt!

Anschlußplatte aufbauen.
Achtung! Federvorspannung!
Mit zwei Befestigungsschrauben überkreuz Anschlußplatte in Gehäuseführung einsetzen.
⚠ Steuerplatten - Nut → Excenterschraube

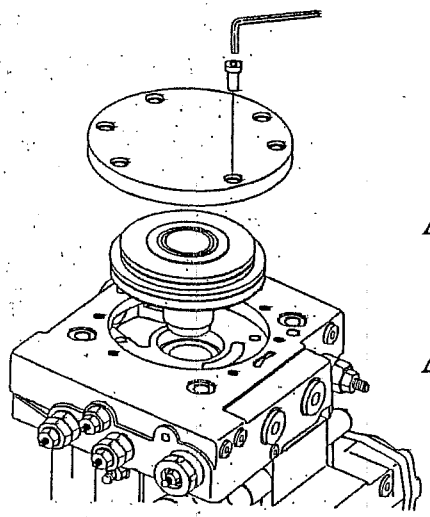
New assembly position:
Note: The control plate is only held in position by the grease!

Assemble connection plate.
Attention! Spring preloaded!
Insert control plate into housing, guidance with two fixing screws crossed over from each other.
⚠ Control plate - groove → eccentric screw



Bei DA-Ausführung: Verdrillschraube nach Markierung ausrichten.

DA-Design: Position the indexing screw to the location mark.



Hilfspumpe montieren.

⚠ Einbaulage für Drehrichtung beachten!
Siehe Seite xx.

Assemble boost pump.

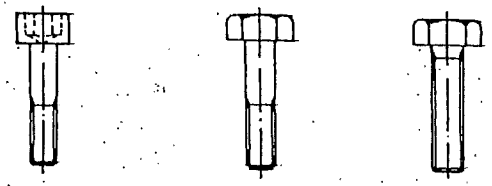
⚠ Take the installation orientation, for direction of rotation, into account.
See page xx.

1. Schaftschrauben (nach N 08.001)

Die Werte gelten für Schaftschrauben mit metrischem ISO-Gewinde nach DIN 13 Teil 13, sowie Kopfauflagemaßen nach DIN 912 Zylinderschrauben, DIN 931 Sechskantschrauben mit Schaft bzw. DIN 933 Sechskantschrauben mit Gewinde bis Kopf.

1. Bolts (to N 08.001)

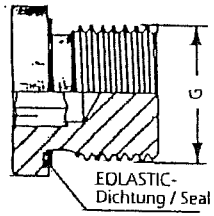
The values stated are valid for bolts with metric ISO threads to DIN 13 part 13, as well as head areas to DIN 912 socked head cap screws, DIN 931 hexagon bolt or DIN 933 hexagon bolts with threads up to the head.



Gewinde / Thread	Festigkeitsklassen / Tensile strength class		
	8.8	10.9	12.9
	Anziehdrehmoment / Tightening torque M_A in Nm		
M 3	1,1	1,6	1,9
M 4	3,1	4,5	5,3
M 5	6,1	8,9	10,4
M 6	10,4	15,5	18
M 8	25	37	43
M 10	51	75	87
M 12	87	130	150
M 14	140	205	240
M 16	215	310	370
M 18	300	430	510
M 20	430	620	720
M 22	580	830	970
M 24	740	1060	1240

2. Verschlußschrauben mit Innensechskant und Profildichtring (nach N 02.009).

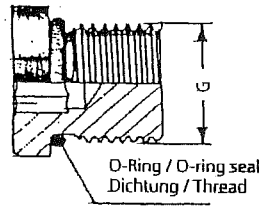
2. Plugs with internal hexagon and profile seal ring (to N 02.009).



Gewinde / Thread	Anziehdrehmoment / Tightening torque M_A in Nm	Gewinde / Thread	Anziehdrehmoment Tightening torque M_A in Nm
M8 x 1	5	G 1/8 A	10
M10 x 1	10	G 1/4 A	30
M12 x 1,5	20	G 3/8 A	35
M14 x 1,5	30	G 1/2 A	60
M16 x 1,5	35	G 3/4 A	90
M18 x 1,5	40	G 1 A	140
M20 x 1,5	50	G 1 1/4 A	240
M22 x 1,5	60	G 1 1/2 A	300
M26 x 1,5	70		
M27 x 2	90		
M30 x 1,5	100		
M33 x 2	140		
M42 x 2	240		
M48 x 2	300		

5. Verschlußschrauben mit Innensechskant, O-Ring und UNF-, UN-Gewinde nach SAE J 514 (nach N 02.106)

5. Plugs with internal hexagon, O-ring and UNF-, UN- threads to SAE J 514 (nach N 02.106)

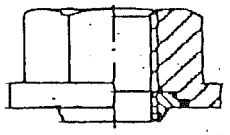


Gewinde / Thread	Anziehdrehmoment M_A in Nm Tightening torque M_A in Nm	Gewinde / Thread	Anziehdrehmoment M_A in Nm Tightening torque M_A in Nm
7/16 - 20 UNF	15	M12 x 1,5	20
1/2 - 20 UNF	20	M14 x 1,5	30
9/16 - 18 UNF	25	M27 x 1,5	90
3/4 - 16 UNF	72		
7/8 - 14 UN	127		
1 1/16 - 12 UN	147		
1 3/16 - 12 UN	173		
1 5/16 - 12 UN	198		
1 5/8 - 12 UN	320		
1 7/8 - 12 UN	390		

6. SEAL-LOCK-Dichtmuttern (nach N 02.100)

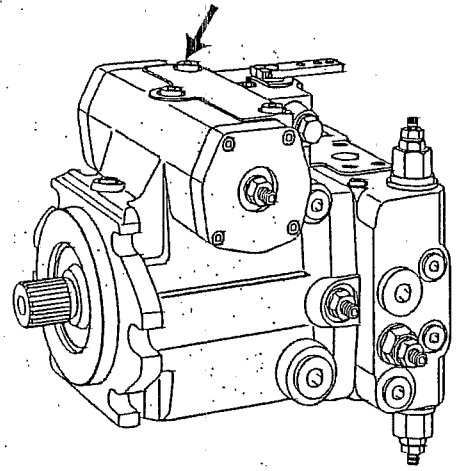
6. SEAL-LOCK-sealing nuts (to N 02.100)

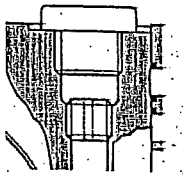
Gewinde / Thread	Anziehdrehmoment M_A in Nm Tightening torque M_A in Nm
M6	10
M6 x 0,5	11
M8	22
M8 x 1	24
M10	40
M10 x 1	44
M12	69
M12 x 1,5	72
M14	110
M14 x 1,5	120
M16	170
M16 x 1,5	180

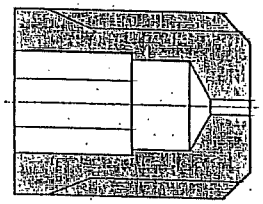


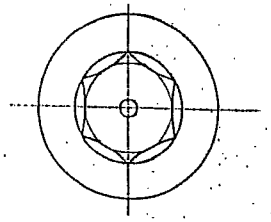
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A4V – Düsen / orifices









Gewinde / Thread	Anziehdrehmomente Nm / Tightening torques Nm	
	bisher / up to	neu / new
M6	6,5	3
M10	28	12

Allgemein

- Machen Sie sich mit der Ausstattung der Maschine vertraut.
- Fahren Sie die Maschine nur, wenn Sie sich völlig mit den Bedien- und Steuerelementen sowie der Arbeitsweise der Maschine vertraut gemacht haben.
- Benutzen Sie Ihre Schutzausrüstung wie Schutzhelm, Sicherheitsschuhe und Gehörschutz.
- Machen Sie sich mit Ihrem Arbeitsgebiet vertraut.
- Benutzen Sie die Maschine nur für den ihr zugedachten Zweck.

Beachten Sie bitte die Richtlinien der Berufsgenossenschaft und des Maschinenherstellers.



Vor dem Start

- Beachten Sie die Bedienungshinweise vor dem Starten.
- Prüfen Sie die Maschine auf auffällige Fehler.
- Fahren Sie die Maschine nicht mit defekten Instrumenten, Kontrolleuchten oder Steuerorganen.
- Alle Schutzvorrichtungen müssen fest auf ihrem Platz sein.
- Nehmen Sie keine losen Gegenstände mit bzw. befestigen Sie diese an der Maschine.
- Halten Sie die Maschine von öligem und zündfähigem Material frei.
- Prüfen Sie vor dem Besteigen der Maschine, ob sich Personen oder Hindernisse neben oder unter der Maschine befinden.
- Vorsicht beim Besteigen der Maschine, benützen Sie Treppen und Griffe.
- Stellen Sie vor dem Start Ihren Sitz ein.

General advice

- Make yourself familiar with the equipment on the machine.
- Only operate the machine if your are completely familiar with the operating and control elements as well as the functions of the machine.
- Use your safety equipment such as helmet, safety shoes and hearing protection.
- Make yourself familiar with your working field.
- Only operate the machine for its intended purpose.

Please observe the guidelines of the Professional Association and the machine manufacturer.



Before starting

- Observe the operating instructions before starting.
- Check the machine for obvious faults.
- Do not operate the machine with defective instruments, warning lights or control elements.
- All safety devices must be fixed into position.
- Do not carry with you movable objects or secure them to the machine.
- Keep oily and inflammable material away from the machine.
- Before entering the driver's cabin, check if persons or obstacles are beside or beneath the machine.
- Be careful when entering the driver's cabin, use stairs and handles.
- Adjust your seat before starting.

Starten
- Beim Starten müssen alle Bedienhebel in "Neutralstellung" stehen.
- Die Maschine nur vom Fahrersitz aus Starten.
- Prüfen Sie die Anzeigeinstrumente nach dem Start, um sicher zu gehen, daß alles ordnungsgemäß funktioniert.
- Lassen Sie die Maschine nicht unbewacht, während der Motor läuft.
- Beim Start mit Batterieverbindungskabeln verbinden Sie Plus mit Plus und Minus mit Minus. Massekabel (Minus) immer zuletzt anschliesen und zuerst abtrennen.

Vorsicht
- Auspuffgase sind lebensgefährlich. Bei Start in geschlossenen Räumen für ausreichende Luftzufuhr sorgen!

Hydraulikanlage
1. Hydraulikanlage steht unter hohem Druck!

⚠ Unter hohem Druck austretende Hochdruck-Flüssigkeiten (Kraftstoff, Hydrauliköl) können die Haut durchdringen und schwere Verletzungen verursachen. Daher sofort einen Arzt aufsuchen, da anderenfalls schwere Infektionen entstehen können!

2. Bei der Suche nach Leckstellen wegen Verletzungsgefahr geeignete Hilfsmittel verwenden!
3. Vor Arbeiten an der Hydraulikanlage diese unbedingt drucklos machen und angebaute Geräte absenken!
4. Bei Arbeiten an der Hydraulikanlage unbedingt Motor abstellen und Maschine gegen Wegrollen sichern (Feststellbremse, Unterlegkeil)!
5. Beim Anschließen von Hydraulikzylindern und -motoren ist auf vorgeschriebenen Anschluß der Hydraulikschläuche zu achten!
6. Bei Vertauschen der Anschlüsse umgekehrte Funktionen (z.B. Heben/Senken) - Unfallgefahr!
7. Hydraulikschlauchleitungen regelmäßig kontrollieren und bei Beschädigung und Alterung austauschen! Die Austauschschlauchleitungen müssen den technischen Anforderungen des Geräteherstellers entsprechen!

⚠ Öle, Kraftstoffe und Filter ordnungsgemäß entsorgen!

Start
- When starting all operating levers must be in "neutral position".
- Only start the machine from the driver's seat
- Check the indicating instruments after start up to assure that all functions are in order.
- Do not leave the machine unobserved when the motor is running.
- When starting with battery connection cables connect plus with plus and minus with minus. Always connect negative (-) cable last and disconnect negative cable first.

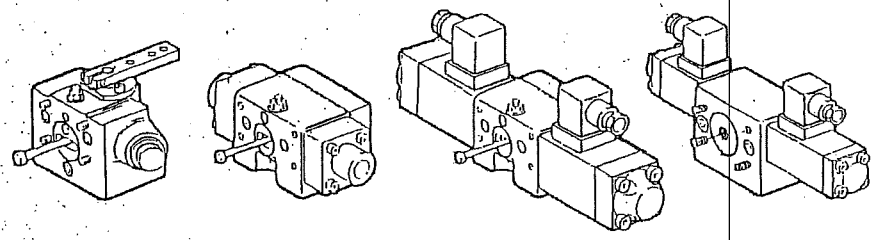
Attention
- Exhaust gas is dangerous. Assure that sufficient fresh air is avaiable when starting in closed rooms!

Hydraulic equipment
1. Hydraulic equipment is under high pressure.

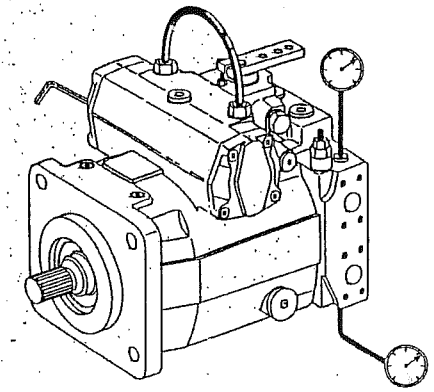
⚠ High pressure fluids (fuel, hydraulic oil) which escape under high pressure can penetrate the skin and cause serious injuries. Therefore immediately consult a doctor as otherwise serious infections can be caused.

2. When searching leakages use appropriate auxiliary devices because of the danger of accidents.
3. Before working at the hydraulic equipment, lower pressure to zero and lower working arms of the machine.
4. When working at the hydraulic equipment, you must stop the motor and secure machine against rolling away (parking brake, shim)!
5. When connecting hydraulic cylinders and motor pay attention to correct connection of hydraulic flexible hoses.
6. In case of exchanging the ports, the functions are vice versa (f. ex. lift-up/lower) - danger of accidents!
7. Check hydraulic flexible hoses regularly and replace them in case of damage or wear! The new hose pipes must comply with the technical requirements of the machine manufacturer!

⚠ Orderly disposal or recycling of oil, fuel and filters!

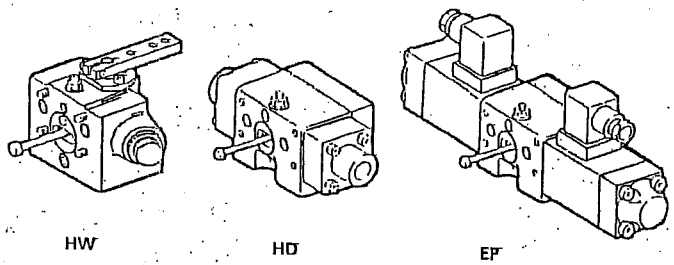


HW HD EP DA



Achtung!
Sicherheitsbestimmungen beachten!
Mit Schlauch NW6 beide Stellkammern verbinden. Vermeidung von Restsignal aus hydraulischer Nullage.
Manometer an M_A und M_B anschließen.
Nullage so einstellen, daß bei blockiertem Antrieb beide Manometer auf gleichem Druckwert stehen.
Hinweis:
Totband der Nullage - vermitteln.

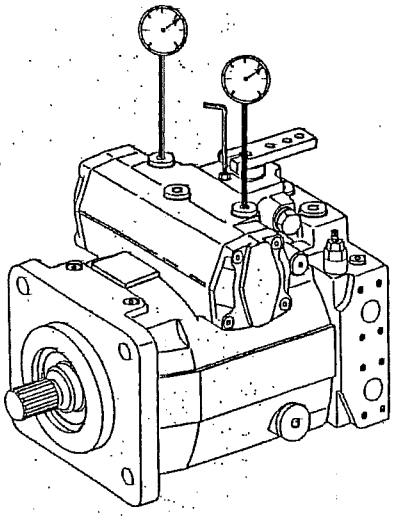
Attention!
Observe safety regulations!
Connect both control chambers with hose NW6. Avoidance of residual signals from hydraulic zero position.
Connect manometer to M_A and M_B. Adjust zero position so that with a blocked drive both manometers indicate the same pressure value.
Note:
Determine the dead band for the zero position.



HW HD EP

Achtung!
Sicherheitsbestimmungen beachten!

Attention!
Observe safety regulations!



Manometer an X_1 und X_2 anschließen.
Nullage so einstellen, daß bei blockiertem Antrieb beide Manometer auf gleichem Druckwert stehen.
Hinweis:
Excenterjustierung
- nicht über ±90° verdrehen.

Connect manometer to X_1 and X_2.
Adjust zero position so that with a blocked drive both manometers indicate the same pressure value.
Note:
Eccentric adjustment
- Do not turn more than ±90°.

Achtung!
Sicherheitsbestimmungen beachten!

Hinweis:
Nachjustierung nur bei Betriebstemperatur.

Manometer an "G" anschließen.

Achtung!
* Speisedruckeinstellung!
Nenndruck p_H = 18 bar
Höchstdruck p_H = 40 bar
Bei Max.-Drehzahl.

Hinweis:
Einstelldaten nach Werksauftrag.

* bei DA-Ausführung

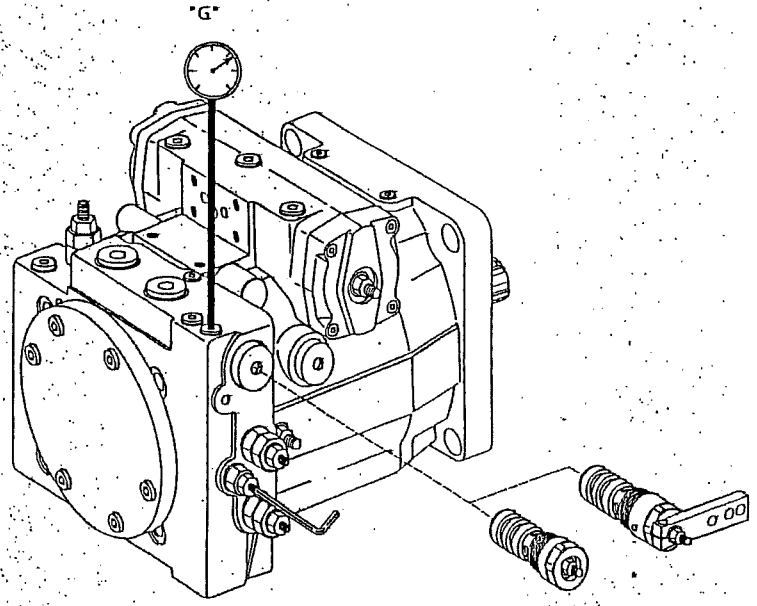
Attention!
Observe safety regulations!

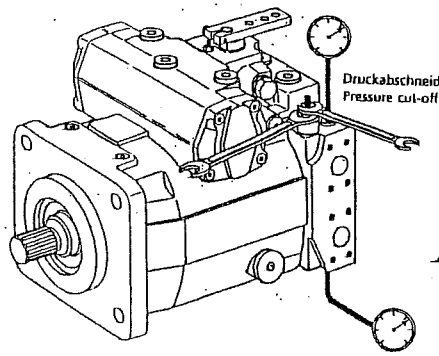
Note:
Re-adjustment only at operating temperature.

Connect manometer to "G".

Attention!
* Boost pressure setting!
Nominal pressure p_H = 18 bar
Peak pressure p_H = 40 bar
at max. speed.

Note:
Adjustment data according to works order.





Achtung!
Sicherheitsbestimmungen beachten!

HD-Ventil ohne Bypass

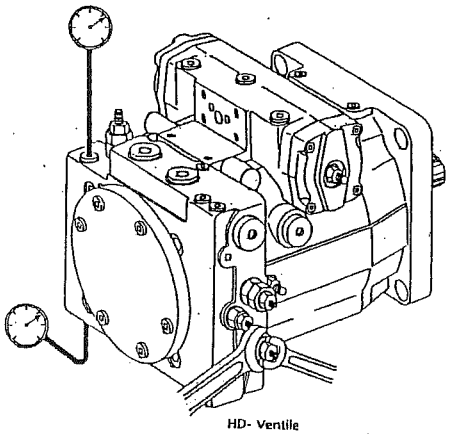
1 . HD- Ventile sind immer 10% höher eingestellt als die Druckabschneidung.
Bei Veränderung eines Einstellwertes immer beide kontrollieren.
2. Nachjustierung nur bei Betriebstemperatur

Manometer an M_A und M_B anschließen.
Druckabschneidung: Maß X Einstellschrauben notieren!
Einstellschraube auf Block drehen.
⚠ Max. 7 Nm

HD- Ventile: Mit geringer Pumpenmenge über Ventile fahren. Einstellwert kontrollieren.
(Nur kurzzeitig "Temperatur".)

Drucklos "Einstellwert" verändern - Kontrolle

Druckabschneidung:
Einstellschraube auf Maß (*) zurückdrehen.
Druckwert kontrollieren bzw. nachjustieren.
Achtung! Differenz von 10% HD- Ventile und Druckabschneidung beachten!
Hinweis: Einstelldaten nach Werksauftrag.


HD- Ventile
HP- valves

Attention!
Observe safety regulations.

HP valve without bypass-function

1 . HP valves are always adjusted 10% higher than the pressure cut-off.
If one setting value is changed, always check both values.
2. Re-adjustment only at operating temperature.

Connect manometer M_A and M_B.
Pressure cut-off: Note dimension X of the setting screw!
Turn setting screw until it locks.
⚠ Max. 7 Nm

HP valves: Operate valves with small pump flow volume.
Check setting value. (Only for a short time " due to temperature").
Change "setting value" - check.

Pressure cut-off:
Turn back setting screw to dimension (*).
Check pressure value and readjust.
Attention! Observe the 10% pressure differention of the HP valves and pressure cut-off!

Fahrzeuge mit rein-hydrostatischem Fahrantrieb bzw. mit hydrostatischem Fahrantrieb und Schaltgetriebe ohne Leerlaufstellung (Freilauf).

Hydrostatischer Antrieb / Bypaß-Schaltung

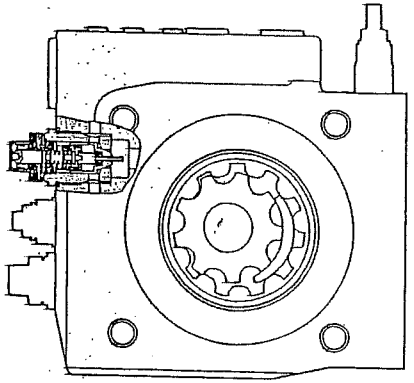
In diesem Fall wird der Fahrantrieb auf freien Umlauf geschaltet. Zu diesem Zweck haben die in der Verstellpumpe integrierten Hochdruckbegrenzungsventile eine sogenannte Bypaß-Funktion. D.h. durch Drehen der entsprechenden Schraube (Pos.1) wird der Ventil-Einsatz so entspannt, daß ein freier Öl-Umlauf möglich ist.

Vehicle with hydrostatic transmission and gear shift without idle position (free wheeling).

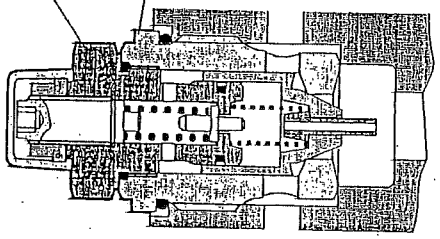
Hydrostatic transmission / Bypass-position

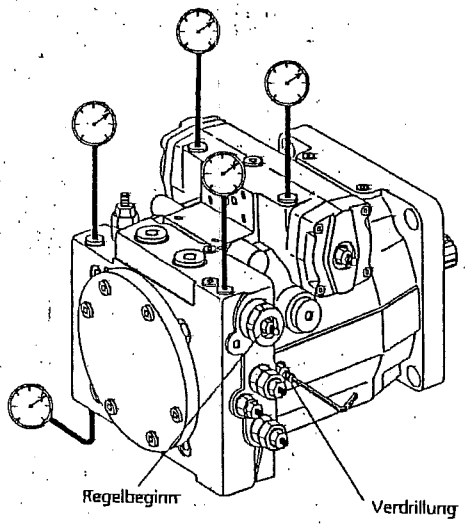
In this case the travel transmission is switched to free wheeling.For this purpose the variable displacement pump has high pressure relief valves incorporated with a bypass function.
The screw (item 1) is unscrewed to such an extent, that the valve cartridge is released and free oil circulation is possible.

A4VG 250



Bypass-Schaltung ca. 2 Umdrehungen /
Bypass position approx. 2 turns
Pos.1
200 ±10 Nm





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Achtung!
Sicherheitsbestimmungen beachten!

Überprüfung der Einstelldaten
Betriebstemperatur soll während des Überprüfungsvorgangs weitgehend konstant gehalten werden.
Antriebsmotor starten, Leerlaufdrehzahl

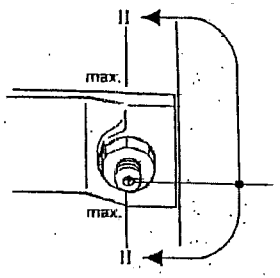
Blockzustand
Fahrtrichtungsschalter "0"
Motordrehzahl langsam steigern bis zur max. Motordrehzahl, dabei Meßgeräte beobachten.
Speisedruck:
Leerlaufdrehzahl
Psp = ca. 15-20 bar
max. Motordrehzahl
Psp = ... bar*

Blockzustand
Fahrtrichtungsschalter - vorwärts
(Straßengang und Festgebremst)

Einstelldaten Pumpe A4V/DA überprüfen
Regelbeginn
HD 40 - 50 bar
Motordrehzahl . . . min.⁻¹ * Psp . . . . . bar*
HD . . . . . bar
Nachjustierung - Regelbeginnschraube

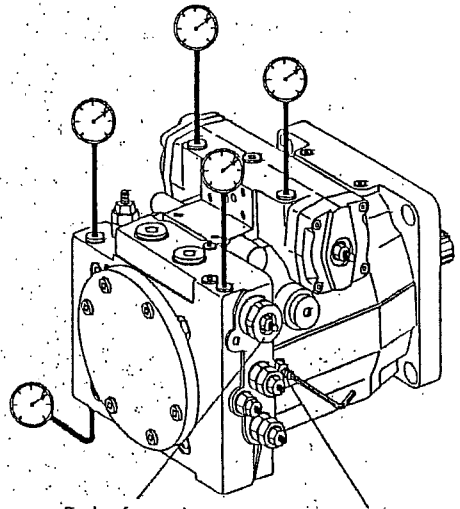
Regelende
HD . . . . . bar*
Motordrehzahl . . . . . min.⁻¹ * Psp . . . . . bar*
Nachjustierung - Verdrillschraube

Hinweis:
Excenterjustierung - Drehrichtung beachten



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Hinweis: * Einstelldaten nach Werksauftrag!



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Attention!
Observe safety regulations!

Check setting data.
Operating temperature should be kept largely constant during the check procedure.
Start prime mover, idle speed.

Block position
Drive direction switch - "0".
Slowly increase motor speed up to the max. motor speed and observe the measuring instruments.

Boost pressure:
Idle speed of prime mover
Psp = approx. 15 - 20 bar
max. motor speed
Psp = ... bar*

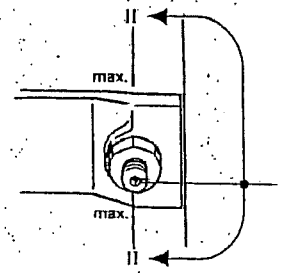
Blocked position
Drive direction switch - forward
(Road gear and fully applied brake)

Check setting data of pump A4V/DA
Start of control:
HD 40 - 50 bar
Motor speed . . . . . rpm* Psp . . . . . bar*
HD . . . . . bar*
Readjustment - control start-up screw

End of control
HD . . . . . bar
Motor speed . . . . . rpm* Psp . . . . . bar*
Readjustment index adjustment screw

Note:
Eccentric adjusting - observe direction of rotation

* Setting data according to order!

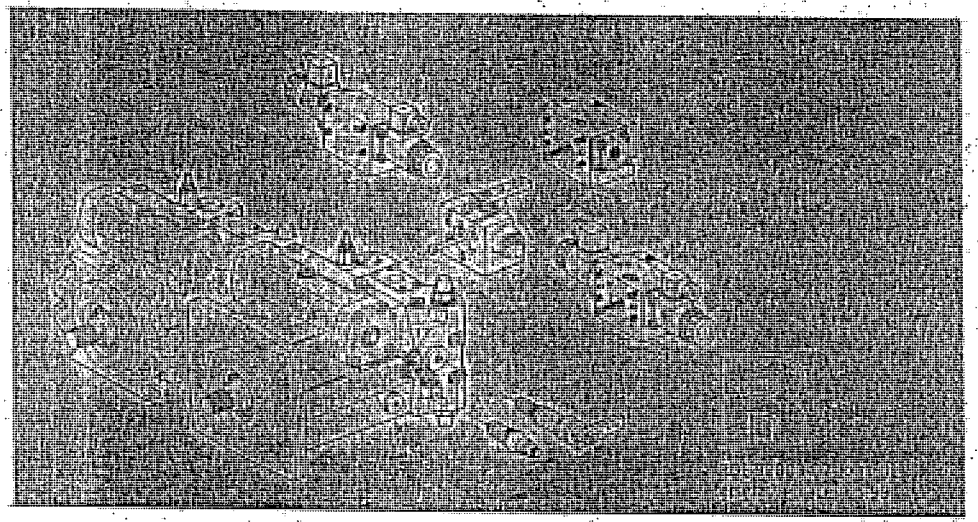


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Bosch Group

Reparaturanleitung / Repair instructions
A4VG 71 – 180 Baureihe/Series 32



Mobile Hydraulics

HINWEIS

Bezeichnungen, Beschreibungen und Darstellungen entsprechen dem Informationsstand zum Zeitpunkt der Drucklegung dieser Unterlage.

Änderungen können den Service am Produkt beeinflussen, Verpflichtungen entstehen uns daraus nicht.

Methoden und Vorrichtungen sind Empfehlungen, für deren Resultat wir keine Haftung übernehmen können.

BRUENINGHAUS HYDROMATIK- Baugruppen, mit Angabe der Fabrik-Nr. bestellt, sind die Basis guter Reparaturen.

Einstell- und Prüfarbeiten sind bei Betriebstemperatur auf dem Teststand vorzunehmen.

Schutz von Personen und Eigentum ist durch Vorkehrungen sicherzustellen.

Sachkenntnis, die Voraussetzung für jede Service-arbeit, vermitteln wir in unseren Schulungskursen.

NOTICE

Specifications, descriptions and illustrative material shown herein were as accurate as known at the time this publication was approved for printing.

BRUENINGHAUS HYDROMATIK reserves the right to discontinue models or options at any time or to change speci-fications, materials, or design without notice and with-out incurring obligation.

Optional equipment and accessories may add cost to the basic unit, and some options are available only in combination with certain models or other options.

For the available combinations refer to the relevant data sheet for the basic unit and the desired option.

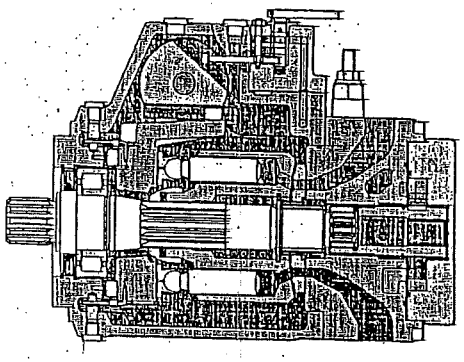
Adjustment and tests have to be carried out on the test bench under operating temperatures.

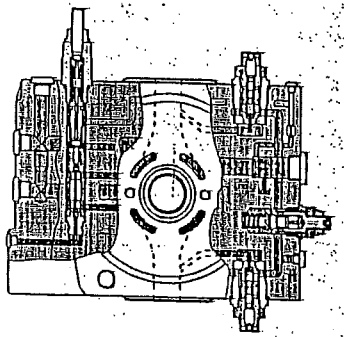
Protection of personnel and property has to be guaranteed by appropriate measures.

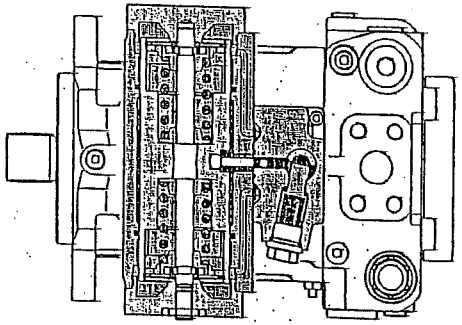
Expert knowledge, the precondition of any service work, can be obtained in our training courses.

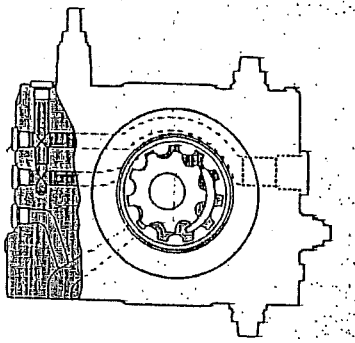
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Hilfspumpe abdichten	11	Sealing of the boost pump
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Speisedruckventil abdichten	14	Sealing of the boost pressure valve
Druckbegrenzungsventil abdichten	15	Sealing of the pressure relief valve HD
Druckabschneidung abdichten	16	Sealing of the pressure cut-off valve
Ansteuergerät abdichten	17	Sealing of the control device
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HW/D



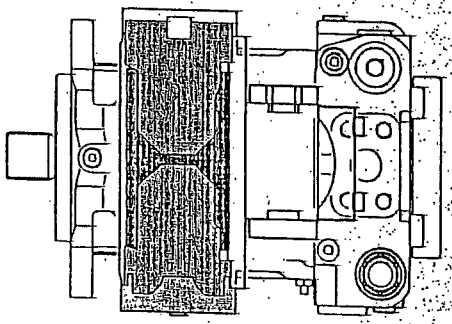




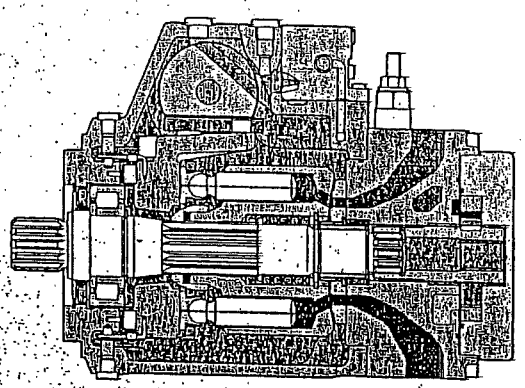


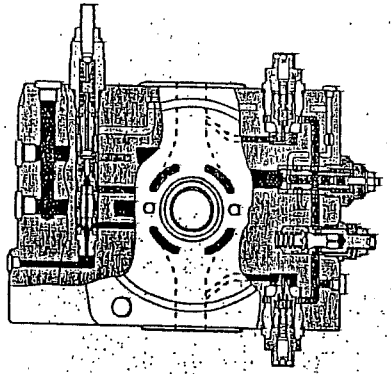
EP/D

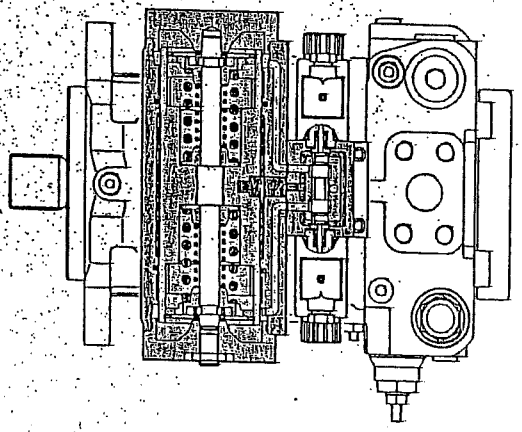
HD/D

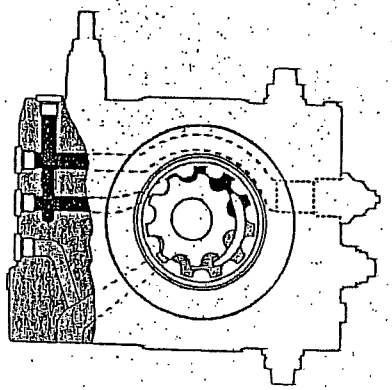


DA/D





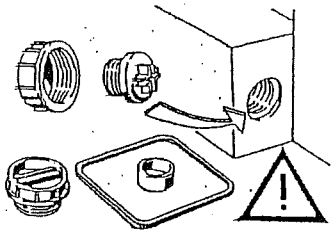






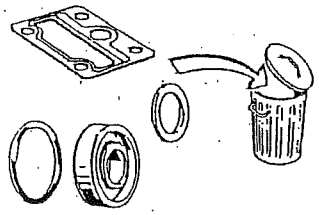
Achtung!
Nachfolgend Hinweise bei allen Reparaturarbeiten an Hydraulikaggregaten beachten!

Attention!
Observe the following notices when carrying out repair work at hydraulic aggregates!



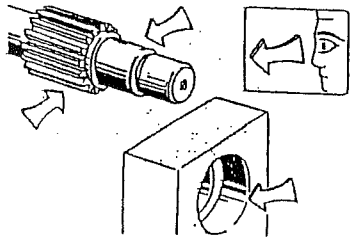
Alle Öffnungen der Hydraulikaggregate verschließen.

Close all ports of the hydraulic aggregates.



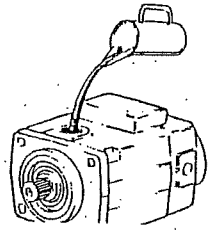
Alle Dichtungen erneuern.
Nur original HYDROMATIK-Ersatzteile verwenden.

Replace all seals.
Use only original HYDROMATIK spare parts.



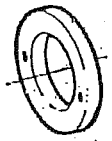
Alle Dicht- und Gleitflächen auf Verschleiß prüfen.
Achtung: Nacharbeiten an Dichtflächen z.B. durch Schleifpapier kann die Oberfläche beschädigen.

Check all seal and sliding surfaces for wear.
Attention: Rework of sealing area f. ex. with abrasive paper can damage surface.



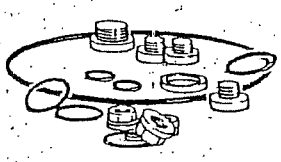
Hydraulikaggregate vor Inbetriebnahme mit Betriebsmedium befüllen.

Fill up hydraulic aggregates with medium before start- up.



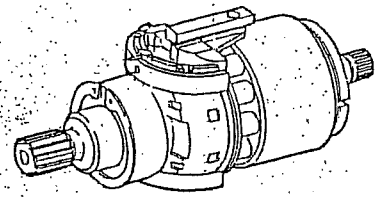
Dichtsatz für Triebwelle.

Seal kit for drive shaft.



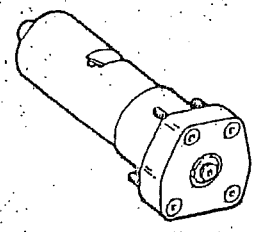
Äußerer Dichtsatz.

External seal kit.



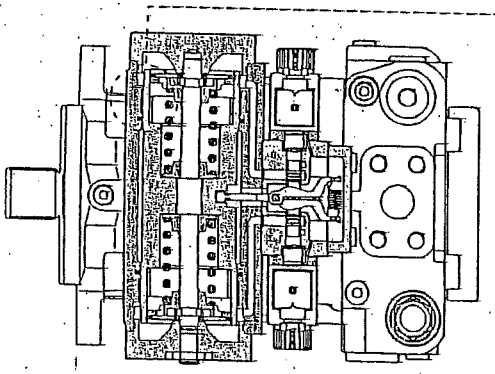
Triebwerk komplett.

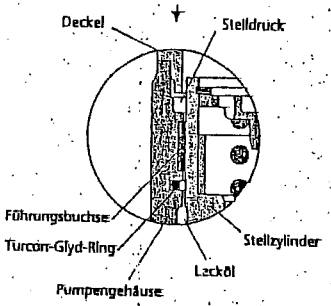
Complete rotary group.



Stellkolben

Positioning piston

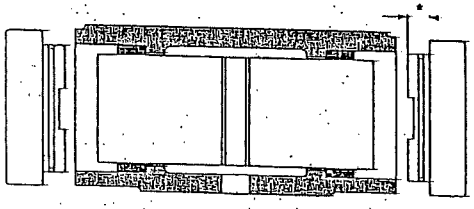




Bei den Verstellpumpen A4VG erfolgt zur Zeit die Umstellung der Verstellung auf Turcon-Dichtungen.
Die Stückliste der kompletten Einheit erhält dabei eine neue Ident.-Nummer.
Typenschlüssel, Typnummer und Außenabmeßungen bleiben dabei unverändert. (Pumpengehäuse ändert sich nur im Bereich vom Stellkolben. Stellkolben ändert sich in eine angefaste Ausführung).

⚠ Alten Stellkolben nicht bei Turcon-Dichtung verwenden (scharfkantig - Dichtungen werden beschädigt).

Pumpengehäuse / Pump housing
mit Lagerbuchse / with bush ALT / OLD



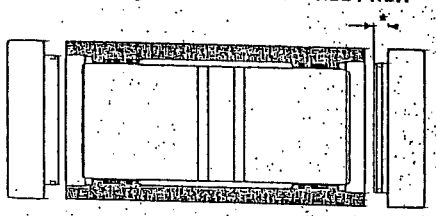
⚠ Die Umstellung der Verstellung auf Turcon-Dichtung ist im allgemeinen mit einer Funktionsverbesserung verbunden (DA-Verhalten, geringerer Temperatureinfluß auf Stellzeiten).

⚠ Bei gleicher Düsenbestückung können sich die Stellzeiten geringfügig verändern.

At present the change of the control into Turcon seal is made for A4VG.
The parts list of the complete unit will receive a new identification number.
Type reference and outside dimensions remain unchanged (pump housing will change at the area of the positioning piston. Positioning piston will change into chamfering design).

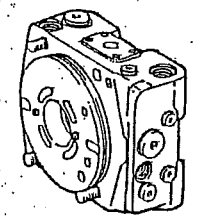
⚠ Do not use old positioning piston with Turcon seal (sharp edged - seal will be damaged).

Pumpengehäuse / Pump housing
mit Turcon-Dichtung / with Turcon seal NEU / NEW



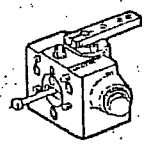
⚠ The change of the control into Turcon seal design improves in general the function (DA-behaviour, lower temperature-influence on control times).

⚠ The control times will slightly change with the same throttle sections. Therefore our customers have to be informed about this change.



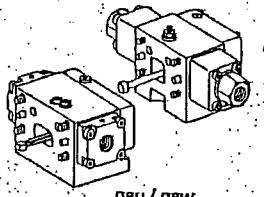
Anschlußplatte

Valve plate



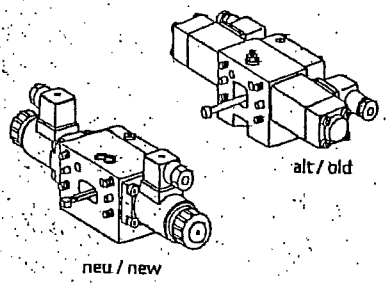
Ansteuergerät HW
Hinweis:
NG 71 wie NG 40 - 56 mit Flachdichtung.

Control device HW
Note:
Size 71 control device as size 40 - 56 with flat seal.



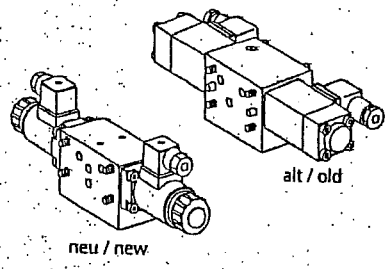
Ansteuergerät HD
Hinweis:
NG 71 wie NG 40 - 56 mit Flachdichtung.

Control device HD
Note:
Size 71 control device as size 40 - 56 with flat seal.



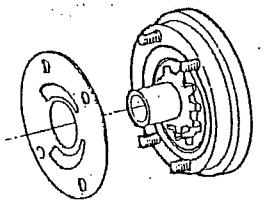
Ansteuergerät EP
Hinweis:
NG 71 wie NG 40 - 56 mit Flachdichtung.

Control device EP
Note:
Size 71 control device as size 40 - 56 with flat seal.



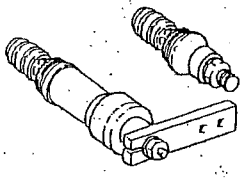
Ansteuergerät DA
Hinweis:
NG 71 wie NG 40 - 56 mit Flachdichtung.

Control device DA
Note:
Size 71 control device as size 40 - 56 with flat seal.



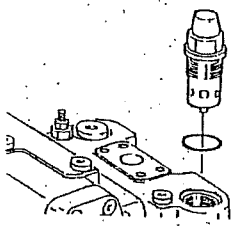
Hilfspumpe

Boost pump



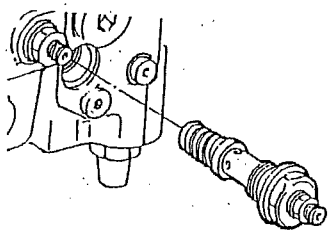
Regelventil

Control valve



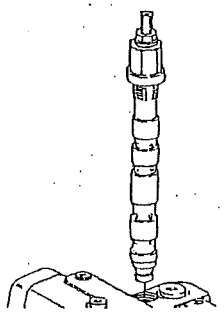
HD - Ventil

High pressure valve



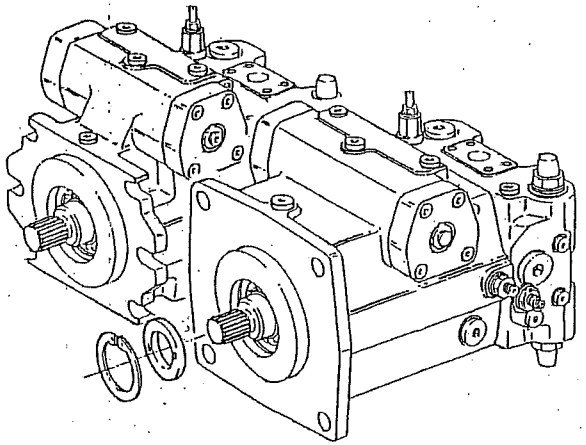
ND - Ventil

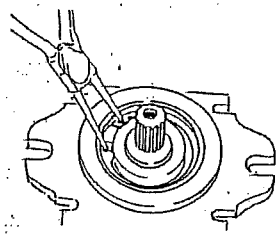
Low pressure valve



Druckabschneidung

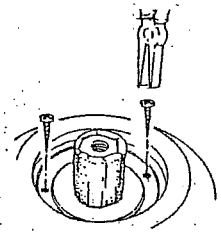
Pressure cut-off





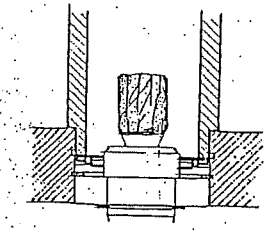
Triebwelle abkleben.
Sicherungsring ausbauen.

Protecting the drive shaft.
Remove retaining ring.



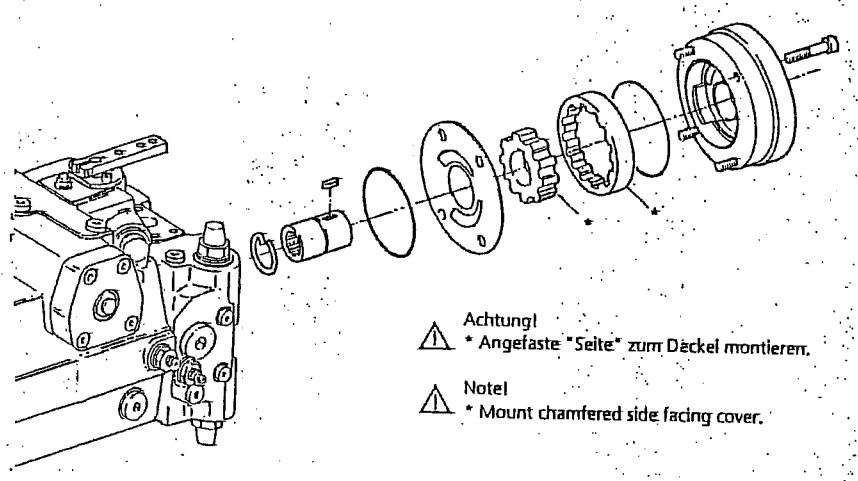
Blechschraube in die mit Gummi gefüllten Löcher eindrehen.
Mit Zange WDR herausziehen.

Screw in sheet metal screw into the holes fitted with rubber.
Pull out shaft seal with pliers.



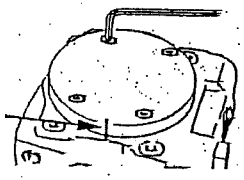
Wellendichtring mit Buchse auf Anschlag einpressen.
Sicherungsring einbauen.
⚠ Dicht- und Staublippe, Wellendichtring leicht einfetten.

Press-in shaft seal with bush to stop.
Assemble retaining ring.
⚠ Lightly grease the seal, dust lips and shaft seal ring.



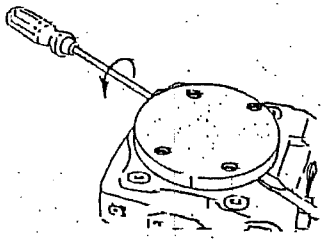
⚠ Achtung!
* Angefaste "Seite" zum Deckel montieren.

⚠ Note!
* Mount chamfered side facing cover.



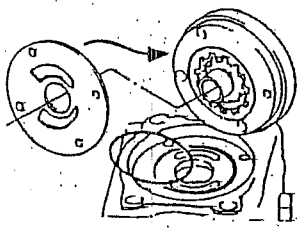
Lage kennzeichnen,
Befestigungsschrauben ausbauen.

Mark position,
remove fixing screws.



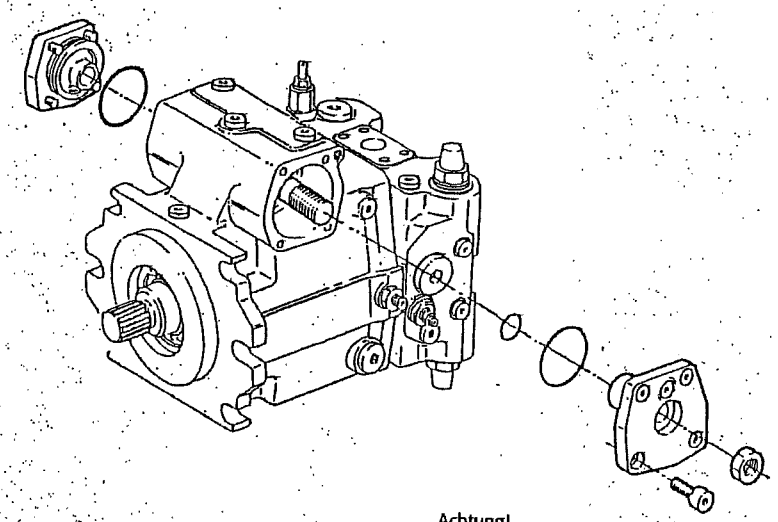
Deckel abdrücken.

Pry-off cover.



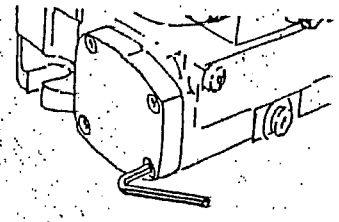
Kontrolle:
O-Ring, Nut,
Lauffläche, Anschlußplatte.

Check:
O-ring, groove,
gliding surface, connection plate.



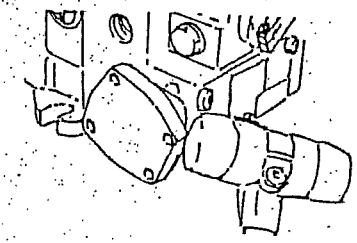
Achtung!
Korrekt mechanische 0-Lageneinstellung überprüfen.

Attention!
Check correct mechanical 0-position.



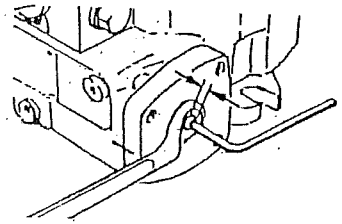
Lage kennzeichnen.

Mark position.



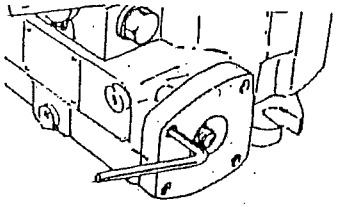
Deckel verdrehen und mit leichten Hammerschlägen lösen.

Rotate cover and release by tapping gently with hammer.



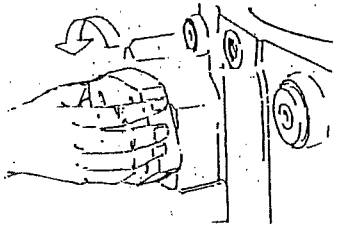
Deckel kennzeichnen. Maß festhalten, Kontermutter lösen, Stellschraube gegenhalten.

Mark cover. Must be fixed, loosen counter nut, hold adjustment screw.



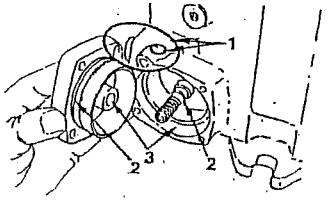
Deckel demontieren.

Remove cover.



Deckel von Stellschraube "abschrauben".

Lift off by turning the setting screw.



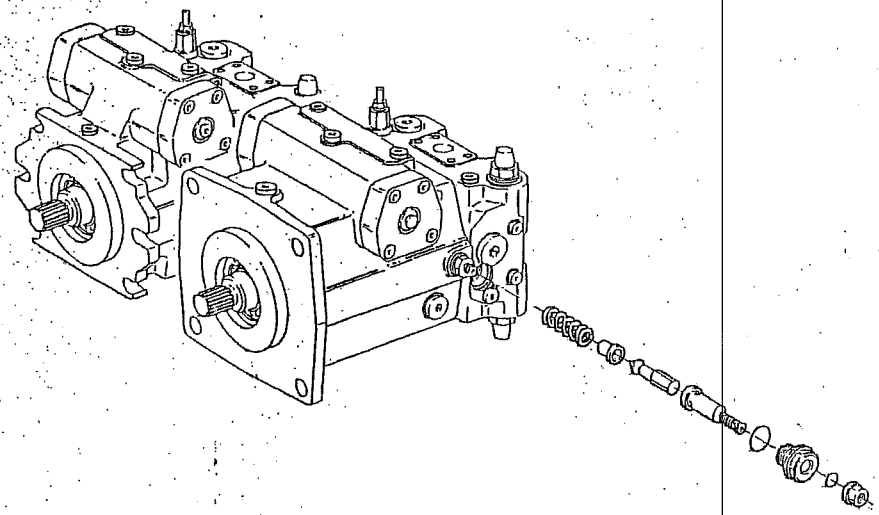
Kontrolle!
O-Ring (1), Nut (2), Gehäuse (3).

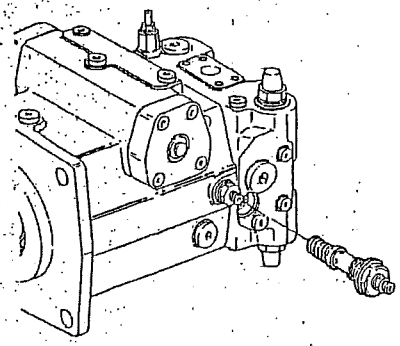
Check!
O-ring (1), groove (2), housing (3).



Achtung!
Korrekte mechanische Nullageneinstellung muß nach Einbau im Gerät bzw. Prüfstand erfolgen.

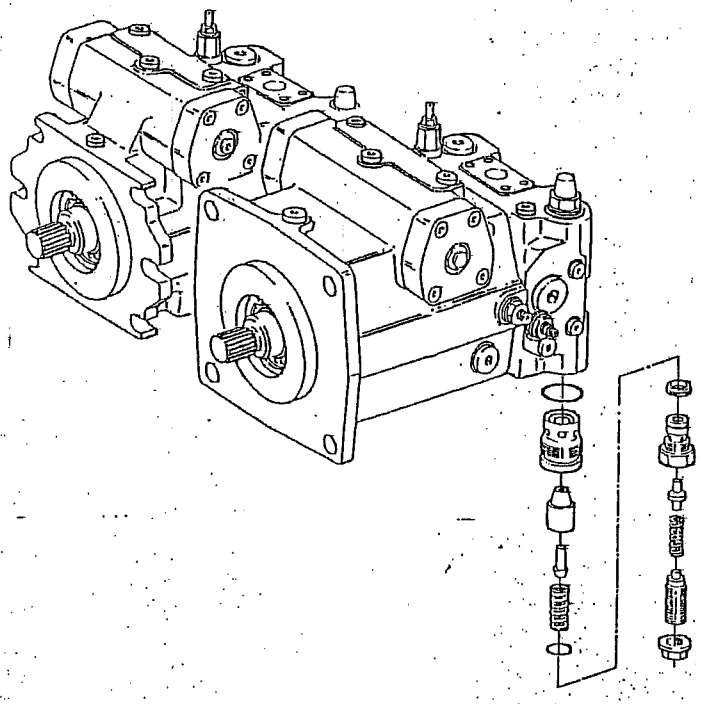
Attention!
Adjustment of the correct zero position to be carried out after installation into the machine or on the test bench.

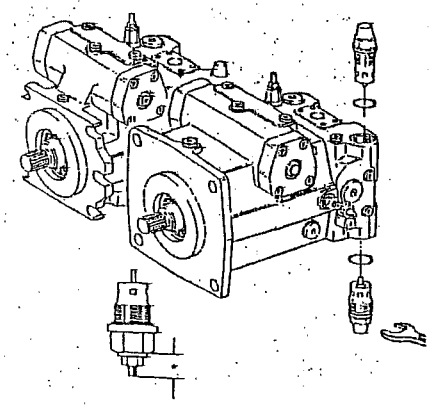




Ventil komplett ausbauen.
Hinweis:
Einstellschraube nicht verändern.
Achtung!
Nach Einbau Ventileinstellung überprüfen!

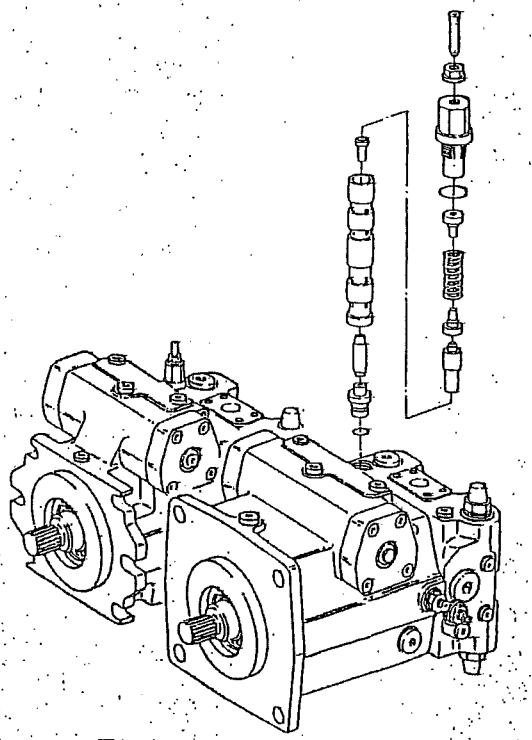
Remove valve completely.
Note:
Do not change adjustment screw.
Attention!
Check valve setting after installation.

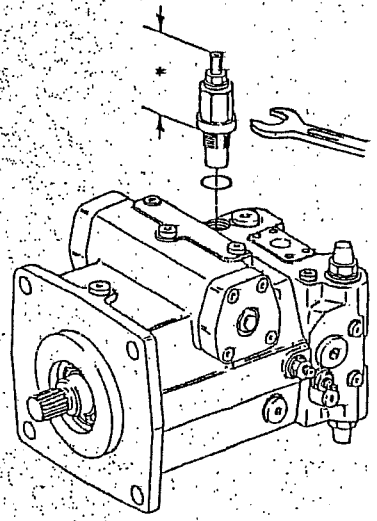




Ventil komplett ausbauen.
Kontrolle: O-Ring, Gehäuse.
Wechsel der Dichtmutter – Einstellmaß (*) festhalten.
Achtung!
Nach Einbau "Ventileinstellung" überprüfen.

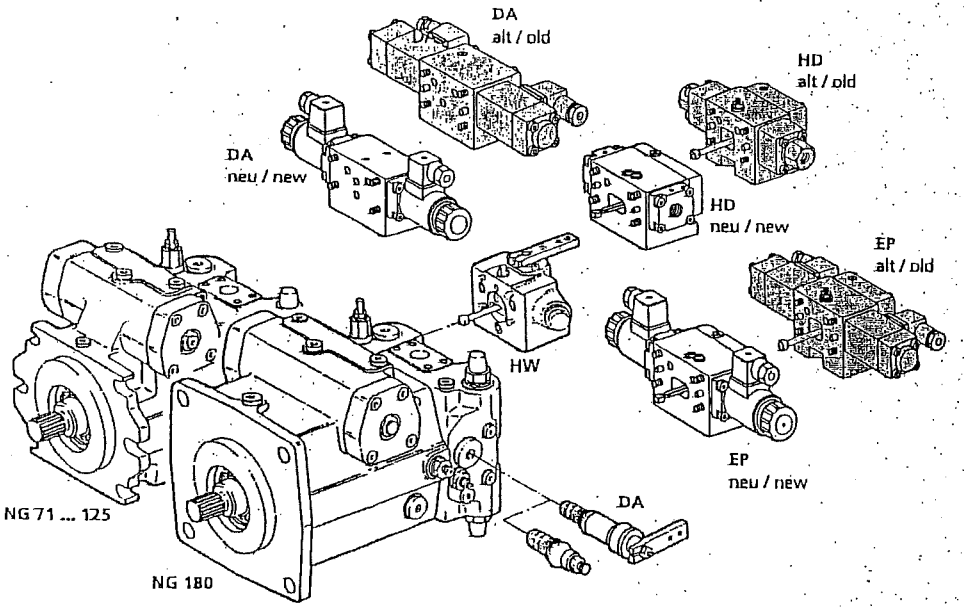
Remove valve completely.
Control: O-ring, housing.
Replacement of the tightening nut, record measure (*).
Attention!
After assembly check "valve setting".





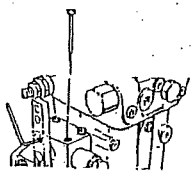
Einstellteil komplett ausschrauben.
Kontrolle: O-Ring, Gehäuse.
Wechsel der Dichtmutter – Einstellmaß (*) festhalten.
Achtung!
Nach Einbau "Ventileinstellung" überprüfen.

Unscrew setting cartridge completely.
Control: O-ring, housing.
Replacement of the tightening nut, record measure (*).
Attention!
After assembly check "valve setting".



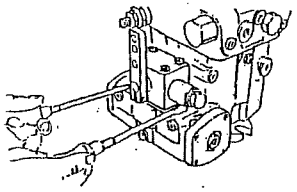
Ansteuergerät abbauen.
Hinweis:
NG 71: Abdichtung der Ansteuergeräte wie NG 40 - 56 mit Flachdichtung.
Achtung!
Korrekte hydraulische Nullageneinstellung überprüfen.

Remove control device.
Note:
Size 71: Sealing of control device as size 40 - 56 with flat seal.
Attention!
Check correct hydraulic 0-position.



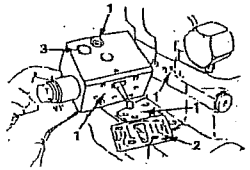
* Befestigungsschrauben demontieren.

* Remove fixing screws.



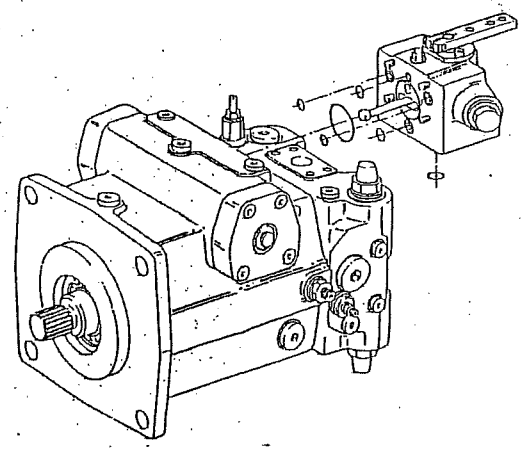
Ansteuergerät abdrücken.

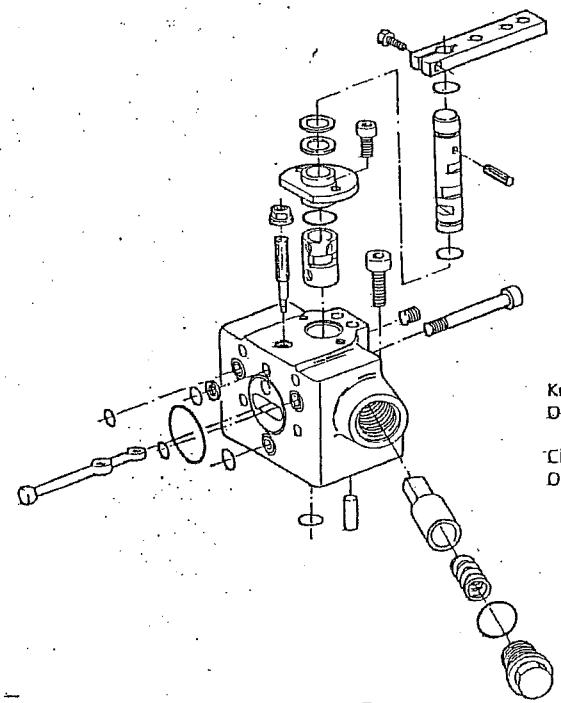
Pry-off the control unit.



Kontrolle
Dichtfläche (1), Flachdichtung (2), O-Ringe (3).

Check
Sealing surface (1), gasket (2), O-rings (3).



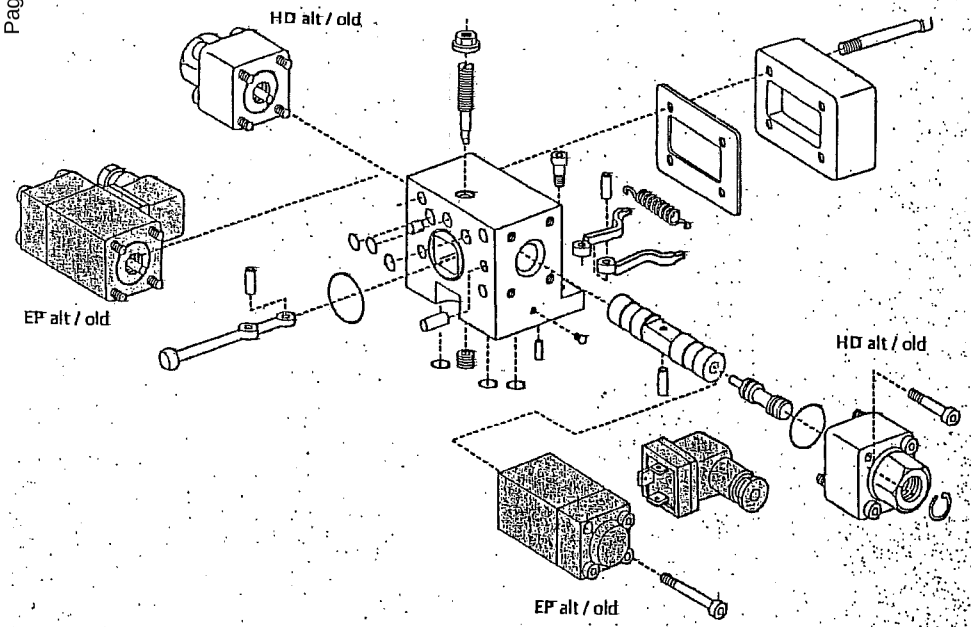


Kontrolle:
O-Ringe und Dichtung.

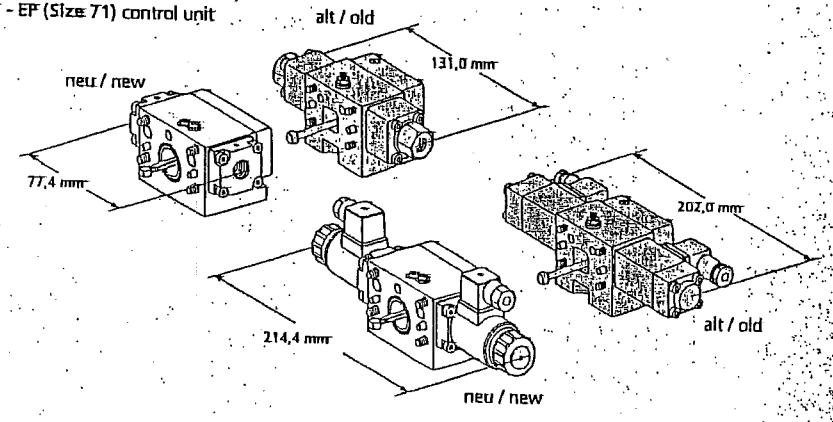
Check:
O-rings, gasket.

Page 801

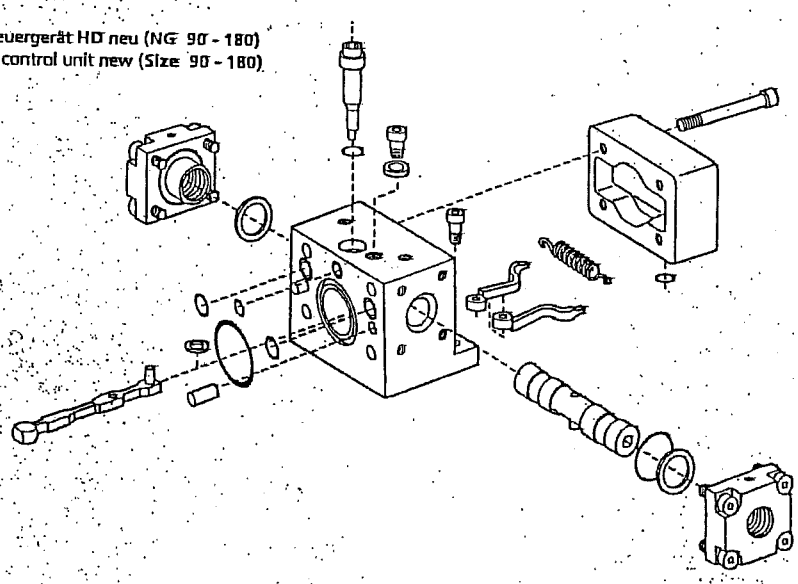
Ansteuergerät HD - EP alt (NG 90 - 180)
HD - EP (Size 90 - 180) control unit old



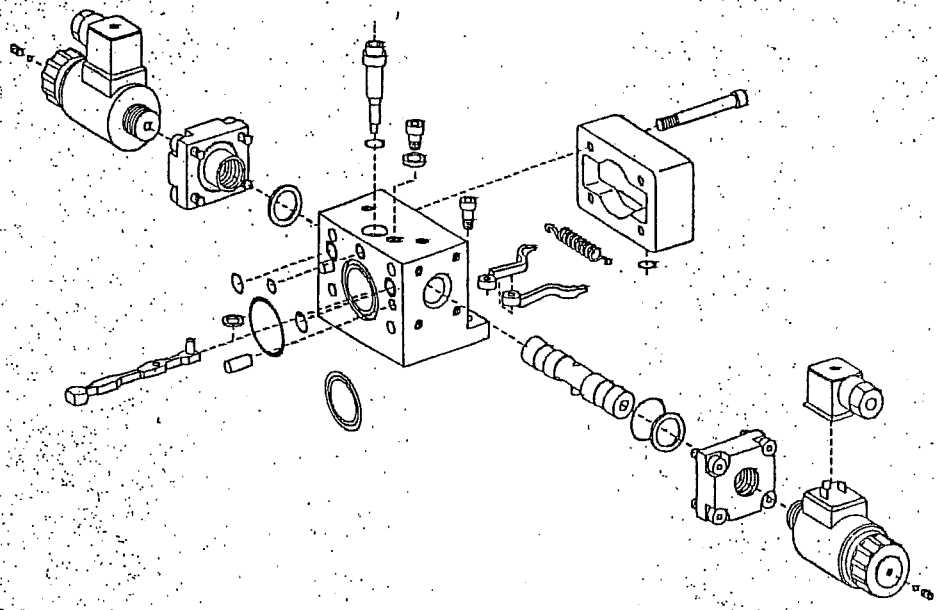
Neues Ansteuergerät HD - EP (NG 71)
New HD - EP (Size 71) control unit



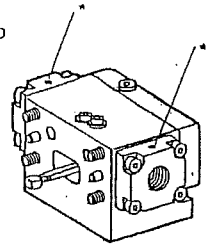
Ansteuergerät HD neu (NG 90 - 180)
HD - control unit new (Size 90 - 180)

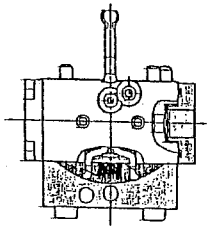


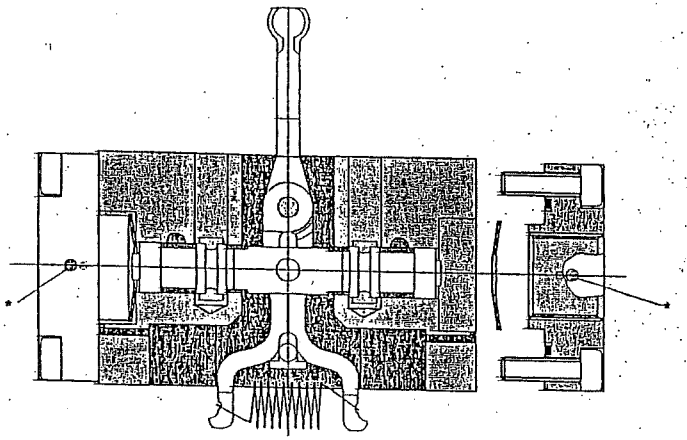
Ansteuergerät EP neu (NG 90 - 180)
EP - control unit new (Size 90 - 180)



* Markierung Montageposition HD
* Marking the assembly position HD







* Markierung
Montageposition HD

* Assembly position marker HD

Wird von EP- auf HD-Ausführung umgebaut - Deckelposition beachten siehe Markierung

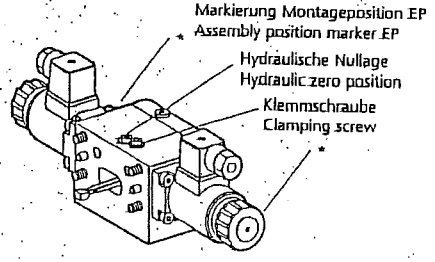
o Leckölkanal offen wird geschlossen.

⚠ Zugfeder tauschen!

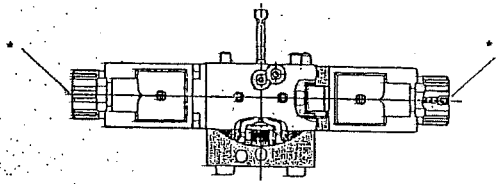
Is converted from EP into the HD version - take note of the cover position, see marker

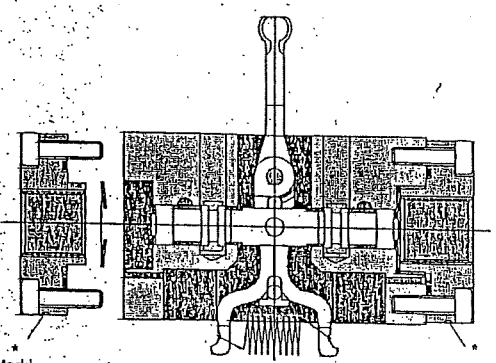
o The open leakage port is plugged

⚠ Exchange the tension spring!



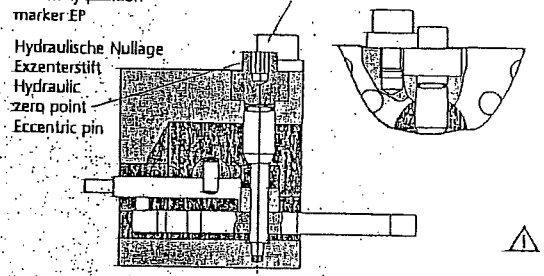
Entlüftungsschraube * max. 2 Umdrehungen herausdrehen.
Bleed screw *. Unscrew by a max. of 2 turns





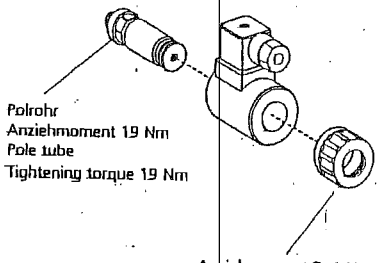
* Markierung Montageposition EP
Assembly position marker EP

Klemmschraube 6,1 Nm
Clamping screw 6,1 Nm



Die neuen Proportionalmagnete müssen bei der Inbetriebnahme entlüftet werden. Wird die Luft nicht aus dem Ankerraum entfernt, kann es zum Schwingen der Ansteuerung kommen.
Zum Entlüften ist am Ende des Magneten, im Messingteil, ein kleiner Gewindestift M4, SW 2 vorhanden. Dieser Gewindestift ist max. 2 Umdrehungen herauszudrehen und nach dem Entlüften mit 1 Nm wieder festzuziehen.
Bei der Ausführung mit Nothand mit Federrückzug muß zum Entlüften die Kunststoffmutter mit Gummibalg entfernt und nach dem Entlüften mit 5+1 Nm wieder angeschraubt werden.

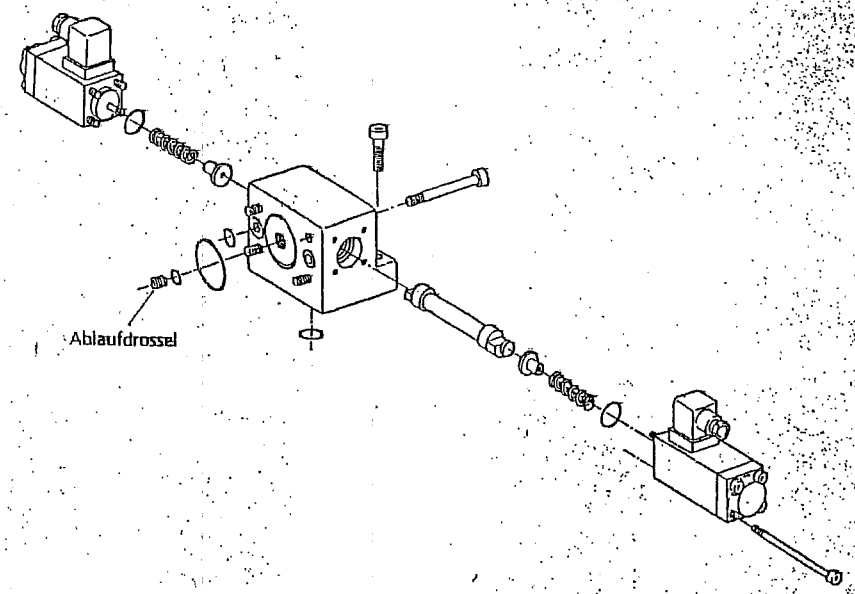
The new proportional solenoids must be bled during commissioning. If the air is not removed from the armature chamber oscillations at the control can occur.
For bleeding purposes there is, on the end of the solenoid, in the brass component a small set screw M4, 2A/F. This can be unscrewed by a maximum of 2 turns and then after completion of the bleeding tightened to a maximum of 2 Nm.
For the version with hand override and spring return the plastic nut with rubber coating has to be removed for bleeding. After bleeding it has to be replaced and tightened with 5+1 Nm.



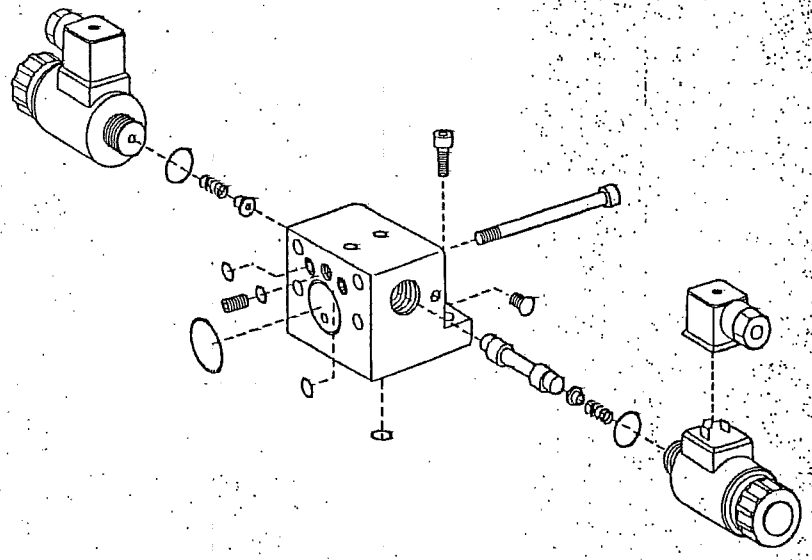
⚠ Beim Lösen der Klemmschraube Exzenterstift - Hydraulische Nullage festhalten.

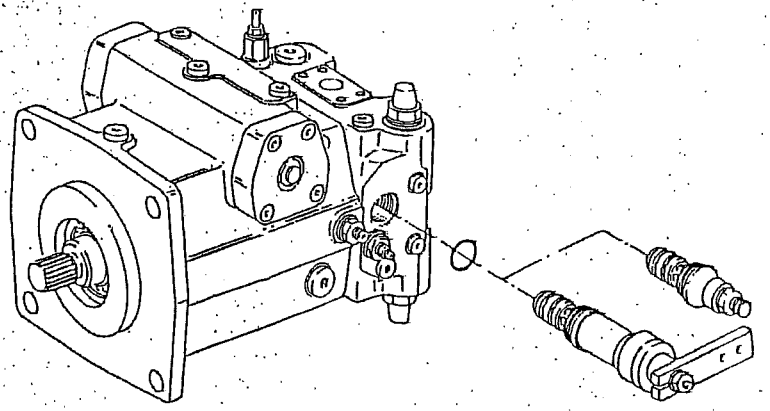
⚠ When loosening the clamping screw Hold the eccentric pin - hydraulic zero point

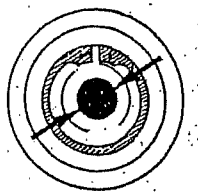
Ansteuergerät DA alt (NG 90 - 180)
DA - control unit old (Size 90 - 180)



Ansteuergerät DA neu (NG 90 - 180)
DA - control unit new (Size 90 - 180)

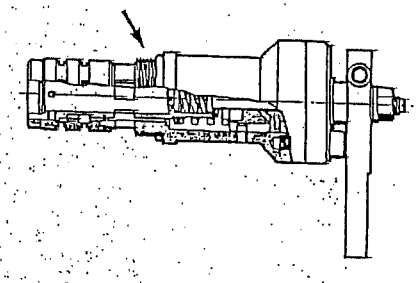






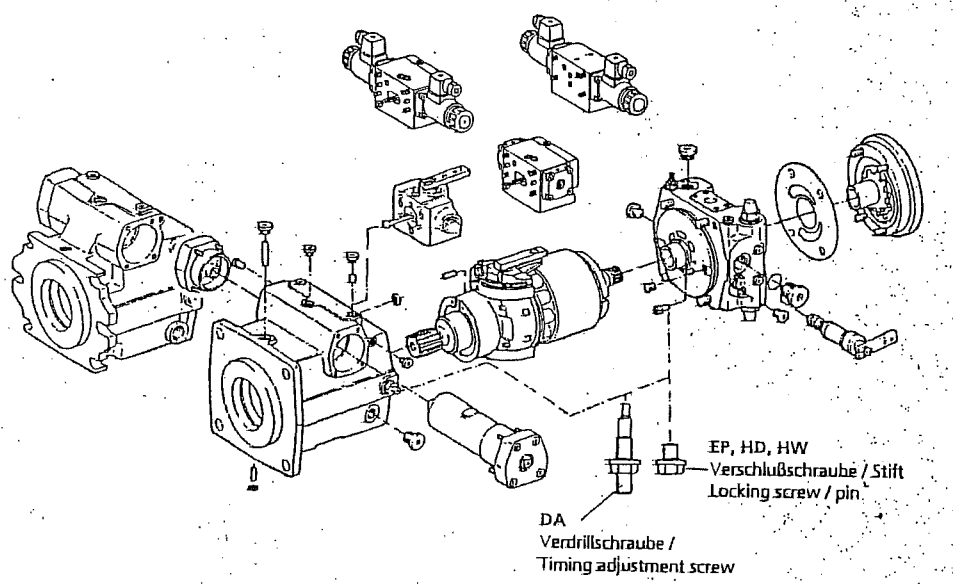
Blende überprüfen.
Keine Beschädigung.

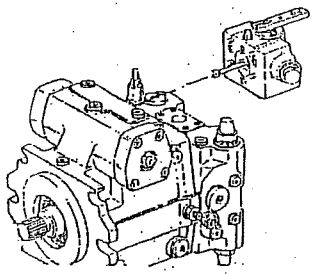
Inspect orifice.
No damage.



Gewinde abkleben.
O-Ring einsetzen.

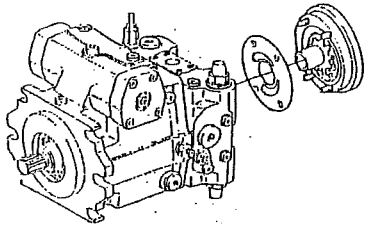
Cover threads.
Insert O-ring.





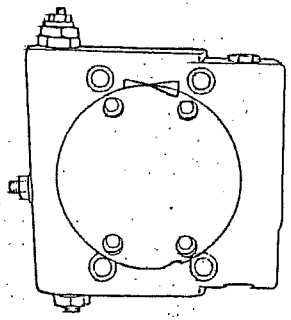
Ansteuergerät abbauen.

Remove control device.



Hilfspumpe ausbauen.
Hinweis:
Einbaulage kennzeichnen.

Remove auxiliary pump.
Note:
Mark assembly position previously.



z.B. Drehrichtung "Rechts"

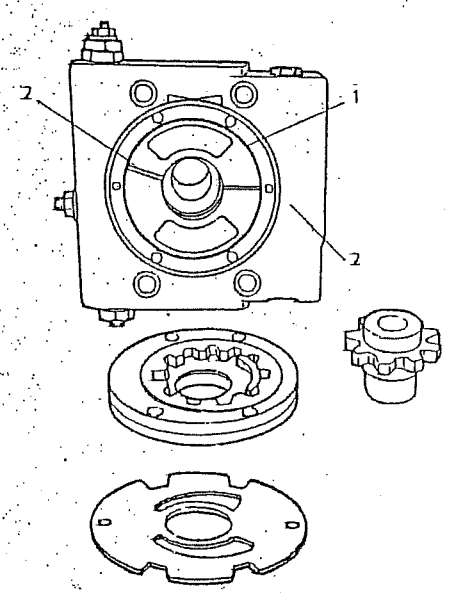
e.g. "clockwise" direction of rotation

Anschlußplatte mit Hilfspumpe

⚠ Achtung: Drehrichtung wird immer mit Blick auf die Triebwelle angegeben.

Port plate with auxiliary pump

⚠ Attention: Direction of rotation is always indicated with view on the drive shaft.



Drehrichtung "rechts"

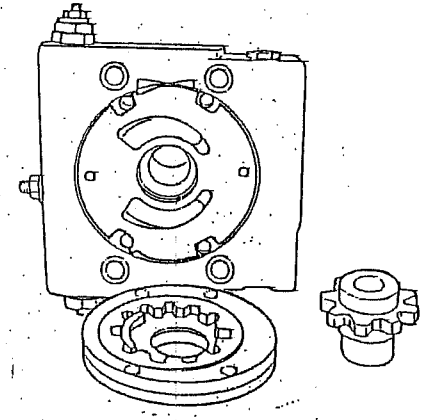
Breite Seite zur Sichel "rechts".

1. O-Ring,
2. Entlastungskanal

Direction of rotation "clockwise"

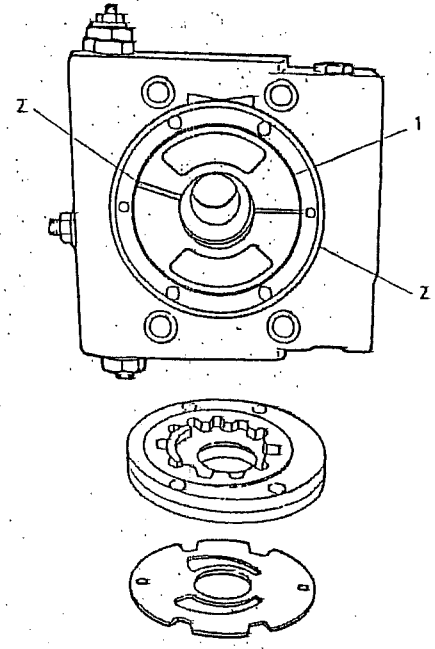
Broadside to the crescent "clockwise"

1. O-ring
2. Discharge channel



Drehrichtung "links"

"Counterclockwise" direction of rotation

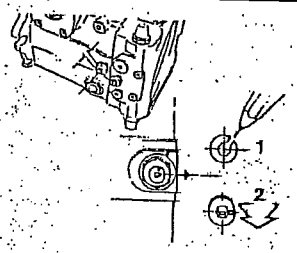


1. O-Ring,
Z. Entlastungskanal

1. O-ring
Z. Discharge channel

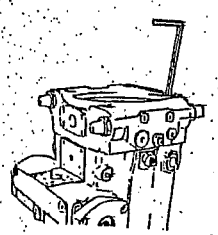
Verschleißplatte 71 – 180

Wear plate 71 – 180



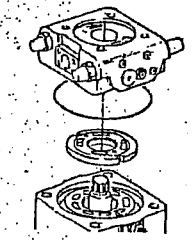
Lage der Verdrillschraube markieren (1).
Einstellmaß festhalten.
Verdrillschraube auf Demontageposition stellen (2).

Mark the position of the indexing screw (1).
Record setting measure.
Set the indexing screw to disassembly position (2).



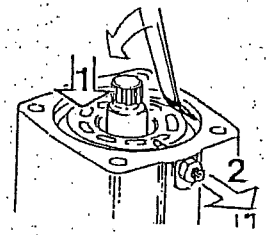
Lage der Hilfspumpe und Anschlußplatte markieren.
Anschlußplattenbefestigung lösen.

Mark position of the connection plate.
Loosen connection plate fixation.



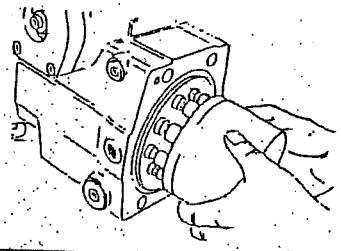
Anschlußplatte und Steuerplatte abheben.

Lift off port plate and control plate.



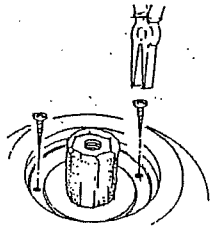
1. Zylinder nach unten drücken.
Z. Verdrillschraube herausdrehen.

1. Press the cylinder to the bottom.
Z. Remove fixing indexing screw.



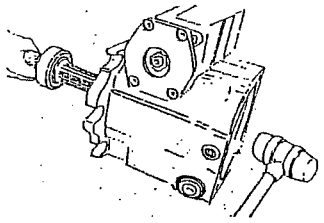
Zylinder komplett mit Kolben und Rückzugeinrichtung ausbauen.

Push off hydraulic section of rotary group.



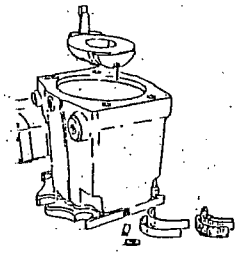
Seegerring / WDR ausbauen.

Remove retaining ring and radial seal ring.



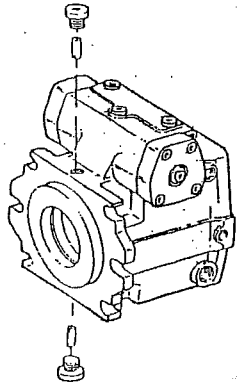
Triebwelle mit leichten Hammerschlägen austreiben.

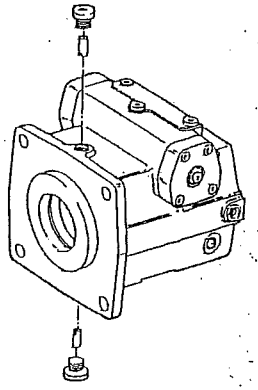
Remove drive shaft with slide hammer strokes.



Schwenkwiege / Lager komplett ausbauen.

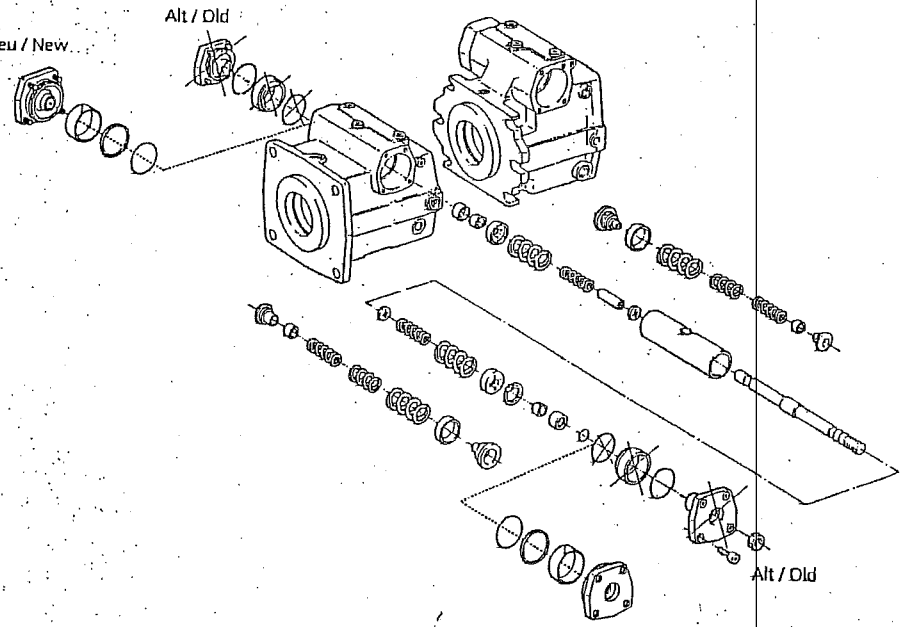
Remove swash plate / bearing cups.

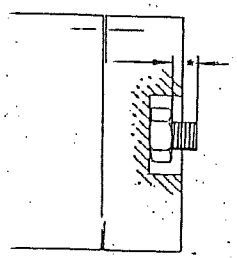




Gelenkstift ausbauen.

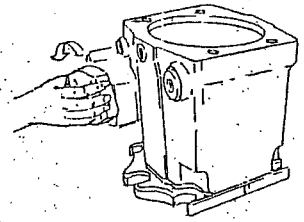
Remove joint pin.





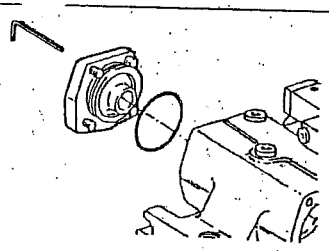
Lage vom Deckel markieren, Maß "Nullage" festhalten, Mutter lösen.

Mark position of the cover, note measure of "zero position". Loosen nut.



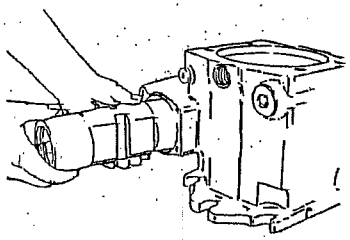
Deckel abdrehen.

Remove cover.



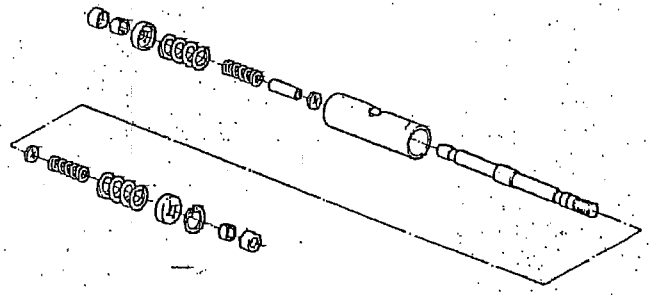
61 Lage des Deckels markieren.
Befestigungsschrauben lösen, abbauen.

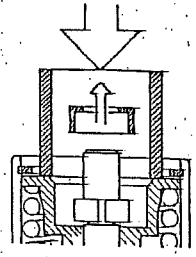
Mark position of the cover.
Loosen locking screw, remove cover.



62 Stellzylinder ausbauen.

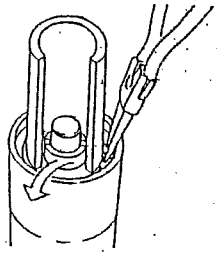
Remove positioning ring.





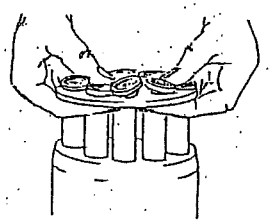
Vorrichtung aufsetzen und Feder vorspannen.
Aufnahmering ausbauen.

Fit tool device and preload spring.
Remove take-off ring.



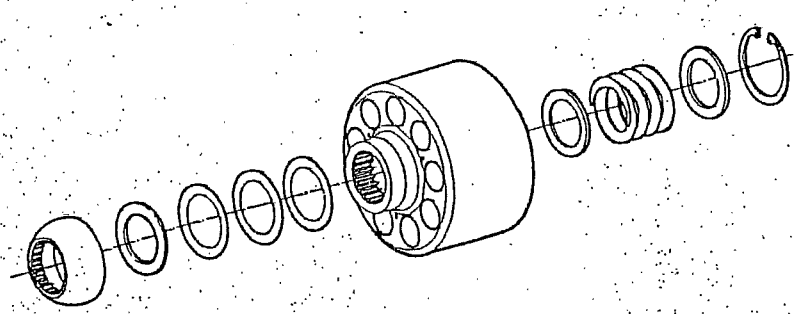
Ringe ausbauen.
Sicherungsring ausbauen.
Achtung: Teile stehen unter Federvorspannung.

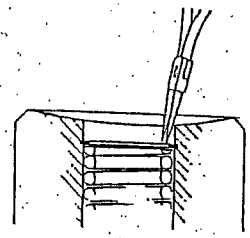
Remove rings.
Remove safety ring.
Attention: Parts are under spring load.



Kolben mit Rückzugeinrichtung ausbauen.
Tragkugel mit Tellerfedersäule abheben.

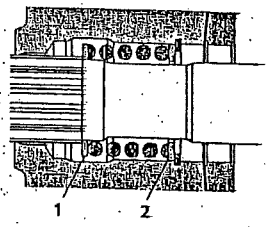
Remove piston with retaining plate.
Remove retaining ball with spring cup assembly.





Sicherungsring ausbauen.

Remove safety ring.

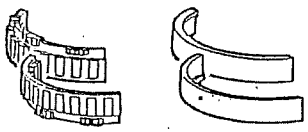


Scheibe 1, 2

Disc 1, 2

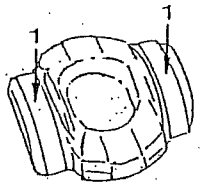
Lager
Bearing

Lagerschalen
Bearing cup



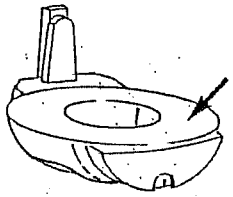
Kontrolle!
Käfig-Paar (1),
Lagerschalenpaar (2).

Check!
Cage set (1),
Bearing cup set (2).



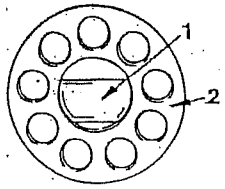
Kontrolle!
Lagerbahnen (1)

Check!
Bearing surfaces (1)



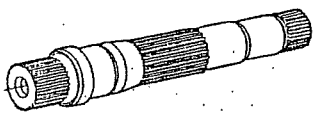
Kontrolle!
Gleitfläche riefenfrei.

Check!
Sliding surface free from scoring.



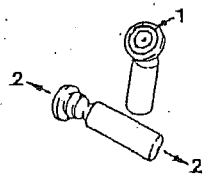
Kontrolle!
Rückzugeinrichtung riefenfrei.

Check!
Check that return device is free of scoring.



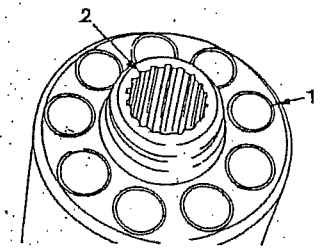
Kontrolle!
1. Verzahnung "ausgeschlagen", Passungsrost.
2. Laufflächen.
3. Lauffläche – Wellendichtring.

Check!
1. Splines for damage or fretting.
2. Running surfaces.
3. Groove cut by shaft seal.



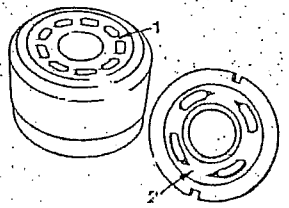
Kontrolle!
Lauffläche (1) keine Kratzer, keine Metalleinlagerungen, kein Axialspiel (2), (Kolben nur satzweise tauschen).

Check!
Check that there are no scratches or metal deposits on sliding surface (1), and there is no axial play (2), (otherwise: pistons must be replaced in sets).



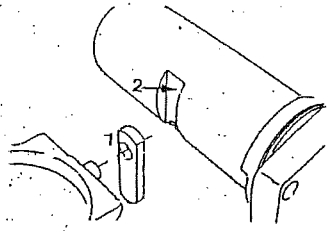
Kontrolle!
Zylinderbohrungen (1), Verzahnungen (2).

Check!
Cylinder bores (1), splines (2).



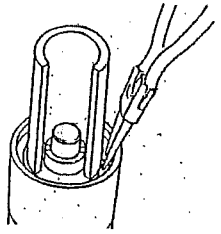
Kontrolle!
Zylindergleitfläche (1) riefenfrei.
Steuerplatte (2) nicht riefig.

Check!
Cylinder surface (1) free of scoring.
Control plate (2) without scoring.



Kontrolle!
Stellkolben - Schwenkwiegenverbindung
Gleitstein (1), Nut im Stellkolben (2), Stellkolben.

Check!
Positioning piston - cradle linkage
Gliding stone (1), groove at the positioning piston (2).
Positioning piston.



Stellkolben montieren.
Hinweis:
Auf korrekten Sitz der geteilten Ringe "achten".

Assemble positioning piston.
Instruction:
Observe correct fit of the divided rings.

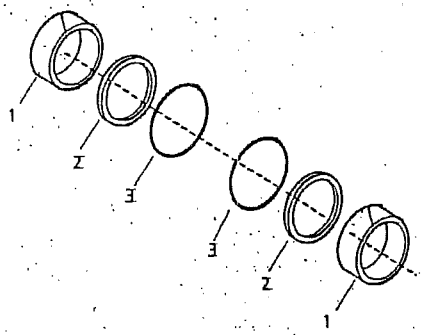
Gehäuse - Turcon-Glyd-Ring montieren / Assemble housing - Turcon-Glyd-ring

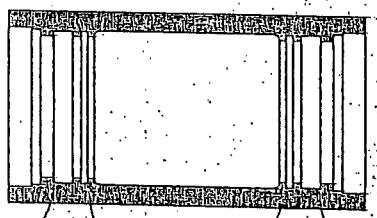
Hilfswerkzeuge / Auxiliary tools:

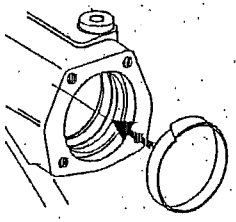
Montagezange / Assembly pliers: B+S x M22

Führungsdorn / Guide thorn: A4VG28 I: 277 4 347
A4VG40 I: 277 4 049
A4VG56 I: 277 4 050
A4VG71 I: 277 4 051
A4VG90 I: 277 4 052
A4VG125 I: 277 4 053
A4VG180 I: 277 4 054
A4VG250 I: 277 4 072

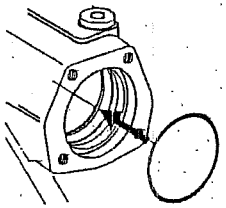
Montage / Assembly A4VG





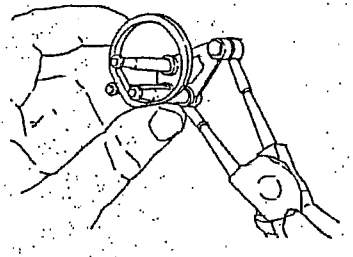


Pos. / Item 1: Stangenführungsring montieren.
Install barguide ring.

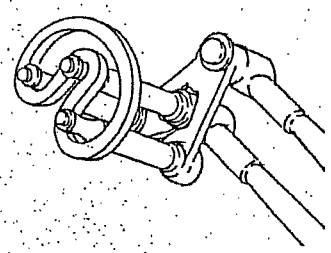


Pos. / Item 3: O-Ring montieren.
Install O-ring.

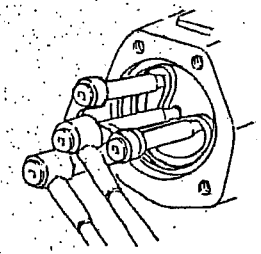
Gehäuse - Turcon-Glyd-Ring montieren / Assemble housing - Turcon-Glyd-ring



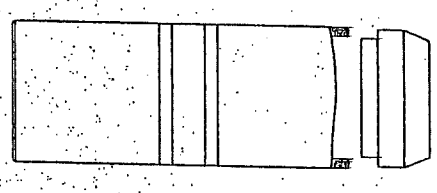
Dichtring (Pos. 2) in die Montagezange einlegen.
Fit the seal ring (Item 2) into the assembly tool.



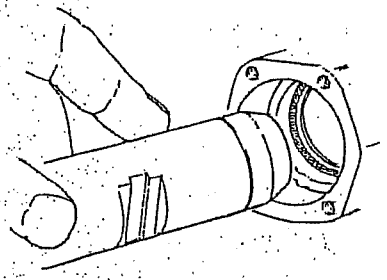
Dichtring mit Zangenschenkel nierenförmig zusammendrücken. Die Verformung von Turcon-Dichtungen ist sorgfältig vorzunehmen, damit die Dichtkanten nicht beschädigt werden.
Press the seal ring into the kidney shape using the assembly tool. The deformation of the Turcon seal has to be done with care so as not to damage the sealing edges.



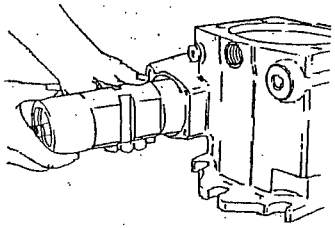
Dichtring ins Gehäuse einführen und in der Aufnahmenut plazieren. Dann Spannung lösen und Montagezange heraus ziehen. Lage des Dichtringes prüfen - eventuell mit dem Finger egalisieren.
Position the seal ring into the housing and place it into the groove. Release the tension and withdraw the assembly tool. Check the position of the seal ring if necessary straighten using a finger.



Führungsdorn in Stellkolben einbauen.
Insert guide thorn into the positioning piston.

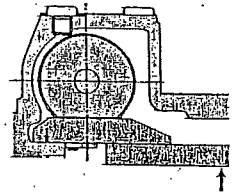


Führungsdorn leicht einfetten.
Stellkolben mit Führungsdorn einbauen.
Grease slightly guide thorn.
Install positioning piston with guide thorn.



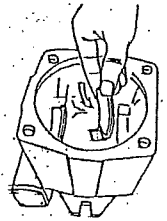
Stellkolben ins Gehäuse einsetzen.
Hinweis:
Stellkolben vor Einbau einölen.

Insert positioning piston into the housing.
Instruction:
Oil positioning piston before assembly.



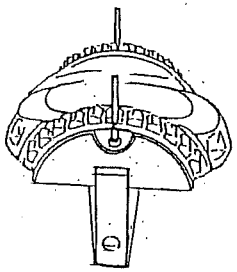
Stellkolben mit Hebel (Id.Nr. 2774491) ausrichten.
* Führung für Gleitstein - Schwenkwiege

Position stroke piston with lever (Id.No. 2774491).
* Sliding stone guidance in the piston.



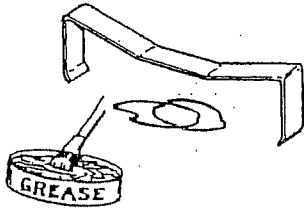
Lagerschalenpaar einsetzen.

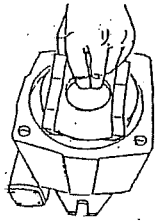
Insert bearing cup set.



Lager, Draht, Gleitstein und Gelenkstift montieren.
Montagehilfe: z.B. - Klammer / Gummiringe / Fett

Assemble bearing, wire, gliding stone and articulating pin.
Assistance: Devices e.g. - Clamp / rubber rings / grease



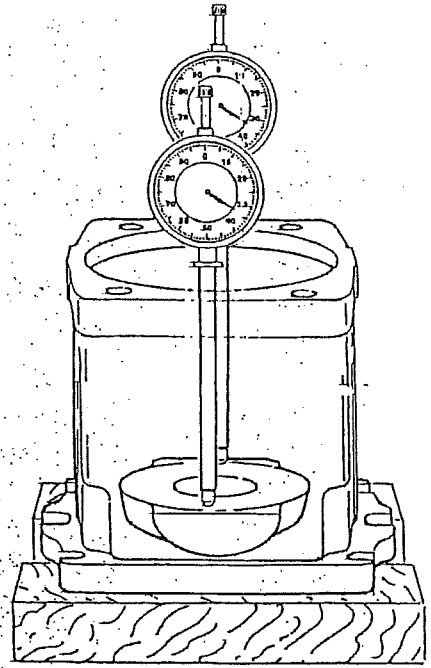


Schwenkwiege komplett ins Gehäuse einsetzen.
Auf korrekten Sitz der Schwenklager im Gehäuse "achten".

⚠ Montagehilfe ausbauen.

Insert completely swivel cradle into the housing.
Pay attention for correct seat of the swivel cradle in the housing.

⚠ Remove auxiliary device.

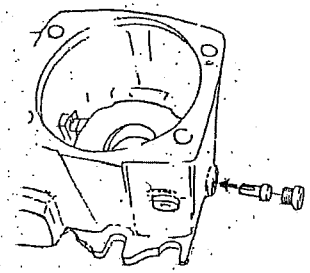


⚠ Kontrolle: Sitz der Schwenklager in der Lagerbahn.

Schwenkwiege mittig stellen mit Meßvorrichtung (Uhr oder Tiefenmaß)
Punkt 1 und 2 kontrollieren - gleiches Maß.

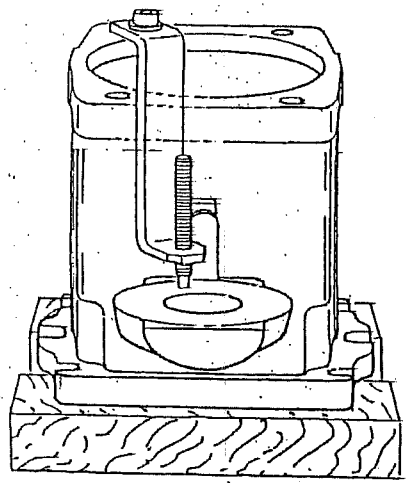
⚠ Check: Location of the swivel-bearing in the bearing.

Centralise the swivel by using a measuring device (dial gauge or depth measurement).
Check points 1 and 2 - they should have the same dimension.



Gelenkstift montieren.

Fit joint pin.



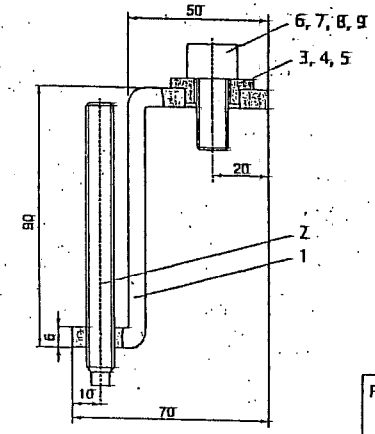
Haltevorrichtung montieren.
Mit Gewindestift Schwenkwiege festhalten.

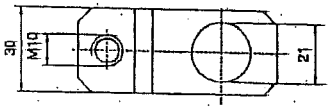
⚠ Keine Gewaltanwendung.

Fit holding device.
Hold swash plate in position utilising the set screw.

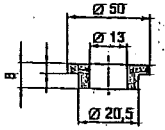
⚠ Do not use force.

Haltevorrichtung "Schwenkwiege" A4V
Holding device "swivel cradle" A4V

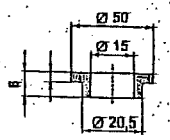




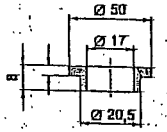
Teil/Part 3



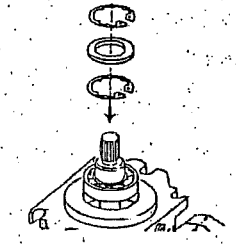
Teil/Part 4



Teil/Part 5

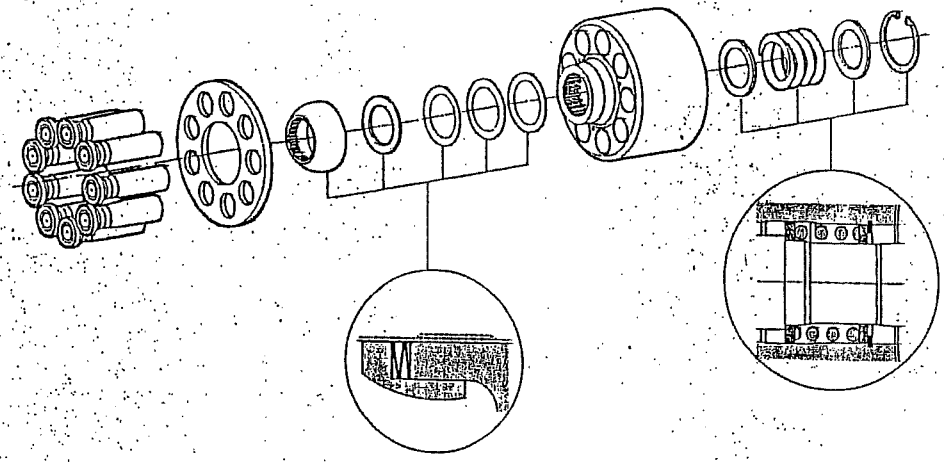


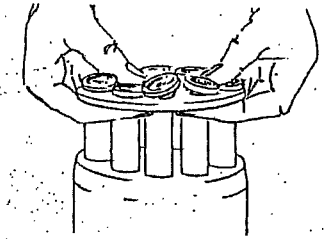
Pos./Item	Benennung/Designation	Stck./Qty.
1	Winkel/Angle	2
2	Gewindestift/Threaded pin	2
3	Scheibe/Shim	2
4	Scheibe/Shim	2
5	Scheibe/Shim	2
6	Zyl. Schraube/Cyl. screw M12 x 25 DIN 912	2
7	Zyl. Schraube/Cyl. screw M14 x 25 DIN 912	2
8	Zyl. Schraube/Cyl. screw M16 x 30 DIN 912	2
9	Zyl. Schraube/Cyl. screw M20 x 35 DIN 912	2



Neue Montageposition!
Triebwelle mit Lager und Wellendichtring einbauen.

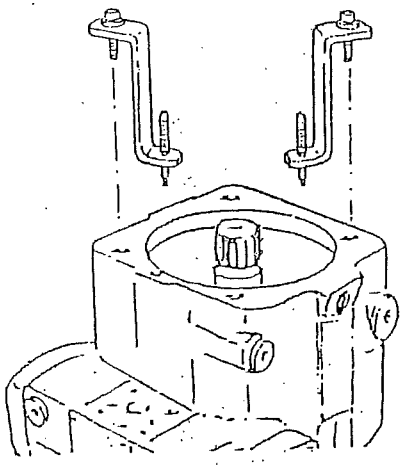
Assemble drive shaft with bearings and radial seal rings.





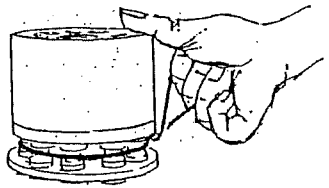
Kolben mit Rückzugeinrichtung montieren.
Hinweis:
Kolben, Gleitschuhe einölen.

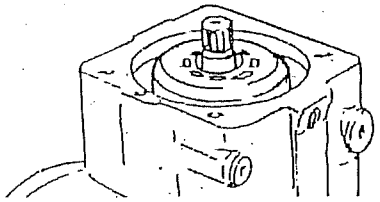
Assemble piston with retaining plate.
Note:
Oil piston and piston pad.



Vorrichtung ausbauen.
Zylinder mit Kolben und Rückzugeinrichtung einbauen.

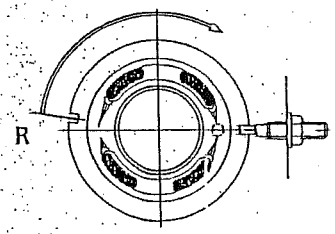
Remove holding device.
Fit cylinder complete with pistons and retaining device.





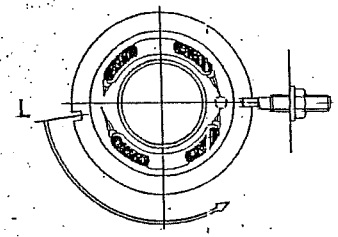
Montagehilfe:
Mit O-Ring Kolben festhalten.

Assembly aid:
Hold the pistons by using an O-ring.



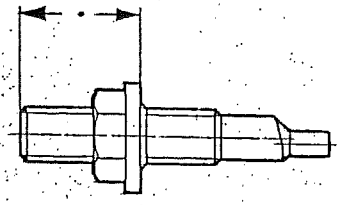
Steuerplatte Rechtslauf - in Drehrichtung verdreht.
Achtung!
Geräuschkerben sind drehrichtungsbezogen eingeschliffen.

Control plate clockwise rotation - indexed in the direction of rotation.
Note!
Noise grooves are machined - in based on direction of rotation.



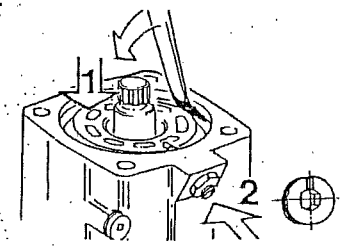
Steuerplatte Linkslauf - in Drehrichtung verdreht.
Achtung!
Geräuschkerben sind drehrichtungsbezogen eingeschliffen.

Control plate counter clockwise rotation - indexed in the direction of rotation.
Note!
Noise grooves are machined - in based on direction of rotation.



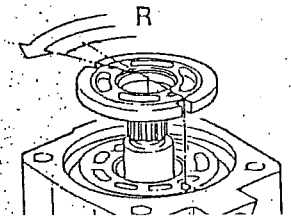
Grundeinstellung - Verdrillschraube /
Basic setting - indexing screw

A4VG...71 * = 28 ± 0,75 mm
A4VG...90 * = 29 ± 0,75 mm
A4VG...125 * = 20 ± 0,75 mm
A4VG...180 * = 22 ± 0,75 mm



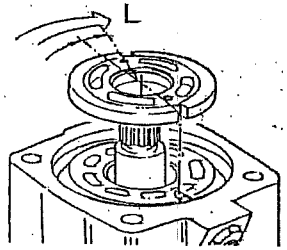
Zylinder nach unten drücken (1).
Verdrillschraube einbauen (2).
Kerbe in Montageposition.

Press the cylinder to the bottom (1).
Screw in the indexing screw (2).
Groove in mounting position.



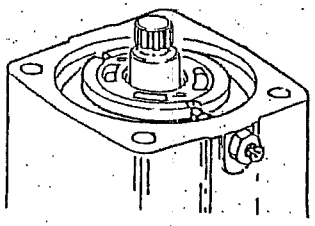
Steuerplatte einsetzen - Rechtslauf.

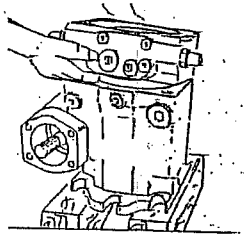
Insert the control plate - clockwise rotation.



Steuerplatte einsetzen - Linkslauf.

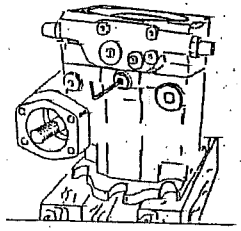
Insert the control plate - Counter- clockwise rotation.





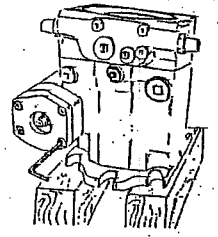
Anschlußplatte aufbauen.
Achtung! Federvorspannung!
Mit zwei Befestigungsschrauben überkreuz Anschlußplatte in Gehäuseführung einsetzen - Fertigmontage!

Assemble connection plate.
Attention! Spring preloaded!
Insert control plate into housing, guidance with two locking screws crossing over -Finish assembly!



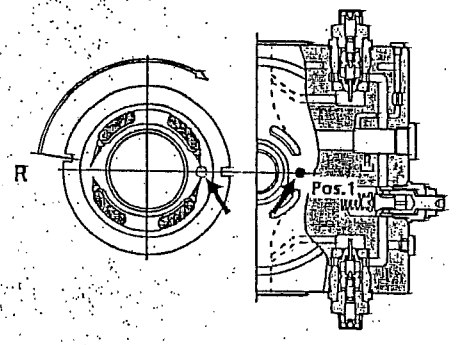
Verdrillschraube - Nach Markierung ausrichten.

Locking screw - Observe adjusting measure.



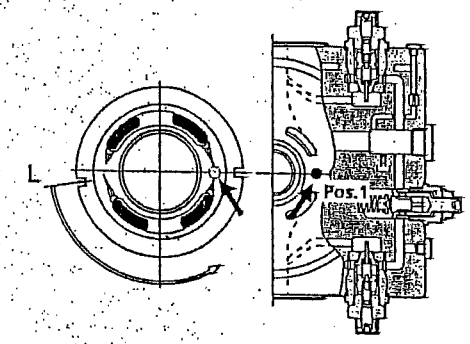
1. Deckel montieren.
2. Nullage nach Maß einstellen.

1. Assemble cover
2. Adjust zero position according to measure.



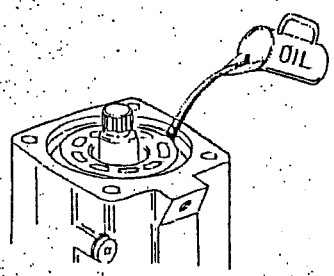
Steuerplatte Rechtslauf - in Drehrichtung verdreht.
Achtung!
Pos.1 Fixierstift
Geräuschkerben sind drehrichtungsbezogen eingeschliffen.

Control plate clockwise rotation - indexed in the direction of rotation.
Note!
Pos.1 Fixing pin
Noise grooves are machined - in based on direction of rotation.



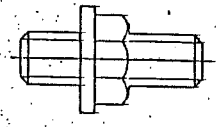
Steuerplatte Linkslauf - in Drehrichtung verdreht.
Achtung!
Pos.1 Fixierstift
Geräuschkerben sind drehrichtungsbezogen eingeschliffen.

Control plate counter clockwise rotation - indexed in the direction of rotation.
Note!
Pos.1 Fixing pin
Noise grooves are machined - in based on direction of rotation.



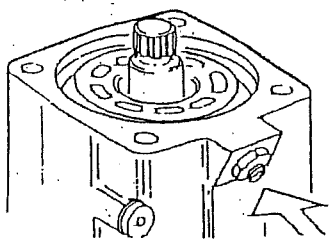
Zylinderflächen und DU-Lager einölen, neue O-Ringe mit Fett einreiben und einsetzen.

Oil the running surfaces of the cylinder barrel and the DU- bearing. Grease the O-rings and insert in grooves.



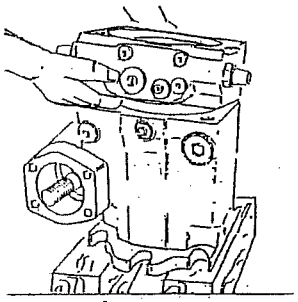
Verschlußschraube

Plug



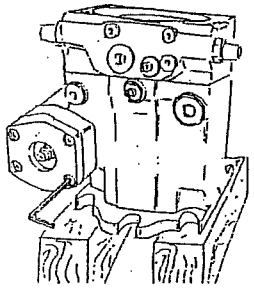
Verschlußschraube einbauen.

Screw in the plug.



Anschlußplatte mit Steuerplatte lagerichtig aufsetzen.
Hinweis:
EP, HD, HW -Steuerplatte mit Fett einsetzen.

Place port block with control plate in correct position.
Note:
EP, HD, HW - Put control plate with grease.



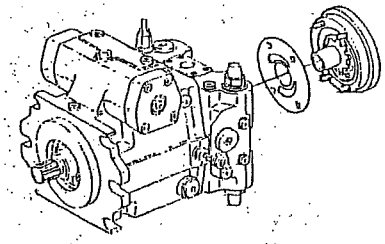
1. Deckel montieren.
2. Nullage nach Maß einstellen.

1. Assemble cover
2. Adjust zero position according to measure.



Achtung!
Korrekte mechanische Nullageneinstellung muß nach Einbau im Gerät bzw. Prüfstand erfolgen.

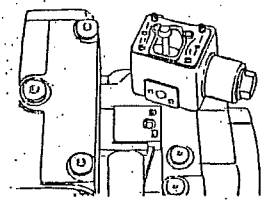
Attention!
Adjustments of the correct zero position to be carried out after installation into the machine or on the bench test.



Hilfspumpe montieren,
Hinweis: Drehrichtung beachten. (Siehe Seite 26, 27)

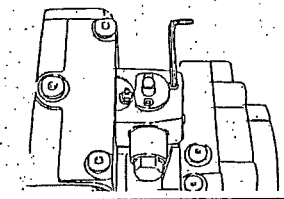
Assemble auxiliary pump.
Note: Take care of direction of rotation. (See page 26, 27)

NG 71



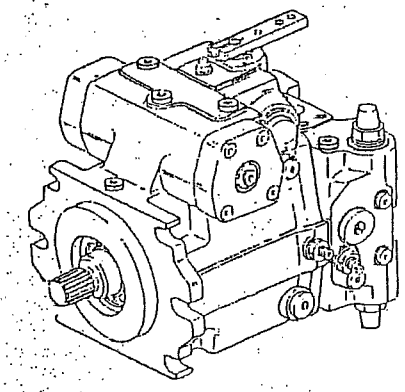
Dichtung mit zwei Befestigungschrauben zentrieren und Ansteuergerät einbauen.
Alle vier Schrauben mit halbem Drehmoment anziehen.

Centre the seal using two fixing screws and fit the control unit.
Tighten all four screws to half of specified torque.



Fünfte Schraube einsetzen und mit Drehmoment = 10,4 Nm festziehen.
Restliche vier Schrauben nach Drehmoment festziehen.

Fit the fifth screw and tighten to a torque of 10,4 Nm.
Then tighten the other four screws to there correct torque.



Ansteuergerät montieren.

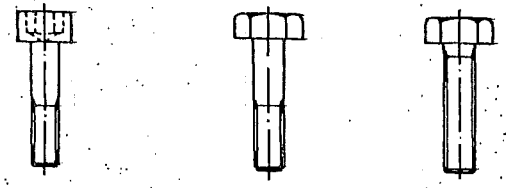
Assemble control device.

1. Schaftschrauben (nach N 08.001)

Die Werte gelten für Schaftschrauben mit metrischem ISO-Gewinde nach DIN 13 Teil 13, sowie Kopfauflagemaßen nach DIN 912 Zylinderschrauben, DIN 931 Sechskantschrauben mit Schaft bzw. DIN 933 Sechskantschrauben mit Gewinde bis Kopf.

1. Bolts (to N 08.001)

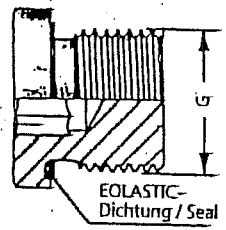
The values stated are valid for bolts with metric ISO threads to DIN 13 part 13, as well as head areas to DIN 912 socked head cap screws, DIN 931 hexagon bolt or DIN 933 hexagon bolts with threads up to the head.



Gewinde / Thread	Festigkeitsklassen / Tensile strength class		
	8.8	10.9	12.9
	Anziehdrehmoment / Tightening torque M_A in Nm		
M 3	1,1	1,6	1,9
M 4	3,1	4,5	5,3
M 5	6,1	8,9	10,4
M 6	10,4	15,5	18
M 8	25	37	43
M 10	51	75	87
M 12	87	130	150
M 14	140	205	240
M 16	215	310	370
M 18	300	430	510
M 20	430	620	720
M 22	580	830	970
M 24	740	1060	1240

2. Verschlußschrauben mit Innensechskant und Profildichtring (nach N 02.009).

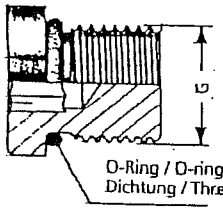
2. Plugs with internal hexagon and profile seal ring (to N 02.009).



Gewinde / Thread	Anziehdrehmoment / Tightening torque M_A in Nm	Gewinde / Thread	Anziehdrehmoment Tightening torque M_A in Nm
M8 x 1	5	G 1/8 A	10
M10 x 1	10	G 1/4 A	30
M12 x 1,5	20	G 3/8 A	35
M14 x 1,5	30	G 1/2 A	60
M16 x 1,5	35	G 3/4 A	90
M18 x 1,5	40	G 1 A	140
M20 x 1,5	50	G 1 1/4 A	240
M22 x 1,5	60	G 1 1/2 A	300
M26 x 1,5	70		
M27 x 2	90		
M30 x 1,5	100		
M33 x 2	140		
M42 x 2	240		
M48 x 2	300		

5. Verschlußschrauben mit Innensechskant, O-Ring und UNF-, UN-Gewinde nach SAE J 514 (nach N 02.106)

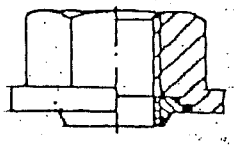
5. Plugs with internal hexagon, O-ring and UNF-, UN- threads to SAE J 514 (nach N 02.106)



Gewinde / Thread	Anziehdrehmoment M_A in Nm Tightening torque M_A in Nm	Gewinde / Thread	Anziehdrehmoment M_A in Nm Tightening torque M_A in Nm
7/16 - 20 UNF	15	M12 x 1,5	20
1/2 - 20 UNF	20	M14 x 1,5	30
9/16 - 18 UNF	25	M27 x 1,5	90
3/4 - 16 UNF	72		
7/8 - 14 UN	127		
1 1/16 - 12 UN	147		
1 3/16 - 12 UN	173		
1 5/16 - 12 UN	198		
1 5/8 - 12 UN	320		
1 7/8 - 12 UN	390		

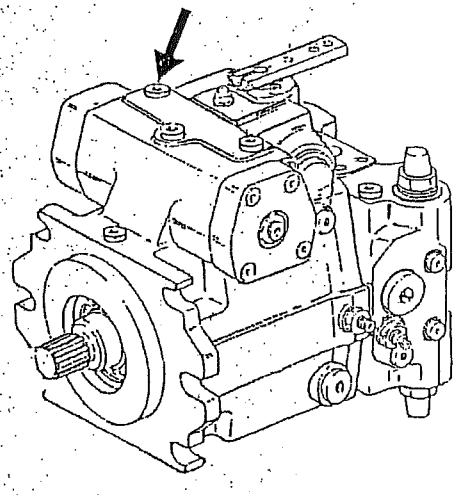
6. SEAL-LOCK-Dichtmuttern (nach N 02.100)

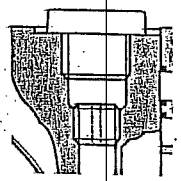
6. SEAL-LOCK - sealing nuts (to N 02.100)

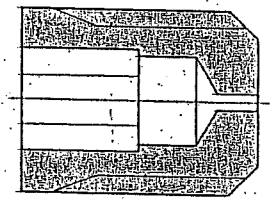


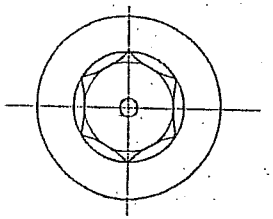
Gewinde / Thread	Anziehdrehmoment M_A in Nm Tightening torque M_A in Nm
M6	10
M6 x 0,5	11
M8	22
M8 x 1	24
M10	40
M10 x 1	44
M12	69
M12 x 1,5	72
M14	110
M14 x 1,5	120
M16	170
M16 x 1,5	180

A10V - Düsen / orifices









Gewinde / Thread	Anziehdremomente Nm / Tightening torques Nm	
	bisher / up to	neu / new
M6	6,5	3
M10	28	12

Allgemein

- Machen Sie sich mit der Ausstattung der Maschine vertraut.
- Fahren Sie die Maschine nur, wenn Sie sich völlig mit den Bedien- und Steuerelementen sowie der Arbeitsweise der Maschine vertraut gemacht haben.
- Benutzen Sie Ihre Schutzausrüstung wie Schutzhelm, Sicherheitsschuhe und Gehörschutz.
- Machen Sie sich mit Ihrem Arbeitsgebiet vertraut.
- Benutzen Sie die Maschine nur für den ihr zugedachten Zweck.

Beachten Sie bitte die Richtlinien der Berufsgenossenschaft und des Maschinenherstellers



Vor dem Start

- Beachten Sie die Bedienungshinweise vor dem Starten.
- Prüfen Sie die Maschine auf auffällige Fehler.
- Fahren Sie die Maschine nicht mit defekten Instrumenten, Kontrolleuchten oder Steuerorganen.
- Alle Schutzvorrichtungen müssen fest auf ihrem Platz sein.
- Nehmen Sie keine losen Gegenstände mit bzw. befestigen Sie diese an der Maschine.
- Halten Sie die Maschine von öligem und zündfähigem Material frei.
- Prüfen Sie vor dem Besteigen der Maschine, ob sich Personen oder Hindernisse neben oder unter der Maschine befinden.
- Vorsicht beim Besteigen der Maschine, benützen Sie Treppen und Griffe.
- Stellen Sie vor dem Start Ihren Sitz ein.

General advice

- Make yourself familiar with the equipment of the machine.
- Only operate the machine if your are completely familiar with the operating and control elements as well as the functioning of the machine.
- Use your safety equipment like helmet, safety shoes and hearing protection.
- Make yourself familiar with your working field.
- Only operate the machine for its intended purpose.

Please observe the guidelines of the Professional Association and the machine manufacturer.



Before starting

- Observe the operating instructions before starting.
- Check the machine for obvious faults.
- Do not operate the machine with defective instruments, warning lights or control elements.
- All safety devices must be in a secure position.
- Do not carry with you movable objects or secure them to the machine.
- Keep oily and inflammable material away from the machine.
- Before entering the driver's cabin, check if persons or obstacles are beside or beneath the machine.
- Be careful when entering the driver's cabin, use stairs and handles.
- Adjust your seat before starting.

Starten

- Beim Starten müssen alle Bedienhebel in "Neutralstellung" stehen.
- Die Maschine nur vom Fahrersitz aus Starten.
- Prüfen Sie die Anzeigeinstrumente nach dem Start, um sicher zu gehen, daß alles ordnungsgemäß funktioniert.
- Lassen Sie die Maschine nicht unbewacht, während der Motor läuft.
- Beim Start mit Batterieverbindungskabeln verbinden Sie Plus mit Plus und Minus mit Minus. Massekabel (Minus) immer zuletzt anschliesen und zuerst abtrennen.

Vorsicht

- Auspuffgase sind lebensgefährlich. Bei Start in geschlossenen Räumen für ausreichende Luftzufuhr sorgen!

Hydraulikanlage

1. Hydraulikanlage steht unter hohem Druck!

   ⚠ Unter hohem Druck austretende Hochdruck-Flüssigkeiten (Kraftstoff, Hydrauliköl) können die Haut durchdringen und schwere Verletzungen verursachen. Daher sofort einen Arzt aufsuchen, da anderenfalls schwere Infektionen entstehen können!
2. Bei der Suche nach Leckstellen wegen Verletzungsgefahr geeignete Hilfsmittel verwenden!
3. Vor Arbeiten an der Hydraulikanlage diese unbedingt drucklos machen und angebaute Geräte absenken!
4. Bei Arbeiten an der Hydraulikanlage unbedingt Motor abstellen und Maschine gegen Wegrollen sichern (Feststellbremse, Unterlegkeil)!
5. Beim Anschließen von Hydraulikzylindern und -motoren ist auf vorgeschriebenen Anschluß der Hydraulikschläuche zu achten!
6. Bei Vertauschen der Anschlüsse umgekehrte Funktionen (z.B. Heben/Senken) - Unfallgefahr!
7. Hydraulikschlauchleitungen regelmäßig kontrollieren und bei Beschädigung und Alterung austauschen! Die Austauschschlauchleitungen müssen den technischen Anforderungen des Geräteherstellers entsprechen!

⚠ Öle, Kraftstoffe und Filter ordnungsgemäß entsorgen!

Start

- When starting all operating levers must be in "neutral position".
- Only start the machine from the driver's seat
- Check the indicating instruments after start to assure that all functions are in order.
- Do not leave the machine unobserved when the motor is running.
- When starting with battery connection cables connect plus with plus and minus with minus. Always connect negative (-) cable last and disconnect negative cable first.

Attention

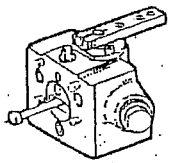
- Exhaust gas is dangerous. Assure sufficient fresh air when starting in closed rooms!

Hydraulic equipment

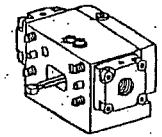
1. Hydraulic equipment is standing under high pressure.

   ⚠ High pressure fluids (fuel, hydraulic oil) which escape under high pressure can penetrate the skin and cause heavy injuries. Therefore immediately consult a doctor as otherwise heavy infections can be caused.
2. When searching leakages use appropriate auxiliary devices because of the danger of accidents.
3. Before working at the hydraulic equipment, lower pressure to zero and lower working arms of the machine.
4. When working at the hydraulic equipment, absolutely stop motor and secure machine against rolling away (parking brake, shim)!
5. When connecting hydraulic cylinders and motor pay attention to correct connection of hydraulic flexible hoses.
6. In case of exchanging the ports, the functions are vice versa (f. ex. lift-up/lower) - danger of accidents!
7. Check hydraulic flexible hoses regularly and replace them in case of dammage or wear! The new hose pipes must comply with the technical requirements of the machine manufacturer!

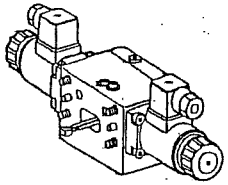
⚠ Orderly disposal or recycling of oil, fuel and filters!



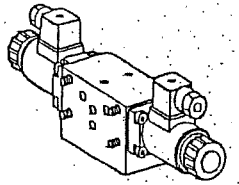
HW



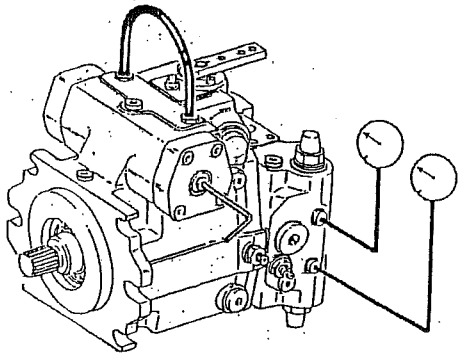
HD



EP

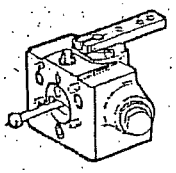


DA

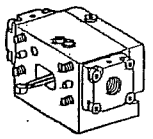


Achtung!
Sicherheitsbestimmungen beachten!
Mit Schlauch NW6 beide Stellkammern verbinden. Vermeidung von Restsignal aus hydraulischer Nullage.
Manometer an M_A und M_B anschließen.
Nullage so einstellen, daß bei blockiertem Antrieb beide Manometer auf gleichem Druckwert stehen.
Hinweis:
Totband der Nullage - vermitteln.

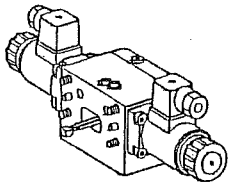
Attention!
Observe safety regulations!
Connect both control chambers with hose NW6. Avoidance of rest signal from hydraulic zero position.
Connect manometer to M_A and M_B. Adjust zero position so that at blocked drive both manometer indicate the same pressure valve.
Note:
Adjust death line of zero position.



HW



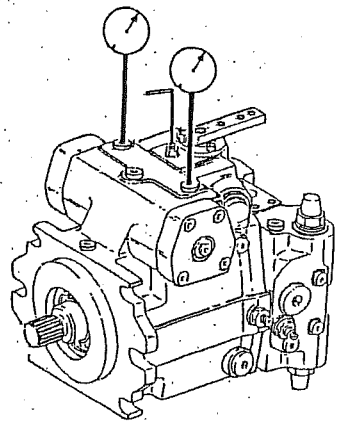
HD



EP

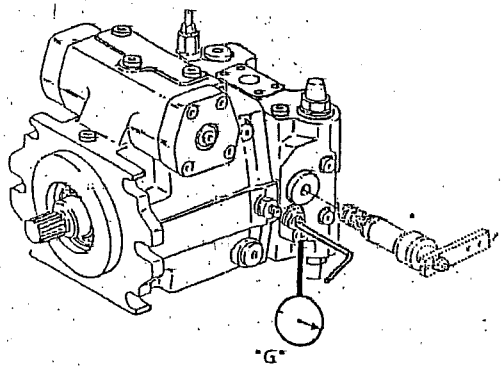
Achtung!
Sicherheitsbestimmungen beachten!

Attention!
Observe safety regulations!



Manometer an X_1 und X_2 anschließen.
Nullage so einstellen, daß bei blockiertem Antrieb beide Manometer auf gleichem Druckwert stehen.
Hinweis:
Excenterjustierung
- nicht über ±90° verdrehen.

Connect manometer to X_1 and X_2.
Adjust zero position so that at blocked drive both manometer indicate the same pressure value.
Note:
Eccentric adjusting
- Do not turn over ±90°.



Achtung!
Sicherheitsbestimmungen beachten!

Hinweis:
Nachjustierung nur bei Betriebstemperatur.

Manometer an "G" anschließen.

Achtung!
* Speisedruckeinstellung!
Nenndruck p_N - 18 bar
Höchstdruck p_H - 40 bar
Bei Max.-Drehzahl.

Hinweis:
Einstelldaten nach Werksauftrag.

* bei DA-Ausführung

Attention!
Observe safety regulations!

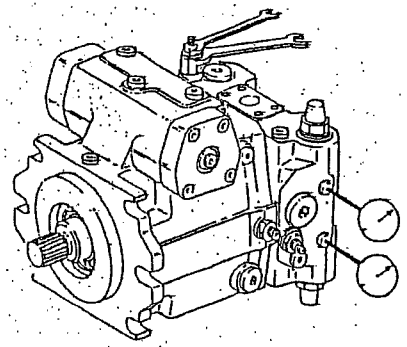
Note:
Readjusting only at operating temperature.

Connect manometer to "G".

Attention!
* Boost pressure setting!
Nominal pressure p_N - 18 bar
Peak pressure p_H - 40 bar
at max. speed.

Note:
Adjusting data according to order.

Druckabschneidung
Pressure cut-off



Achtung!
Sicherheitsbestimmungen beachten!

HD-Ventil ohne Bypass

1. HD-Ventile sind immer 10% höher eingestellt als die Druckabschneidung.
Bei Veränderung eines Einstellwertes immer beide kontrollieren.
2. Nachjustierung nur bei Betriebstemperatur

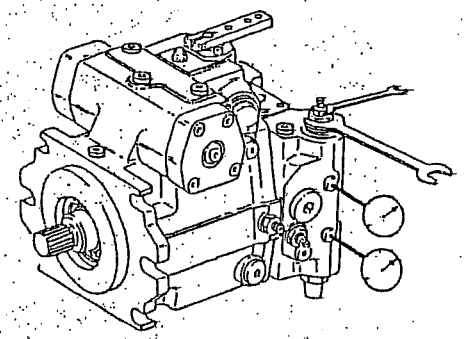
Manometer an M_A und M_B anschließen.
Druckabschneidung: Maß X Einstellschrauben notieren!
Einstellschraube auf Block drehen.

HD-Ventile: Mit geringer Pumpenmenge über Ventile fahren. Einstellwert kontrollieren.
(Nur kurzzeitig "Temperatur".)

Drucklos: Einstellwert verändern - Kontrolle

Druckabschneidung:
Einstellschraube auf Maß (*) zurückdrehen.
Druckwert kontrollieren bzw. nachjustieren.
Achtung! Differenz von 10% HD-Ventile und Druckabschneidung beachten!
Hinweis: Einstelldaten nach Werksauftrag.

HD-Ventile
HP-valves



Attention!
Observe safety regulations.

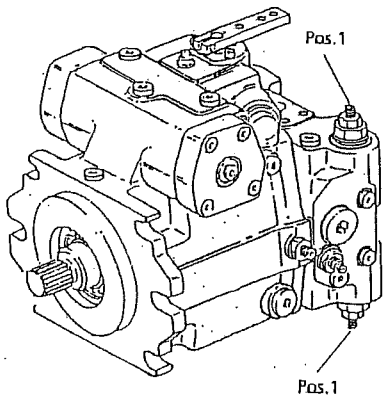
HP valve without bypass-function

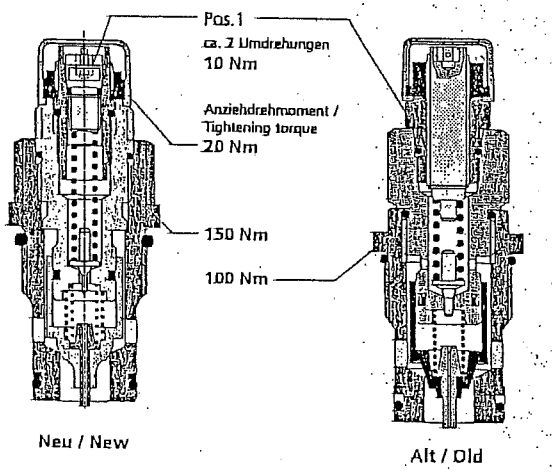
1. HP valves are always adjusted 10% higher than the pressure cut-off.
If one setting value is changed, always check both values.
2. Readjusting only at operating temperature.

Connect manometer M_A and M_B.
Pressure cut-off: Note measure X setting screw! Turn setting screw on block.
HP valves: Operate valves with small pump flow volume.
Check setting value. ("temperature" only for a short time).
Change setting value - check.

Pressure cut-off:
Turn back setting screw to measure (*).
Check pressure value and readjust.
Attention! Observe 10% pressure difference HP valves and pressure cut-off!

A4VG 71 - 90





Fahrzeuge mit rein-hydrostatischem Fahrantrieb bzw. mit hydrostatischem Fahrantrieb und Schaltgetriebe ohne Leerlaufstellung (Freilauf).

Hydrostatischer Antrieb / Bypaß-Schaltung

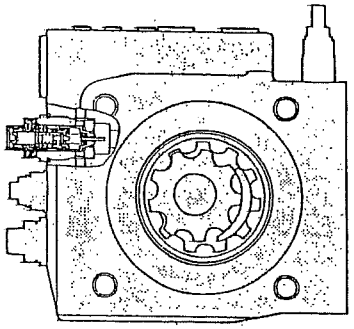
In diesem Fall wird der Fahrantrieb auf freien Umlauf geschaltet. Zu diesem Zweck haben die in der Verstellpumpe integrierten Hochdruckbegrenzungsventile eine sogenannte Bypaß-Funktion. D.h. durch Drehen der entsprechenden Schraube (Pos.1) wird der Ventil-Einsatz so entspannt, daß ein freier Öl-Umlauf möglich ist.

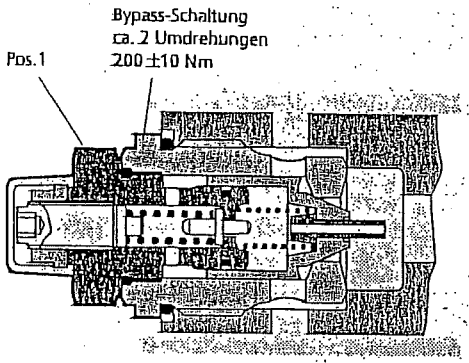
Vehicle with hydrostatic transmission and gear shift without idling setting position (free wheeling).

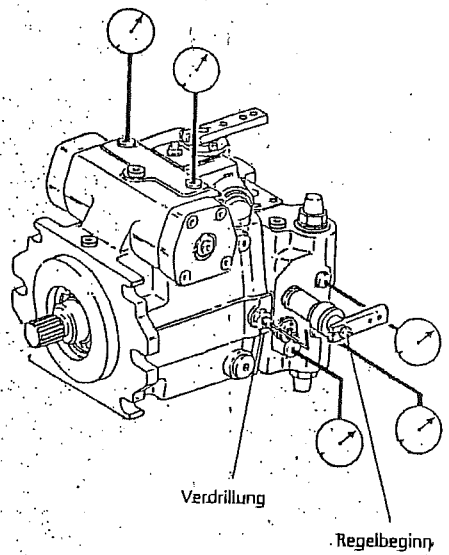
Hydrostatic transmission / Bypass-switching

In this case the travel transmission is switched on to free wheeling. For this purpose the variable displacement pump has incorporated high pressure relief valves with bypass function.
The screw (item 1) is unscrewed to such an extent, that the valve cartridge is released and free oil circulation is possible.

A4VG 125 - 250







Achtung!
Sicherheitsbestimmungen beachten!

Überprüfung der Einstelldaten
Betriebstemperatur soll während des Überprüfungsvorgangs weitgehend konstant gehalten werden.
Antriebsmotor starten, Leerlaufdrehzahl

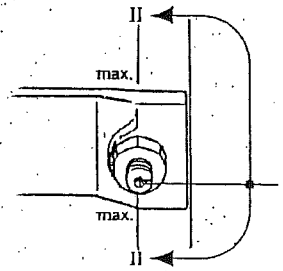
Blockzustand
Fahrtrichtungsschalter "0"
Motordrehzahl langsam steigern bis zur max. Motordrehzahl, dabei Meßgeräte beobachten.
Speisedruck:
Leerlaufdrehzahl
Psp = ca. 15-20 bar
max. Motordrehzahl
Psp = ... bar*

Blockzustand
Fahrtrichtungsschalter - vorwärts
(Straßengang und Festgebremst)

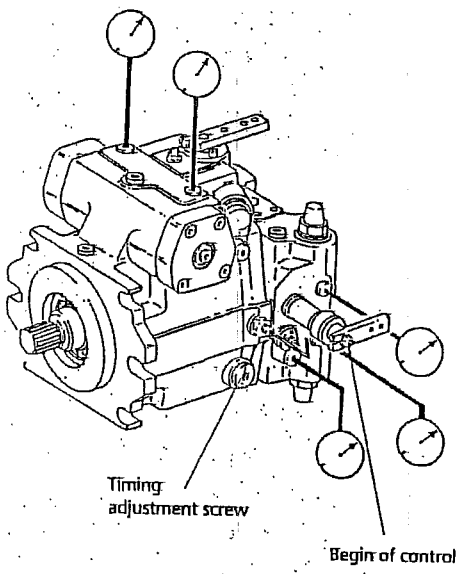
Einstelldaten Pumpe A4V/DA überprüfen
Regelbeginn
HD 40 - 50 bar
Motordrehzahl . . min.⁻¹ * Psp . . . . . bar*
HD . . . . . bar
Nachjustierung - Regelbeginnschraube

Regelende
HD . . . . . bar*
Motordrehzahl . . . . . min.⁻¹ * Psp . . . . . bar*
Nachjustierung - Verdrillschraube

Hinweis:
Excenterjustierung - Drehrichtung beachten



Hinweis: * Einstelldaten nach Werksauftrag!



Attention!
Observe safety regulations!

Check setting data.
Operating temperature should be kept largely constant during the check procedure.
Start prime mover, idle speed.

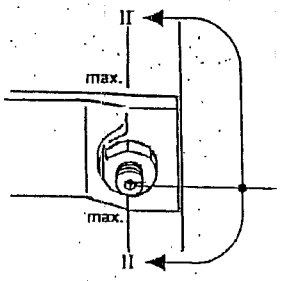
Block position
Drive direction switch - "0".
Slowly increase motor speed up to the max. motor speed and thereby observe measuring instruments.

Boost pressure:
Idle speed of prime mover
Psp = approx. 15 - 20 bar
max. motor speed
Psp = ... bar*

Block position
Drive direction switch - forward
(Road gear and fully applied brake)

Check setting data pump A4VIDA
Begin of control:
HD 40 - 50 bar
Motor speed . . . . . rpm* Psp . . . . . bar*
HD . . . . . bar*
Readjusting - control start screw

End of control
HD . . . . . bar
Motor speed . . . . . rpm* Psp . . . . . bar*
Readjusting timing adjustment screw



Note:
Eccentric adjusting - observe direction of rotation

* Setting data according to order!

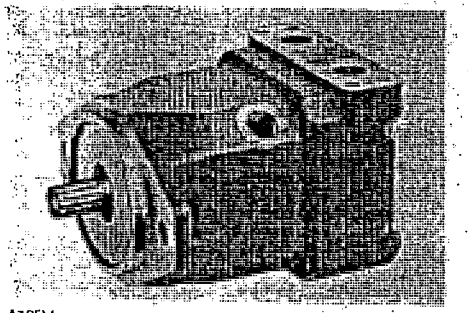
Brueninghaus Hydromatik GmbH, Werk Elchingen, Glockeraustraße 2, D-89275 Elchingen, Tel. (07308) 820, Fax (07308) 7274, E-Mail: service.elchingen@bru-hyd.com
Brueninghaus Hydromatik GmbH, Werk Horb, An der Kelterwiesen 14, D-72160 Horb, Tel. (07451) 920, Fax (07451) 8221, E-Mail: service.horb@bru-hyd.com

RE 91 172/07.98
Replaces : 05.95

engineering
mannesmann
Rexroth

Fixed displacement motor A10FM
Fixed displacement plug-in motor A10FE
for open and closed circuit applications

Size 23 - 63
Series 5
Nominal pressure 280 bar
Peak pressure 350 bar



A10FM

Contents

Features	1
Ordering code / standard range	2
Hydraulic fluid, filtration	3
Technical data	4
Unit sizes A10FM 23-28	5
Unit sizes A10FE 23-28	6
Unit sizes A10FM 37-45	7
Unit sizes A10FE 37-45	8
Unit sizes A10FM 63	9
Integrated flushing valve	10
Series A10, range of motors	11
Series A10, range of pumps	12

Features

- Fixed displacement motor, axial piston in swashplate design for hydrostatic transmissions in open and closed circuit applications
- Output speed directly proportional to the inlet flow rate and inversely proportional to the motor displacement
- Output torque increases with the pressure gradient between high and low-pressure sides
- For mobile and stationary use
- Long service life
- High permissible output speed
- Tried-and-tested A10 power unit technology
- Favourable power/weight ratio – compact size
- Low noise
- Mechanical and hydraulic connections to SAE standards
- 2-hole special mounting flange for A10FE

- Further information:

Fixed displacement motor A10FSM Size 18	RE 91 180
Variable displacement motor A10VM/E Size 28 - 60	RE 91 703
Hydrostatic fan drives for vehicles	RE 98 065

Brueninghaus Hydromatik

Ordering code / standard range

A10F | | | / | 5 | 2 | W | – | V | | | | | |

Hydraulic fluid
Mineral oil (without abbreviation)

Axial piston pump
Swashplate design, fixed displacement, nominal press. 280 bar, peak press. 350 bar: A10F

Operating mode
Motor: M
Plug-in motor: E

Size
= Motor displacement V_g in cm³

23*	28*	37*	45*	63	80
●	●	●	●	●	D

Series
5

Index
2

Direction of rotation (Viewing onto shaft end)
changing: W

Seal
FPM (fluororubber to DIN ISO 1629): V

Shaft end

	23	28	37	45	63	
SAE splined shaft	●	●	●	●	D	R
SAE splined shaft	D	D	●	●	●	W
Tapered with threaded pin and feather key	●	●	●	●	D	C

Mounting flange

SAE 2-hole flange for A10FM	●	●	●	●	●	C
Special 2-hole flange for A10FE	●	●	●	●	D	F

Ports for service lines

	23	28	37	45	63	
Ports A/B at side - same side; SAE, UNC fixing screws	●	●	●	●	●	60N00
Ports A/B at side - same side; SAE, metric fixing screws	●	●	●	●	●	10N00
Ports A/B at side - same side; metric screw connection	D	D	D	D	D	16N00
Ports A/B at side - same side; UNF screw connection	D	D	D	D	D	66N00
Ports A/B at rear; SAE, UNC fixing screws	D	D	D	D	D	61N00
Ports A/B at rear; SAE, metric fixing screws	D	D	D	D	D	11N00
Ports A/B at rear; UNF screw connection	D	D	D	D	D	64N00

Valves

Without valves	●	●	●	●	●	D
Integrated flushing valve, only with ports at side (60N00, 10N00, 16N00 and 66N00)	●	●	●	●	D	7

Speed monitoring

Without speed sensing (no code)	–
Prepared for speed sensing, A10FM only	D

Planning note for sizes 23, 28, 37 and 45
Replacement service for pressure range 250/315 bar with previous mounting patterns on request

● = available D = in preparation

Hydraulic fluid

Please refer to our catalogue sheets RE 90220 (mineral oil) and RE 90221 (environmentally friendly hydraulic fluids) for detailed information on selecting hydraulic fluids and on service conditions before the project planning stage.

Operation with environmentally friendly hydraulic fluids may result in modifications to the technical specifications; please consult us if necessary (the hydraulic fluid used must be clearly stated in the order).

Operating viscosity range

We recommend selecting the service viscosity (at operating temperature) in the range of

v_{opt} = opt. service viscosity 16...36 mm²/s

for optimum efficiency and useful life, referred to the circulation temperature - closed circuit or tank temperature for open circuit.

Limiting viscosity range

Service limits are set at the following values:

v_{min} = 5 mm²/s

briefly at max. permissible leakage oil temperature of t_{max} = 115 °C.

Note that the maximum fluid temperature must not exceed 115 °C at any point (e.g. around bearings).

v_{max} = 1600 mm²/s

briefly on cold start (t_{min} = -40 °C).

Special precautions are required at temperatures between -25 °C and -40 °C, depending on the installation conditions. Please consult the manufacturer.

Hydraulic fluid filtering

The more efficient the filtration, the cleaner the fluid becomes and the longer the service life of the unit.

To ensure operational reliability, the service fluid must conform to at least purity class 9 to NAS 1638

18/15 to ISO/DIS 4406.

Please consult the manufacturer if the above classes cannot be maintained.

Comment on selecting hydraulic fluid

The service temperature in the circuit - for closed circuit, for open circuit - the tank temperature must be known as a function of the ambient temperature in order to choose the correct hydraulic fluid.

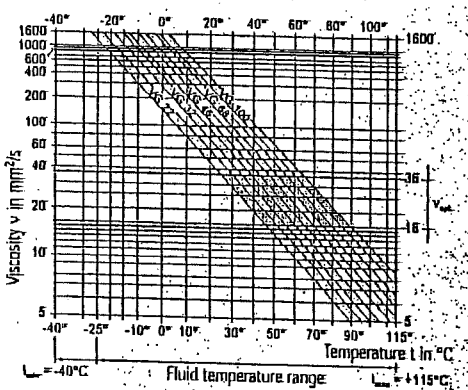
The hydraulic fluid must be selected in such a way that service viscosity lies within the optimum range (v_{opt}) for the operating temperature span, see shaded area in the chart. We recommend selecting the next higher viscosity class in each case.

Example: A service temperature of 60 °C is established in the circuit at an ambient temperature of X °C. Given the optimum service viscosity range (v_{opt}; shaded area), this will require viscosity classes VG 46 or VG 68; class to select: VG 68.

Note: The leakage oil temperature depends on the pressure and speed and is always higher than the temperature in circulation/tank. However, temperature must not exceed 115 °C anywhere in the system.

Please contact us if it is not possible to meet the above conditions due to extreme service parameters or high ambient temperature.

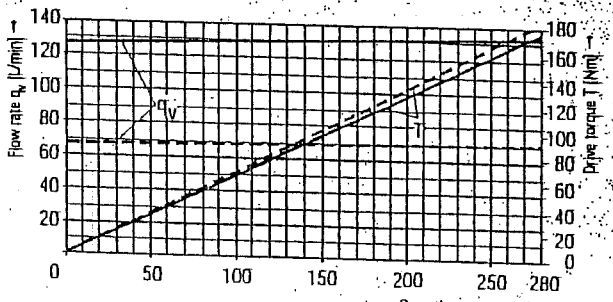
Selection chart



Flow rate and drive torque

(Operating fluid: hydraulic oil to ISO VG 46 DIN 51519, t=50 °C)

Example:
Size 45
Displacement V_g = 45 cm³
$p_{inl\,abs}$ = 1 bar
n= 1500 min⁻¹ ------
n= 2800 min⁻¹ ——



Other sizes on request.

Technical data

Operating pressure range

Pressure at port A or B
(Pressure data to DIN 24312)

Nominal pressure p_N ——— 280 bar
Peak pressure p_{max} ——— 350 bar

The sum of the pressures at ports A and B may not exceed 560 bar.

Case drain pressure

Maximum permissible leakage fluid pressure at ports L and L_1
$p_{abs\,max}$ ——— 2 bar abs.

Installation position

Any. The motor housing must be filled with hydraulic fluid when starting up and during operation. The drain line must be arranged so that the housing does not empty itself when the motor is stationary. The end of the line must enter the tank below the minimum oil level.

The port, located at the highest point must be used in all installation positions to fill the housing and to connect the drain line.

Direction of rotation

Pressure in A = Clockwise rotation
Pressure in B = Anti-clockwise rotation

Symbol

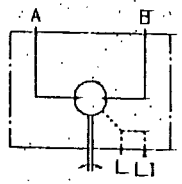
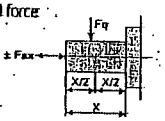


Table of values (theoretical values, without considering η_{mh} and η_v; values rounded)

Size					23	28	37	45	63
Motor displacement			$V_{g\,max}$	cm³	23.5	28.5	36.7	44.5	63.1
Max. speed [1]			n_{max}	rpm	4900	4700	4200	4000	3400
Max. inlet flow rate	at n_{max}		$q_{v\,max}$	L/min	115	134	154	178	215
Max. power	at n_{max}	Δp = 280 bar	P_{max}	kW	43.6	62.5	71.8	83.1	100.1
Max. torque	at $V_{g\,max}$	Δp = 280 bar	T_{max}	Nm	105	127	163	198	281
Mass moment of inertia (about the output shaft)			J	kgm²	0.0017	0.0017	0.0033	0.0033	0.0056
Filling volume, approx.				L	0.6	0.6	0.7	0.7	0.8
Weight, approx.			m	kg	12	12	17	17	22
Permissible load on output shaft, max. perm. axial force			$F_{ax\,max}$	N	1000	1000	1500	1500	2000
Max. perm. radial force			$F_{q\,max}$	N	1200	1200	1500	1500	1700
Actual starting torque at n = 0 rpm		Δp = 280 bar		Nm	58	85	92	138	182

[1] The low pressure of 16 bar must be present for max. speed.

Applied force



Calculating size

Inlet flow rate $q_v = \frac{V_g \cdot n}{1000 \cdot \eta_v}$ in L/min

Torque $T = \frac{1.59 \cdot V_g \cdot \Delta p \cdot \eta_{mh}}{100}$ in Nm

Output power $P = \frac{T \cdot n}{9549} = \frac{q_v \cdot \Delta p \cdot \eta_t}{600}$ in kW

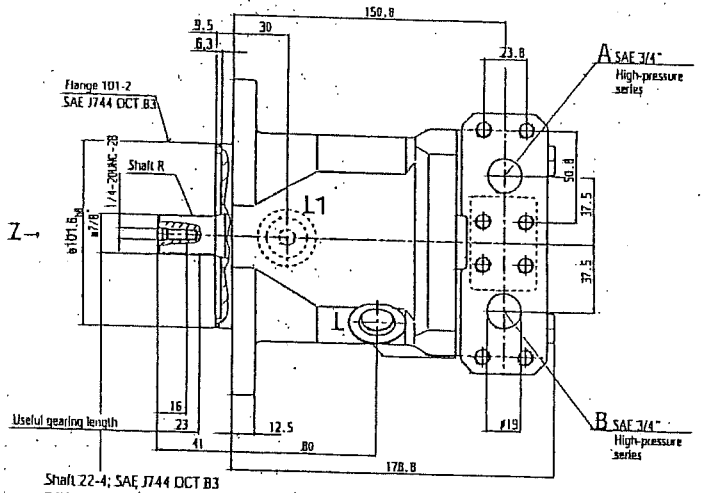
Output speed $n = \frac{q_v \cdot 1000 \cdot \eta_v}{V_g}$ in rpm

V_g = geometric motor displacement per revolution in cm³
Δp = pressure differential in bar
n = speed in rpm
η_v = volumetric efficiency
η_{mh} = mechanical-hydraulic efficiency
η_t = total efficiency ($\eta_t = \eta_v \cdot \eta_{mh}$)

Unit dimensions A10FM; sizes 23 and 28

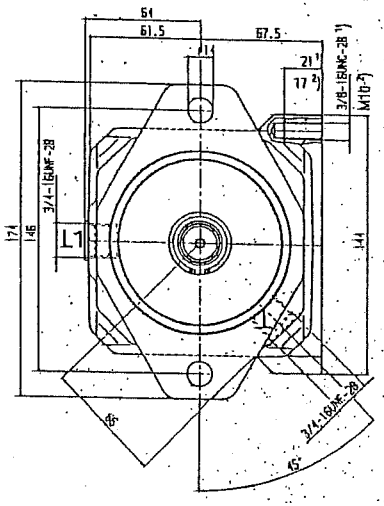
Before finalising your design, please request certified assembly drawing.

Port plates 60 / 10
Shaft R



Shaft 22-4; SAE J744 OCT B3
7/8" dia. splined shaft; 30° pressure angle; 13 teeth;
16/32 pitch; flat base; flank centering;
fit class 5; ANSI B92. 1a-1976

View Z



1) for port plate 60
2) for port plate 10

Ports

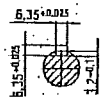
A,B	Pressure ports	SAE 3/4", high-pressure series
L, L_1	Drain ports	7/8 - 14 UNF - 2B

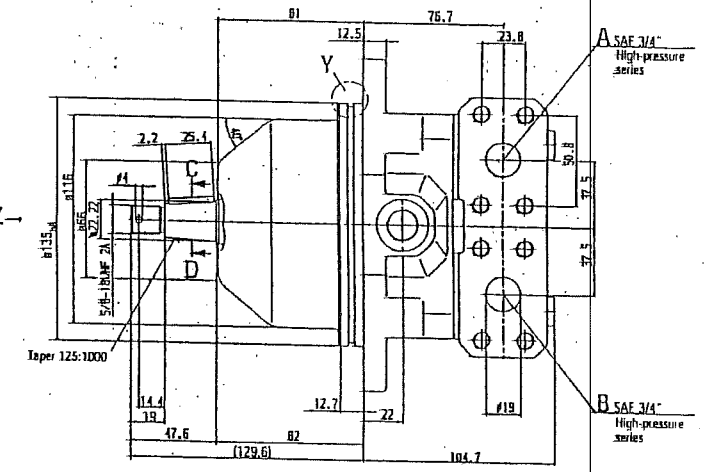
Unit dimensions A10FE; sizes 23 and 28

Before finalising your design, please request certified assembly drawing.

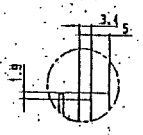
Port plates 60 / 10
Shaft C

Section C-D

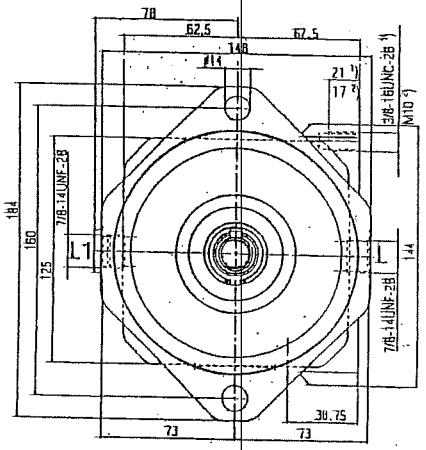




Detail Y



View Z



1) for port plate 60
2) for port plate 10

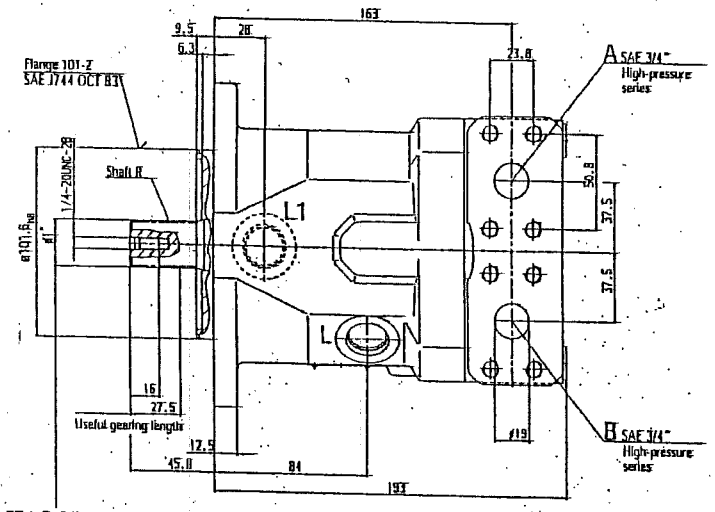
Ports

A,B	Pressure ports	SAE 3/4", High-pressure series
L, L_1	Drain ports	7/8 - 14 UNF - 2B

Unit dimensions A10FM; sizes 37 and 45

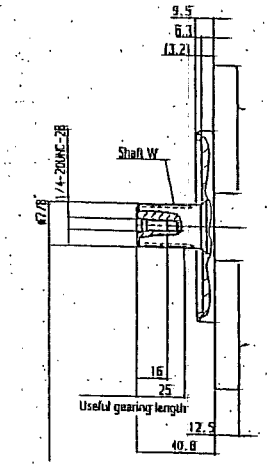
Before finalising your design, please request certified assembly drawing.

Port plates 60 / 10
Shaft R



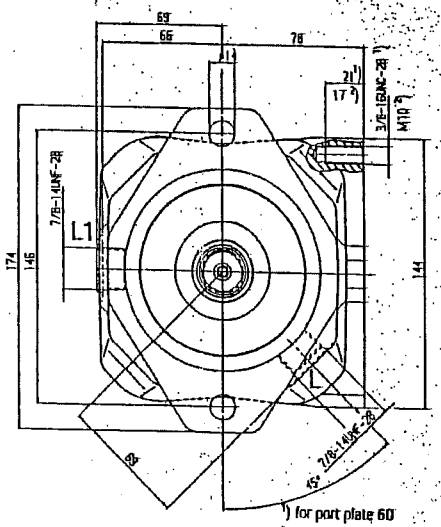
Shaft 25-4; SAE J744 OCT 83
1" dia. splined shaft; 30° pressure angle; 15 teeth;
16/32 pitch; flat base; flank centering;
fit class 5; ANSI B92. 1a-1976

Shaft W



Shaft 22-4; SAE J744 OCT 83
7/8" dia. splined shaft; 30° pressure angle; 13 teeth;
16/32 pitch; flat base; flank centering;
fit class 5; ANSI B92. 1a-1976

View Z



1) for port plate 60
2) for port plate 10

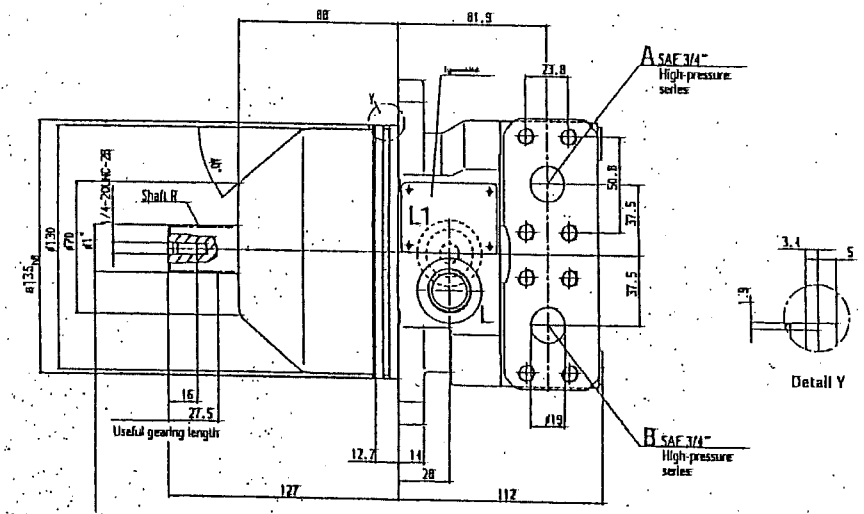
Ports

A,B	Pressure ports	SAE 3/4", High-pressure series
L, L_1	Drain ports	7/8 - 14 UNF - 2B

Unit dimensions A10FE sizes 37 and 45

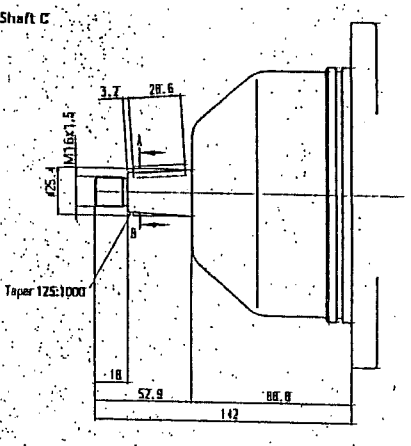
Before finalising your design, please request certified assembly drawing.

Port plates 60 / 10
Shaft R

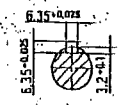


Shaft 25-4; SAE J744 OCT 83
1" dia. splined shaft; 30° pressure angle; 15 teeth;
16/32 pitch; flat base; flank centering;
fit class 5; ANSI B92. 1a-1976

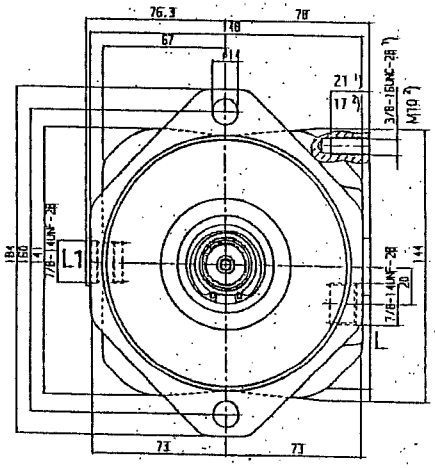
Shaft C



Section C-D



View Z



1) for port plate 60
2) for port plate 10

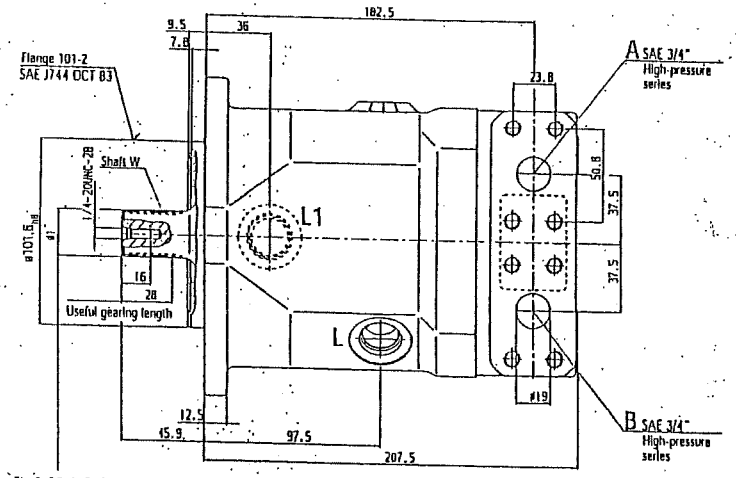
Ports

A,B	Pressure ports	SAE 3/4", High-pressure series
L, L_1	Drain ports	7/8 - 14 UNF - 2B

Unit dimensions A10FM; size 63

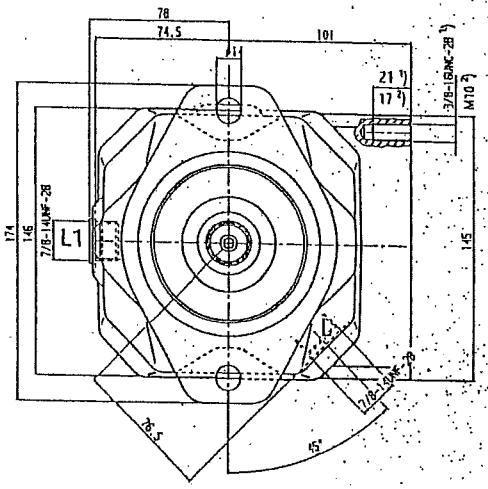
Before finalising your design, please request certified assembly drawing.

Port plates 60 / 10
Shaft W



Shaft 25-4; SAE J744 OCT 83
1" dia. splined shaft; 30° pressure angle; 15 teeth;
16/32 pitch; flat base; flank centering;
fit class 5; ANSI B92. 1a-1976

View Z



1) for port plate 60
2) for port plate 10

Ports

A,B	Pressure ports	SAE 3/4", High-pressure series
L, L_1	Drain ports	7/8 - 14 UNF - 28

Integrated flushing and boost pressure valve

Before finalising your design, please request certified assembly drawing.

Flushing and boost pressure valve N007

The flushing and boost pressure valve is used in closed circuit applications to avoid any excessive build-up of heat and to safeguard the minimum boost pressure (16 bar, invariable). The valve is integrated into the port plate.
A fixed flow, determined by an orifice, is flushed out of the low-pressure side and discharged into the motor housing. Together with the leakage oil, it flows via the drain port to the tank. The fluid withdrawn from circulation in this way must be replaced with cooled oil from the boost pump.

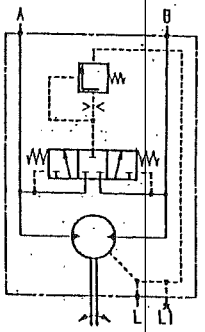
Standard flushing flow

At low pressure of 25 bar and orifice dia. of 1.6 mm the flushing flow amounts to

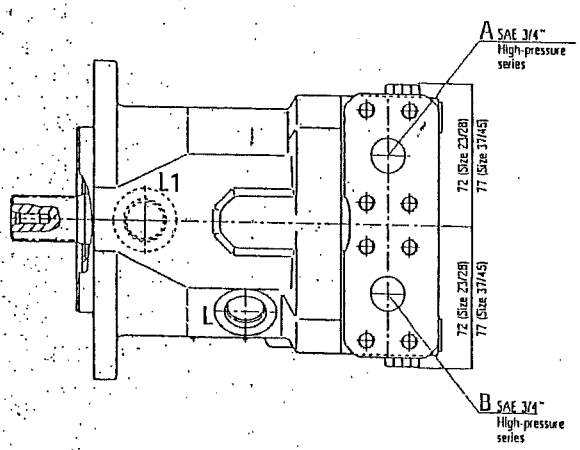
6.5 L/min (sizes 23 - 63)

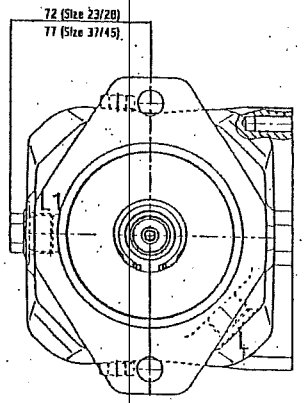
Other flushing flows available on request

Circuit diagram

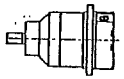


Unit dimensions A10FM with integrated flushing and boost pressure valve





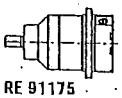
Other motors in series A10



RE 91180

Fixed displacement motor
A10FSM
Series 31

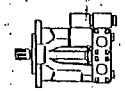
Size:
18 cm³



RE 91175

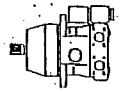
Fixed displacement motor
A10FP
Series 52

Size:
18 cm³



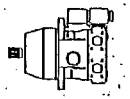
Dual displacement motor
A10VM
Series 52

Size:
28 cm³ 45 cm³ 60 cm³



RE 91703
(in preparation)

Dual displacement plug-in motor
A10VE
Series 52



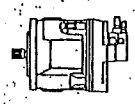
RE 91710

Dual displacement motor
with integrated valves
A10VEC
Series 52

Size:
45 cm³ 60 cm³ 80 cm³

RE 91 172/07.98

The A10 series of pumps

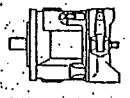


RE 92701

Variable displacement pump
A10VO
Series 31

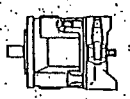
Size:
28 cm³ 45 cm³ 71 cm³ 100 cm³ 140 cm³

Control devices:
DG Two-point control, directly controlled
DR Pressure controller
DFR Pressure and flow controller
DFLR Pressure, flow and power controller
DFSR Pressure, flow and total power controller
FHD Flow controller, dependent on pilot pressure, with pressure control
FE1 Flow controller, electronic
DFE1 Pressure and flow controller, electronic



RE 92711

Variable displacement pump
A10VSO
Series 31

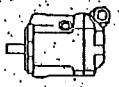


RE 92712

Variable displacement pump
A10VSO
Series 31

Size:
18 cm³

Control devices:
DR Pressure controller
DRG Pressure controller, remote-controlled
DFR Pressure and flow controller
DFR1 Pressure and flow controller, channel X plugged
DFE1 Pressure and flow controller, electronic

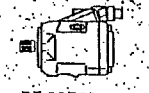


RE 92713

Variable displacement pump
A10VSO
Series 52

Size:
10 cm³

Control devices:
DR Pressure controller
DRG Pressure controller, remote-controlled
DFR Pressure and flow controller
DFR1 Pressure and flow controller, channel X plugged

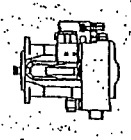


RE 92703

Variable displacement pump
A10VO
Series 52

Size:
28 cm³ 45 cm³ 60 cm³ 85 cm³

Control devices:
DR Pressure controller
DRG Pressure controller, remote-controlled
DFR Pressure and flow controller
DFR1 Pressure and flow controller, channel X plugged



RE 92730

Compact unit
A10CO
Series 52

Size:
45 cm³

Control devices:
DR Pressure controller
DRG Pressure controller, remote-controlled
DFR Pressure and flow controller
DFR1 Pressure and flow controller, channel X plugged

Brueninghaus Hydromatik GmbH
Plant Horb
An den Kelterwiesen 14 • D-72160 Horb
Telefon +49 (0) 74 51 / 92-0
Telefax +49 (0) 74 51 / 82 21

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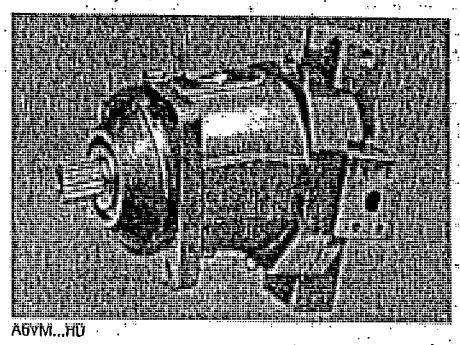
RE 91 604/05.99
replaces: 12.95

engineering
mannesmann Rexroth

Variable Displacement Motor A6VM

for open and closed circuits

Sizes 28...1000
Series 6
Nominal pressure up to 400 bar
Peak pressure up to 450 bar



A6VM...HD

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Features

- Variable displacement motor with axial piston rotary group of bent axis design, for hydrostatic drives in open and closed circuits.
- The motor is suitable for both mobile and industrial applications.
- The wide control range of the variable displacement motor allows it to meet the requirements of high speed and high torque.
- The displacement is infinitely variable in the range $V_{g\,max}$ to $V_{g\,min} = 0$.
- Output speed is proportional to flow and inversely proportional to displacement.
- The output torque increases with the pressure drop between the high and low pressure sides and with increasing displacement.
- Wide control range for hydrostatic drives
- Various control and regulating devices
- Cost saving through elimination of gearbox and possibility of using smaller motors
- Compact, robust bearing system with long service life
- Low unit power
- Good starting characteristics
- Low inertia
- Wide swivel range

Ordering Code / Standard Program

Hydraulic fluid

Mineral oil (no code)		
HF-fluids	sizes 28...200 (no code)	
	sizes 250...1000 (only in connection with drive shaft bearings "L")	E

Axial piston unit

Bent axis design, variable displacement	A6V

Drive shaft bearings

	28...200	250...500	1000	
Mechanical bearings (no code)	•	•	–	
Long-life bearings	–	•	•	L

Mode of operation

Motor (plug-in motor A6VE see RE 91606)	M

Size

≙ Displacement $V_{g\,max}$ (cm³)	28	55	80	107	140	160	200	250	355	500	1000

Sizes 28...200: production plant Elchingen; Sizes 250...1000: production plant Horb

Control device

				28	55	80	107	140	160	200	250	355	500	1000	
Hydraulic control, pilot pressure related	pilot pressure increase	10 bar	HD1	•	•	•	•	•	•	•	•	•	•	•	HD1
		25 bar	HD2	•	•	•	•	•	•	•	•	•	•	•	HD2
		35 bar	HD3	–	–	–	–	–	–	–	•	○	•	○	HD3
Hydraulic two-position control			HZ	–	–	–	–	–	–	–	•	•	•	•	HZ
			HZ1	•	–	–	–	•	•	•	–	–	–	–	HZ1
			HZ3	–	•	•	•	–	–	–	–	–	–	–	HZ3
Electrical control, with proportional solenoid	control voltage	12 V	EP1	•	•	•	•	•	•	•	•	•	•	○	EP1
		24 V	EP2	•	•	•	•	•	•	•	•	•	•	○	EP2
Electrical two-position control, with switching solenoid	control voltage	12 V	EZ1	•	–	–	–	•	•	•	•	•	•	•	EZ1
		24 V	EZ2	•	–	–	–	•	•	•	•	•	•	•	EZ2
		12 V	EZ3	–	•	•	•	–	–	–	–	–	–	–	EZ3
		24 V	EZ4	–	•	•	•	–	–	–	–	–	–	–	EZ4
Automatic control, high pressure related	without pressure increase		HA1	•	•	•	•	•	•	•	•	•	•	○	HA1
	with pressure increase Δp = 100 bar		HA2	•	•	•	•	•	•	•	•	•	•	○	HA2
Hydraulic control, speed related			DA	–	–	–	–	–	–	–	•	•	•	○	DA
p_x/p_{HP} = 5/100, hydraulic valve for travel direction			DA1	•	•	•	•	•	•	•	–	–	–	–	DA1
	electrical valve for travel direction + electrical $V_{g\,max}$-switch	12 V	DA2	•	•	•	•	•	•	•	–	–	–	–	DA2
		24 V	DA3	•	•	•	•	•	•	•	–	–	–	–	DA3
p_x/p_{HP} = 8/100, hydraulic valve for travel direction			DA4	•	•	•	•	•	•	•	–	–	–	–	DA4
	electrical valve for travel direction + electrical $V_{g\,max}$-switch	12 V	DA5	•	•	•	•	•	•	•	–	–	–	–	DA5
		24 V	DA6	•	•	•	•	•	•	•	–	–	–	–	DA6

Pressure control (only for HD, EP)

	28	55	80	107	140	160	200	250	355	500	1000	
without pressure control (no code)	•	•	•	•	•	•	•	•	•	•	•	
Pressure control, direct control	•	•	•	•	•	•	•	•	•	•	•	D
direct control, with 2nd pressure setting	•	•	•	•	•	•	•	–	–	–	–	E
remote control	–	–	–	–	–	–	–	•	•	•	•	G

Override of HA-control (only for HA1, HA2)

			28	55	80	107	140	160	200	250	355	500	1000	
without override (no code)			•	•	•	•	•	•	•	•	•	•	○	
Hydraulic override			•	•	•	•	•	•	•	•	•	•	○	T
Electrical override	control voltage	12 V	•	•	•	•	•	•	•	–	–	–	–	U1
		24 V	•	•	•	•	•	•	•	–	–	–	–	U2
Electrical override + el. valve for travel direction	control voltage	12 V	•	•	•	•	•	•	•	–	–	–	–	R1
		24 V	•	•	•	•	•	•	•	–	–	–	–	R2

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Axial piston unit
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Direction of rotation

viewed on shaft end	alternating	W

Setting range for displacement [1]

		28...200	250...1000	
$V_{g\,min}$ = 0 to 0,8 $V_{g\,max}$ (no code)		•	–	
$V_{g\,min}$ = 0 to 0,4 $V_{g\,max}$	$V_{g\,max}$ = $V_{g\,max}$ to 0,8 $V_{g\,max}$	–	•	1
$V_{g\,min}$ > 0,4 $V_{g\,max}$ to 0,8 $V_{g\,max}$	$V_{g\,max}$ = $V_{g\,max}$ to 0,8 $V_{g\,max}$	–	•	2

Seals

	28	55	80	107	140	160	200	250	355	500	1000	
FKM (fluor-caoutchouc)	•	•	•	•	•	•	•	•	•	•	•	V

Shaft end

Splined shaft DIN 5480	•	•	•	•	–	•	•	–	–	–	–	A
Parallel shaft with key DIN 6885	–	–	–	–	–	–	•	•	•	•	•	Z
	–	–	–	–	–	–	•	•	•	•	•	P

Mounting flange

ISO 4-hole	•	•	•	•	•	•	•	•	–	–	–	B
ISO 8-hole	–	–	–	–	–	–	–	•	•	•	•	H

Service line connections

			28	55	80	107	140	160	200	250	355	500	1000	
Ports A, B: SAE rear end (metric threads)	01	0	•	•	•	•	•	•	•	•	•	•	•	010
		7	•	•	•	•	•	•	•	•	•	•	o	017
Ports A, B: SAE on (opposite) sides (metric threads)	02	0	•	•	•	•	•	•	•	•	•	•	•	020
		7	•	•	•	•	•	•	•	•	•	•	o	027
Port plate for mounting a motion control valve	08	0	–	–	–	–	–	–	–	•	–	–	–	080
		8	–	–	–	–	–	–	–	•	–	–	–	088
Ports A, B: SAE on (opposite) sides + rear end	15	0	–	–	–	–	–	–	–	•	o	•	o	150
Port plate with pressure relief valve, for mounting a motion control valve [2]	37	0	–	–	–	•	–	–	–	–	–	–	–	370
	38	0	–	•	•	•	•	•	–	–	–	–	–	380

Valves

without valve	0
with flushing and boost pressure valve	7
with built-on motion control valve (only for size 250)	8

Speed sensor

	28	55	80	107	140	160	200	250	355	500	1000	
without speed sensor (no code)	•	•	•	•	•	•	•	•	•	•	•	
suitable for fitting speed sensor	•	•	•	•	•	•	•	•	•	•	o	D

Swivel angle indicator

without swivel angle indicator (no code)	•	•	•	•	•	•	•	•	•	•	–	
with optical swivel angle indicator	–	–	–	–	–	–	–	•	•	•	•	V
with electronical swivel angle indicator	–	–	–	–	–	–	–	•	•	•	•	E

Start of control

at $V_{g\,min}$ (standard for HA)	•	•	•	•	•	•	•	•	•	•	•	A
at $V_{g\,max}$ (standard for HD, HZ, EP, EZ, DA)	•	•	•	•	•	•	•	•	•	•	•	B

[1] Indicate in the order displacement setting in clear text: $V_{g\,min}$ = ... cm³, $V_{g\,max}$ = ... cm³
[2] only possible in connection with controls HD, HA1, HA2, EP

• = available o = in preparation – = not available

▨ = Preferred program (preferred types see page 39)

Technical Data

Fluid

We request that before starting a project detailed information about the choice of pressure fluids and application conditions are taken from our catalogue sheets RE 90220 (mineral oil), RE 90221 (environmentally acceptable hydraulic fluids) and RE 90223 (fire resistance fluids, HF).

When using HF- or environmentally acceptable hydraulic fluids possible limitations for the technical data have to be taken into consideration. If necessary please consult our technical department (please indicate type of the hydraulic fluid used for your application on the order sheet).

Operating viscosity range

In order to obtain optimum efficiency and service life, we recommend that the operating viscosity (at operating temperature) be selected from within the range:

v_{opt} = operating viscosity 16...36 mm²/s

referred to the loop temperature (closed circuit) or tank temperature (open circuit).

Viscosity limits

The limiting values for viscosity are as follows:

Sizes 28...200

v_{min} = 5 mm²/s,
short term at a max. permissible temperature t_{max} = 115°C

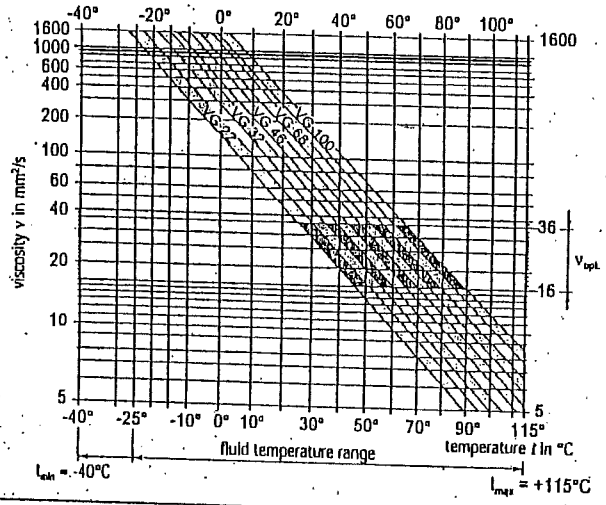
v_{max} = 1600 mm²/s,
short term on cold start (t_{min} = -40°C)

Sizes 250...1000

v_{min} = 10 mm²/s,
short term at a max. permissible leakage oil temperature t_{max} = 90°C

v_{max} = 1000 mm²/s,
short term on cold start (t_{min} = -25°C)

Selection diagram



Please note that the max. fluid temperature of 115°C is also not exceeded in certain areas (for instance bearing area).

At temperatures of -25°C up to -40°C special measures may be required for certain installation positions. Please contact us for further information.

Notes on the selection of the hydraulic fluid

In order to select the correct fluid, it is necessary to know the operating temperature in the loop (closed circuit) or the tank temperature (open circuit) in relation to the ambient temperature.

The hydraulic fluid should be selected so that within the operating temperature range, the operating viscosity lies within the optimum range (v_{opt}) (see shaded section of the selection diagram). We recommend that the highest possible viscosity range should be chosen in each case.

Example: At an ambient temperature of X°C the operating temperature is 60°C. Within the operating viscosity range (v_{opt}; shaded area), this corresponds to viscosity ranges VG 46 or VG 68. VG 68 should be selected.

Important: The leakage oil (case drain oil) temperature is influenced by pressure and motor speed and is always higher than the circuit temperature. However, at no point in the circuit may the temperature exceed 115°C for sizes 28...200 or 90°C for sizes 250...1000.

If it is not possible to comply with the above condition because of extreme operating parameters or high ambient temperatures we recommend housing flushing via port U or use of a flushing valve (see page 36). Please consult us.

Filtration

The finer the filtration the better the achieved purity grade of the pressure fluid and the longer the life of the axial piston unit. To ensure the functioning of the axial piston unit a minimum purity grade of:

9 to NAS 1638

18/15 to ISO/DIS 4406 is necessary.

At very high temperatures of the hydraulic fluid (90°C to max. 115°C, not perm. for sizes 250...1000) at least cleanless class

8 to NAS 1638

17/14 to ISO/DIS 4406 is necessary.

If above mentioned grades cannot be maintained please consult supplier.

Operating pressure range

Maximum pressure at port A or B (pressure data to DIN 24312)

Sizes 28...200

Nominal pressure p_N	400 bar
Peak pressure p_{max}	450 bar*

*) Attention: shaft end Z with drives of radial force loads at the drive shaft (pinion V-belt drives) necessitate reduction of the nominal pressure to p_N = 315 bar (please contact us).

Sizes 250...1000

Nominal pressure p_N	350 bar
Peak pressure p_{max}	400 bar

With pulsating loads above 315 bar we recommend using the model with splined shaft A (sizes 28...200) or with splined shaft Z (sizes 250...1000).

The summ of the pressures at ports A and B may not exceed 700 bar.

Direction of flow

clockwise rotation	anti-clockwise rotation
A to B	B to A

Speed range

There is no limitation on minimum speed n_{min}. If uniformity of rotation is required, however, speed n_{min} should not be allowed to fall below 50 rpm. See table on page 6 for max. permissible speeds.

Installation position

Optional. The motor housing must be filled with fluid prior the commissioning, and must remain full whenever it is operating.

For extensive information on installation position, please consult our data sheet RE 90 270 before completing your design work.

Long-Life-bearings (sizes 250...1000)
(for high life expectancy and use of HF-fluids)

The outer dimensions of the axial piston motors are identical to standard design (without long life bearings). The change from standard design to long life bearing system is possible. We recommend to apply bearing flushing at port U.

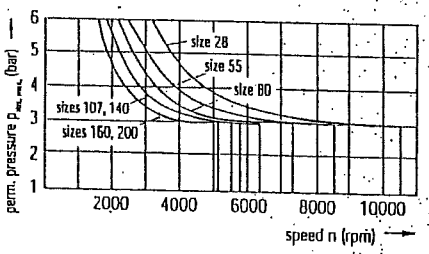
Case Drain Pressure

Shaft seal ring FKM (fluor-caoutchouc)
The lower the speed and the case drain pressure the higher the life expectation of the shaft seal ring. The values shown in the diagram are permissible loads of the seal ring and shall not be exceeded.

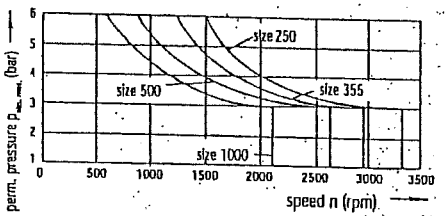
At stationary pressure loads in the range of the max. admissible leakage pressure a reduction of the life experience of the seal ring will result.

For a short period (t < 5 min.) pressure loads up to 5 bar independent from rotational speeds are permissible respectively for sizes 28...200.

Sizes 28...200



Sizes 250...1000



Special operation conditions may require limitations of these values.

Note:

- max. permissible motor speeds are given in the table on page 6.
- max. permissible housing pressure $p_{abs\ max}$ ..... 6 bar

The pressure in the housing must be the same as or greater than the external pressure on the shaft seal.

Influence housing pressure to start of control

The housing pressure influences the start of control of the variable motor for the following controls: An increase of the housing pressure leads to an increase of the start of control for the HA control (only sizes 250...1000), HA.T and HD. For the DA control a lowering of the start of control is effected.

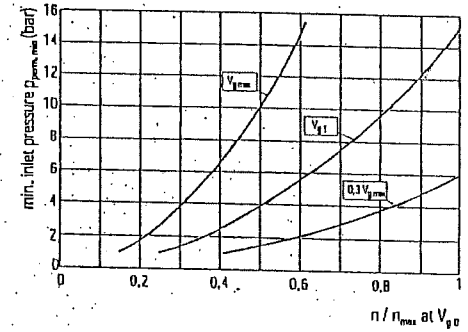
The setting on the test bench in the factory prior to delivery is p_{abs} = 1 bar (sizes 250...1000) respectively p_{abs} = 2 bar housing pressure (sizes 28...200).

Table of values (theoretical values, without considering η_{mh} and η_v; values rounded)

Size			28	55	80	107	140	160	200	250	355	500	1000
Displacement [1]	$V_{g\,max}$	cm³	28,1	54,8	80	107	140	160	200	250	355	500	1000
	$V_{g\,0}$	cm³	0	0	0	0	0	0	0	0	0	0	0
Max. speed (at max. permitted flow)	n_{max} at $V_{g\,max}$	rpm	5550	4450	3900	3550	3250	3100	2900	2500	2240	2000	1600
	n_{max} at $V_g < V_{g1}$	rpm	8750	7000	6150	5600	5150	4900	4600	3300	2950	2650	2100
	V_{g1}	cm³	18	35	51	68	88	101	126	190	270	385	762
	n_{max} at $V_{g\,0}$	rpm	10450	8350	7350	6300	5750	5500	5100	3300	2950	2650	2100
Max. perm. flow	$q_{v\,max}$	L/min	156	244	312	380	455	469	580	625	795	1000	1600
Torque constants	T_t at $V_{g\,max}$	Nm/bar	0,446	0,87	1,27	1,70	2,23	2,54	3,18	3,98	5,65	7,96	15,92
Max. torque	T_{max} at $V_{g\,max}$ [1]	Nm	179	349	509	681	891	1019	1273	1391	1978	2785	5571
Case volume		L	0,5	0,75	1,2	1,5	1,8	2,4	2,7	3,0	5,0	7,0	16,0
Moment of inertia about drive axis	J	kgm²	0,0014	0,0042	0,0080	0,0127	0,0207	0,0253	0,0353	0,061	0,102	0,178	0,550
Weight (approx.)	m	kg	16	26	34	47	60	64	80	90	170	210	430

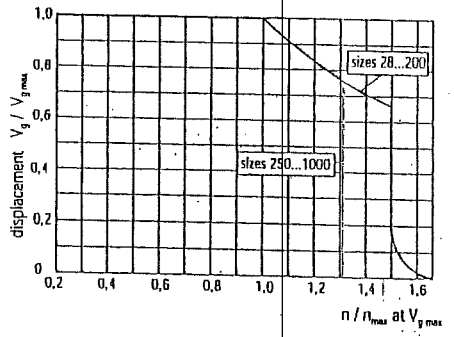
[1] The minimum and maximum displacement are infinetely adjustable, see ordering code page 3 (note for sizes 250...1000: $V_{g\,min} = 0{,}2 \cdot V_{g\,max}$, $V_{g\,max} = V_{g\,max}$, when there is no indication in the order!)
[2] sizes 28...200: Δp = 400 bar; sizes 250...1000: Δp = 350 bar

Minimum inlet pressure at port A (B)



In order to avoid damage of the variable motor a minimum inlet pressure at the inlet zone must be assured. The minimum inlet pressure is related to the rotational speed and swivel angle (displacement) of the variable motor.

Permissible displacement, speed related



Tech. Data

Output drive

Permissible axial and radial loading on drive shaft.
The values given are maximum values and not permissible for continuous operation.

Size			28	55	80	107	140	160	200	250	355	500	1000
a	mm		12,5	15	17,5	20	22,5	22,5	25	41	52,5	52,5	67,5
$F_{q\,max}$	N		5696	10440	13114	15278	17808	20320	22896	1200[1]	1500[1]	1900[1]	2600[1]
$\pm F_{ax\,max}$	N	$+F_{ax\,max}$	315	500	710	900	1030	1120	1250	4000	5000	6250	10000
		$-F_{ax\,max}$	315	500	710	900	1030	1120	1250	1200	1500	1900	2600
$\pm F_{ax\,perm.}$/bar		N/bar		4,6	7,5	9,6	11,3	13,3	15,1	17,0	[1]	[1]	[1] [2]

[1]) Axial piston unit in stationary or in bypass operation, please contact us when appearing higher forces!
[2]) Please contact us!

Code explanation

a = distance of F_q from shaft shoulder
$F_{q\,max}$ = max. perm. radial force at distance a (at intermittent operation)
$\pm F_{ax\,max}$ = max. perm. axial force when stationary or when axial piston unit is running at zero pressure
$\pm F_{ax\,perm.}$/bar = perm. axial force/bar operating pressure

The direction of the max. axial force must be noted by sizes 28...200.
$-F_{ax\,max}$ = increased bearing life
$+F_{ax\,max}$ = reduced bearing life (avoid if possible)

Calculation of size

Flow $q_v = \dfrac{V_g \cdot n}{1000 \cdot \eta_v}$ in L/min

Output speed $n = \dfrac{q_v \cdot 1000 \cdot \eta_v}{V_g}$ in rpm

Output torque $T = \dfrac{V_g \cdot \Delta p \cdot \eta_{mh}}{20 \cdot p}$

$= \dfrac{1{,}59 \cdot V_g \cdot \Delta p \cdot \eta_{mh}}{100}$ in Nm

or $T = T_k \cdot \Delta p \cdot \eta_{mh}$ in Nm

Output power $P = \dfrac{2p \cdot T \cdot n}{60\,000} = \dfrac{T \cdot n}{9549}$

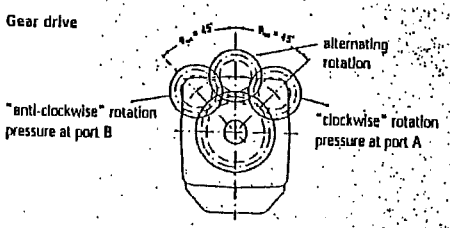
$= \dfrac{q_v \cdot \Delta p}{600} \cdot \eta_t$ in kW

V_g = geometric displacement per rev. in cm³
T = torque in Nm
Δp = pressure differential in bar
n = speed in rpm
T_k = torque constants in Nm/bar
η_v = volumetric efficiency
η_{mh} = mech.-hyd. efficiency
η_t = overall efficiency

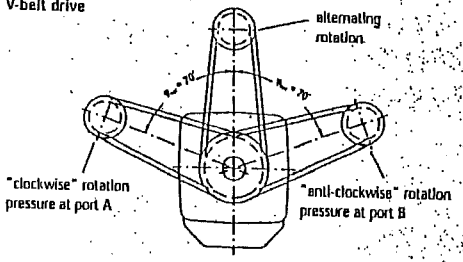
Optimal force direction of F_q (valid for sizes 28...200)

By means of appropriate force directions of F_q the bearing load caused by inside rotary group forces can be reduced. An optimal life expectation of the bearing can be reached.

Gear drive



V-belt drive



DA Hydraulic Control, Speed Related

The A6VM variable motor with speed related hydraulic control is particularly suitable for use in hydrostatic transmissions in conjunction with variable pump A4VG with DA control.

The swivel angle of the hydraulic motor is controlled by means of the pilot pressure determined by the input speed of the A4VG variable pump and by the operating pressure.

An increase in the pump input speed and thus in the pilot pressure causes the motor, in relation to the existing operating pressure, to swivel towards a lower displacement volume (lower torque, higher speed).

If operating pressure should rise above the value set with the pressure control, the motor is then swivelled towards a higher displacement volume (higher torque, lower speed).

When designing a drive using DA control, note also the technical data of variable pump A4VG with DA control.

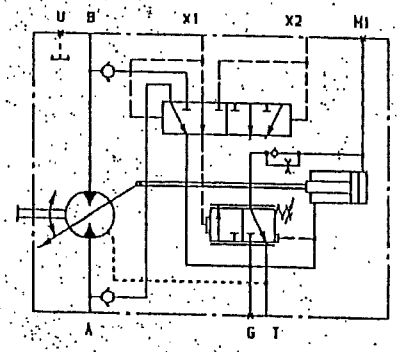
A computer program is available at Brueninghaus Hydromatik to help you with the design of your drive. Full details from our Mobile Sales Division on request.

DA, DA1, DA4
Hydraulic control, speed related with hydraulic valve for travel direction

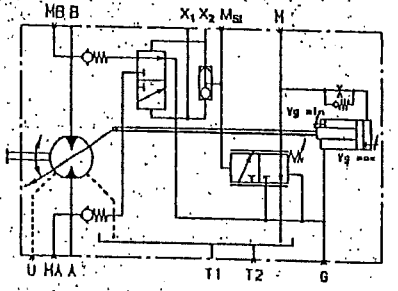
Through the control pressure X_1 or X_2 this valve is switched on/off dependend on the direction of rotation (travel direction).

direction of rotation	operation pressure in	control pressure in
clockwise	A	X_1
anti-clockwise	B	X_2

Hydraulic control, speed related DA1, DA4
Sizes 28...200



Hydraulic control, speed related DA
Sizes 250...1000



DA2, DA3, DA5, DA6
Hydraulic control, speed related with el. valve for travel direction + el. $V_{g\,max}$-switching process

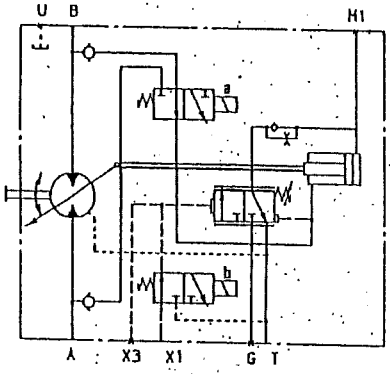
The electrical valve is operated by the pressure spring or switch solenoid (a) dependent on the rotational direction (travel direction).

Through connection of the electric current at the switch solenoid (b) override of the control is possible and the motor is switched to max. swivel angle (high torque, low speed) (el. $V_{g\,max}$-switching process).

DA2, DA5	switching solenoid a, b 12 V DC; 1,6 A (min.)
DA3, DA6	switching solenoid a, b 24 V DC; 0,8 A (min.)

direction of rotation	operating pressure in	switching solenoid a
clockwise	A	energised
anti-clockwise	B	de-energised

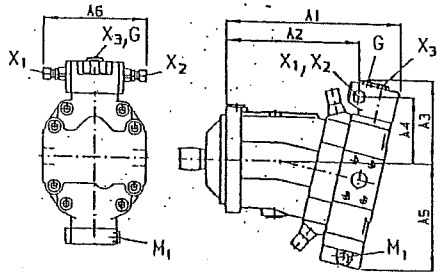
Hydraulic control, speed related DA2, DA3, DA5, DA6
Sizes 28...200



Unit Dimensions DA

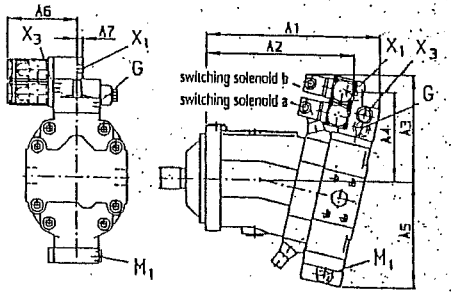
Before finalising your design, please request a certified drawing.

Unit dimensions DA1, DA4
Sizes 28...200



Size	A1	A2	A3	A4	A5	A6	ports X_1, X_2
28	216	152	120	93	136	160	locking GE-BLM
55	242	179	122	94	151	160	locking GE-BLM
80	271	207	127	100	167	160	locking GE-BLM
107	291	216	134	107	175	174	locking GE-BLM
140	322	247	141	115	195	174	locking GE-BLM
160	329	254	141	115	197	174	locking GE-BLM
200	346	271	146	119	209	174	locking GE-BLM

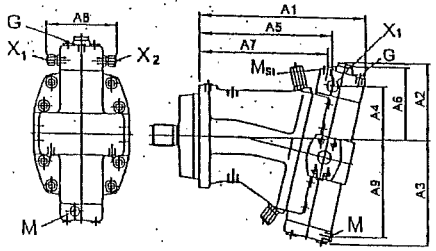
Unit dimensions DA2, DA3, DA5, DA6
Sizes 28...200



Size	A1	A2	A3	A4	A5	A6	A7	port X_1
28	218	175	158	130	136	110	8,5	M14x1,5
55	245	202	159	132	151	110	8,5	M14x1,5
80	271	230	162	138	167	110	8,5	M14x1,5
107	292	239	173	146	175	112	8,5	M14x1,5
140	323	270	181	154	195	112	8,5	M14x1,5
160	330	277	181	153	197	112	8,5	M14x1,5
200	347	294	185	158	209	112	8,5	M14x1,5

X_1: pilot pressure port

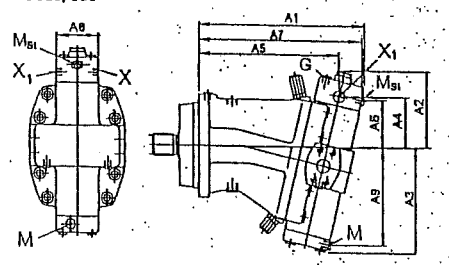
Unit dimensions DA
Size 250



Size	A1	A2	A3	A4	A5	A6	A7	A8	A9
250	385	188 (max)	248	126	307	161	296	159	227

ports X_1, X_2: locking BO-GEV BL/M14x1,5-WD

Unit dimensions DA
Sizes 355, 500



Size	A1	A2	A3	A4	A5	A6	A7	A8	A9
355	432	203 (max)	279	140	327	123	422	108	257
500	490	215 (max)	306	151	423	137	481	123	284

ports X_1, X_2: M14x1,5

HA Automatic Control, High Pressure Related

With the automatic, high pressure related control, setting of the displacement is effected automatically as a function of the operating pressure.

This control device measures the operating pressure at A or B internally (no pilot line required) and swivels from $V_{g\,min}$ with increasing working pressure to $V_{g\,max}$ once the pressure setting of the control is reached.

Standard version HA1, HA2:

Start of control at $V_{g\,min}$ (min. torque, max. perm. speed)

End of control at $V_{g\,max}$ (max. torque, min. speed)

HA1: Virtually no pressure increase

An working pressure increase of $\Delta p \leq 10$ bar results in an increase of the displacement from 0 cm³ to $V_{g\,max}$ (sizes 28...200) respectively from 0,2 $V_{g\,max}$ to $V_{g\,max}$ (sizes 250...1000).

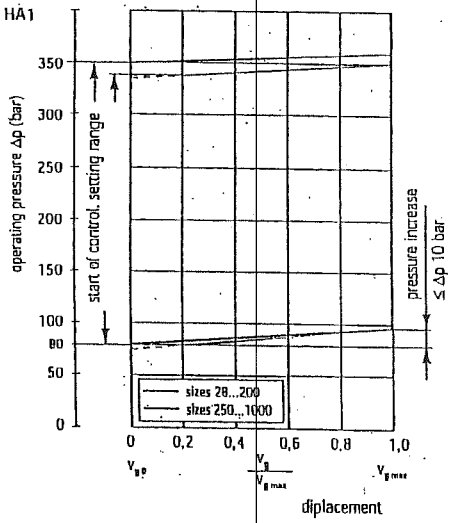
Start of control, setting range

sizes 28...200 _____ 80 – 350 bar

sizes 250...10000 _____ 80 – 340 bar

When ordering please state required start of control in clear text, e.g.: start of control at 300 bar

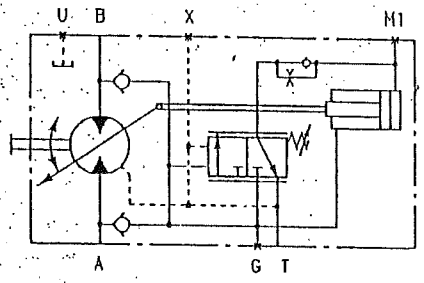
HA1



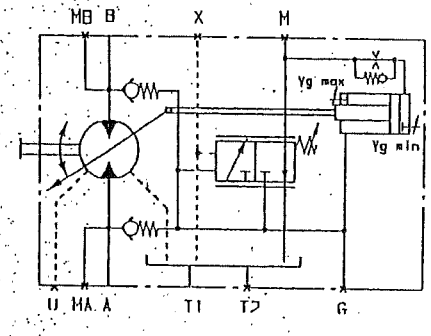
Note:

- Because of safety reasons hoist winch drives are not allowed with control devices with start of control at $V_{g\,min}$ (standard design with HA)!

Automatic control, high pressure related HA1
Sizes 28...200



Automatic control, high pressure related HA1
Sizes 250...1000



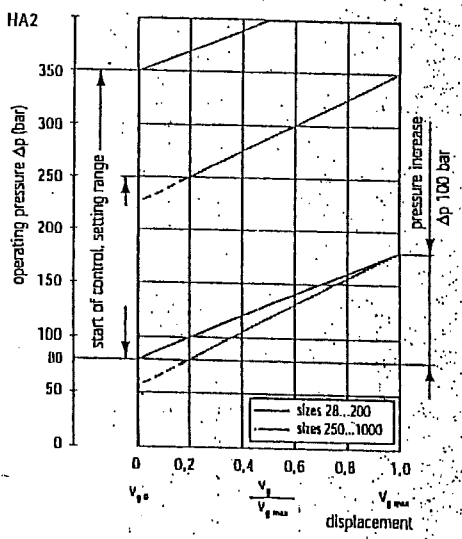
HA2: Pressure increase Δp = 100 bar

An working pressure increase from Δp = 100 bar results in an increase of the displacement from 0 cm³ to $V_{g\,max}$ (sizes 28...200) respectively from 0,2 $V_{g\,max}$ to $V_{g\,max}$ (sizes 250...1000).

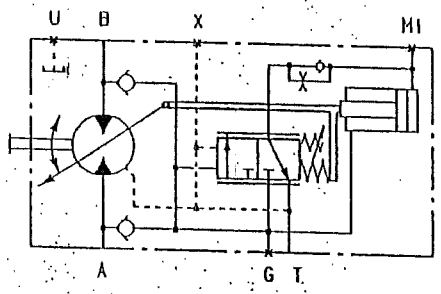
Start of control, setting range

sizes 28...200	80 – 350 bar
sizes 250...10000	80 – 250 bar

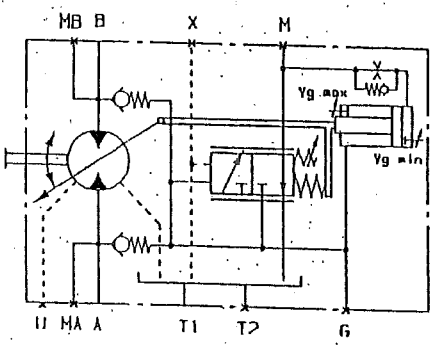
When ordering please state required start of control in clear text, e.g.: start of control at 200 bar



Automatic control, high pressure related HA2
Sizes 28...200



Automatic control, high pressure related HA2
Sizes 250...1000



U1, U2
Electrical override of pressure setting

On version HA1 the high pressure related control can be overridden by means of an electrical signal to a switching solenoid.

The override causes the motor to swivel to its maximum angle.

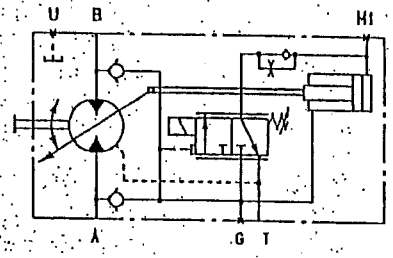
Switching solenoid de-energised ≙ no override

Switching solenoid energised ≙ motor set to $V_{g\,max}$

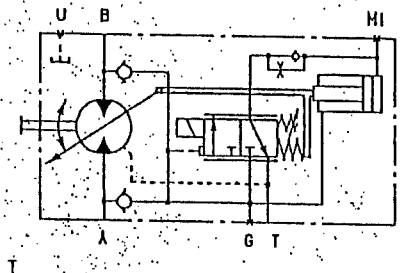
U1	switching solenoid 12 V DC, 1,6 A (min.)
U2	switching solenoid 24 V DC, 0,8 A (min.)

Start of control adjustable between 80 and 300 bar (state required setting in clear text when ordering)

HA1U1, HA1U2



HA2U1, HA2U2



T

Hydraulic override of pressure setting

For the HA control the start of control can be influenced by applying a pilot pressure at port X.

1 bar control pressure lowers the start of control by 17 bar (sizes 28...200) or 8 bar (sizes 250...1000).

Example (sizes 28...200):

Start of control setting	300 bar	300 bar
Pilot pressure at X	0 bar	10 bar
Start of control	300 bar	130 bar

If the override is only required to set the max displacement (motor swivel to $V_{g\,max}$), a pilot pressure of up to 100 bar max. is permissible.

(Circuit diagram and unit dimensions see control HA1, HA2, port X open, at sizes 250...1000 no connection from X to T)

R1, R2
Electrical override of pressure setting, with electrical valve for travel direction

On the HA control version the high pressure related control can be overridden by a electrical signal to a switching solenoid b. The override swivels the variable to a max. swivel angle.

switching solenoid b de-energised ≙ no override

switching solenoid b energised ≙ motor set to $V_{g\,max}$

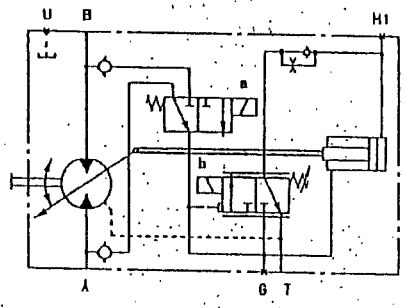
The travel directional valve assures that the preselected pressure side of the variable motor always controls the swivel angle even at a change of the high pressure side (for instance travel drive down hill). The swivel of the variable motor to a bigger displacement can be avoided.

In relation of a change of direction (travel direction) the travel directional valve is actuated through the pressure spring or the switch solenoid a.

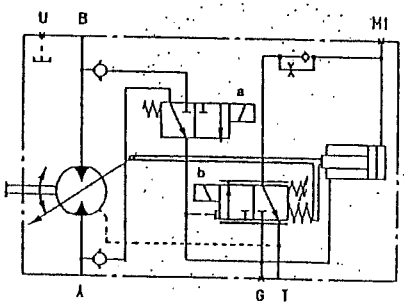
direction of rotation	operating pressure in	swtiching solenoid a
clockwise	A	de-energised
anti-clockwise	B	energised

R1	switching solenoid a, b 12 V DC 1,6 A (min.)
R2	switching solenoid a, b 24 V DC 0,8 A (min.)

HA1R1, HA1R2



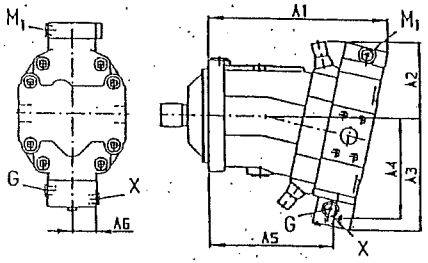
HA2R1, HA2R2



Unit Dimensions HA

Before finalising your design, please request a certified drawing.

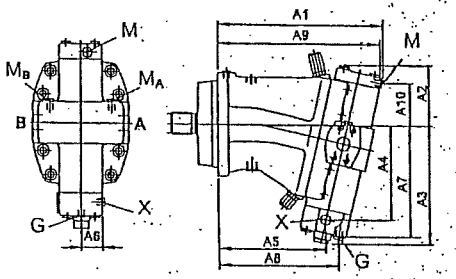
Unit dimensions HA1, HA2, HA1T, HA2T
Sizes 28...200



Size	A1	A2	A3	A4	A5	A6
28	209	97	151	133	134	34,5
55	237	104	159	142	159	33,4
80	268	114	171	152	183	34,5
107	290	122	183	164	199	40,5
140	316	132	198	178	225	40,5
160	323	137	200	181	232	40,5
200	339	143	209	190	245	40,5

port X: M 14x1,5 (plugged, open for design HA.T)

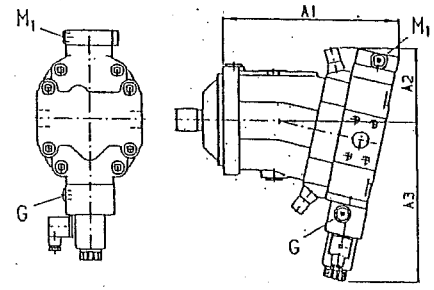
Unit dimensions HA1, HA2, HA1T, HA2T
Sizes 250...1000



Size	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
250	384	161	275	210	248	48,5	248	278	377	116
355	432	181	300	234	279	54	275	315	425	132
500	489	196	325	258	322	61,5	300	359	483	144
1000										

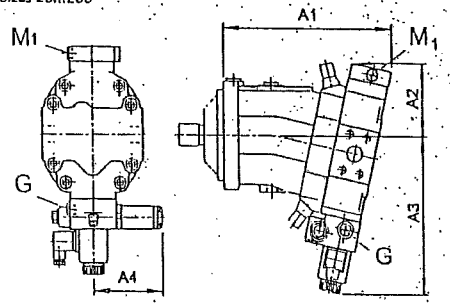
port X: M 14x1,5 (plugged, open for design HA.T)

Unit dimensions HA.U1, HA.U2
Sizes 28...200



Size	A1	A2	A3
28	209	97	216
55	237	104	224
80	268	114	238
107	282	122	249
140	316	132	263
160	323	137	266
200	339	143	275

Unit dimensions HA.R1, HA.R2
Sizes 28...200



Size	A1	A2	A3	A4
28	209	97	216	110
55	237	104	224	110
80	268	114	238	110
107	282	122	249	112
140	316	132	263	112
160	323	137	266	112
200	339	143	275	112

HD Hydraulic Control, Pilot Pressure Related

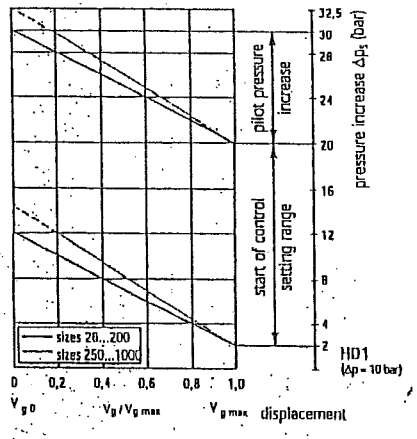
The pilot pressure related hydraulic control allows infinite variation of the motor displacement in relation to a pilot pressure signal. The control function is proportional to the pilot pressure applied at port X.

HD1: Pilot pressure increase Δp_s = 10 bar

A pilot pressure increase of 10 bar at port X results in a decrease of the displacement from $V_{g\,max}$ to 0 cm³ (sizes 28...200) respectively from $V_{g\,max}$ to 0,2 $V_{g\,max}$ (sizes 250...1000).

Start of control, setting range _____ 2 – 20 bar

Standard setting: start of control at 3 bar (end of control at 13 bar)

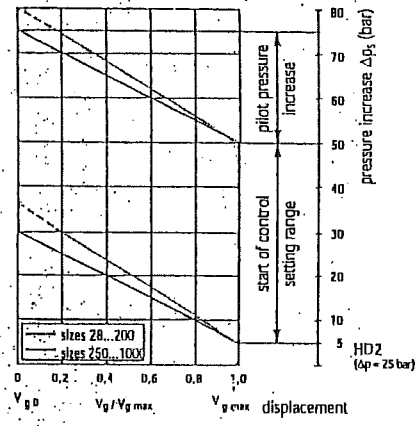


HD2: Pilot pressure increase Δp_s = 25 bar

A pilot pressure increase of 25 bar at port X results in a decrease of the displacement from $V_{g\,max}$ auf 0 cm³ (sizes 28...200) respectively from $V_{g\,max}$ to 0,2 $V_{g\,max}$ (sizes 250...1000).

Start of control, setting range _____ 5 – 50 bar

Standard setting: start of control at 10 bar (end of control at 35 bar)



Standard version:

- start of control at $V_{g\,max}$ (max. torque, min. speed)
- end of control at $V_{g\,min}$ (min. torque, max. perm. speed)

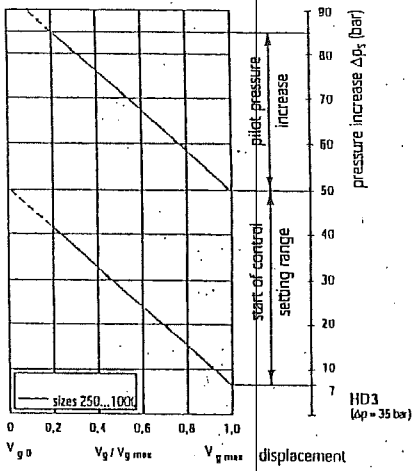
HD3: Pilot pressure increase Δp_s = 35 bar

A pilot pressure increase of 35 bar at port X results in a decrease of the displacement from $V_{g\,max}$ to 0,2 $V_{g\,max}$ (sizes 250...1000).

Start of control, setting range _____ 7 – 50 bar

Standard setting: start of control at 10 bar (end of control at 45 bar)

Note:

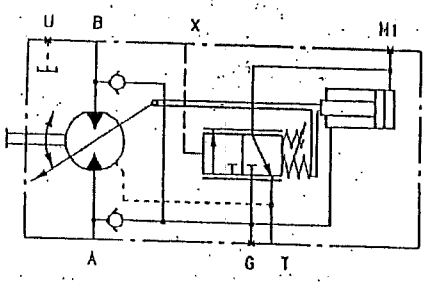


- The start of control and the HD curve is influenced by the housing pressure. An increase of the housing pressure causes an increase of the start of control and thus a parallel displacement of the curve characteristic (see page 5).
- The required control oil is taken from the high pressure side; for this, a minimum operating pressure of 15 bar is necessary. If it is necessary to operate the control at an operating pressure of <15 bar, a boost pressure of min. 15 bar must be applied at port G via an external check valve (max. perm. pilot pressure 100 bar).
- Due to internal leakage a leakage flow of approx. 0,3 L/min occurs at port X. In order to avoid the influence of the curve characteristic the leakage flow must be led out through the control module into the tank.
- When ordering please state required start of control in clear text, e.g.: start of control at 10 bar

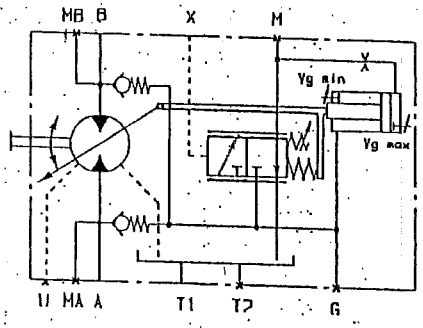
Unit dimensions control HD, see pages 23...33

Hydraulic control, pilot pressure related HD1, HD2, HD3

Sizes 28...200



Sizes 250...1000



Variation: Constant pressure control (HD.D)

The constant pressure control is superimposed on the HD function. Should system pressure rise as a result of the load torque or reduction of the motor swivel angle, when the setting of the constant pressure control is reached the motor is swivelled out to a higher angle.

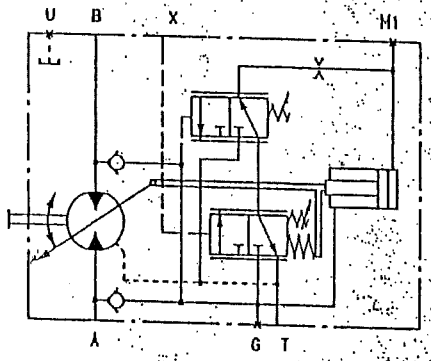
As a result of the increased displacement and consequent pressure reduction, the control deviation is eliminated. By increasing the displacement the motor produces a higher torque at a constant pressure.

Setting range of constant pressure control valve:

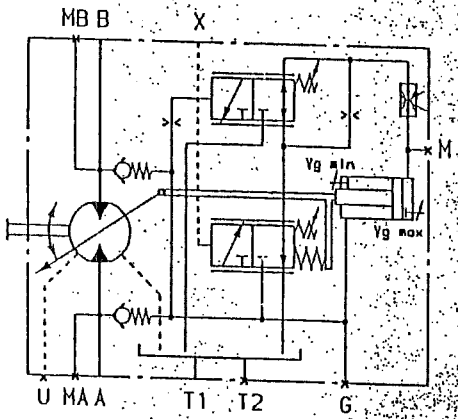
sizes 28...200 _____ 80 - 400 bar

sizes 250...1000 _____ 80 - 350 bar

Sizes 28...200 (HD.D)



Sizes 250...1000 (HD.D)



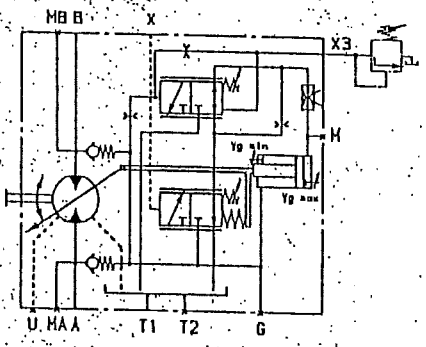
Variation: Remote constant pressure control (HD.G)

The remote pressure control controls the motor when reaching the set pressure command signal continuously until it reaches the max. displacement $V_{g\,max}$. A pressure relief valve (not supplied), which is separate to the motor, is responsible for the control of the internal pressure cut-off valve. As long as the pressure command signal has not been obtained, the valve is, in addition to the spring force, pressurised from both sides, and is held closed. The pressure command signal is between 80 bar and 350 bar. On reaching the pressure command signal at the separate pressure relief valve, this opens, whereby the pressure on the spring side is allowed to flow to tank. The internal pilot valve operates and the motor swivels to maximum displacement $V_{g\,max}$. The pressure difference at the pilot valve is set as standard to 25 bar. We recommend the following as a separate pressure relief valve:

DBD 6 (hydraulic) to RE 25402

The max. line length should not exceed 2 m.

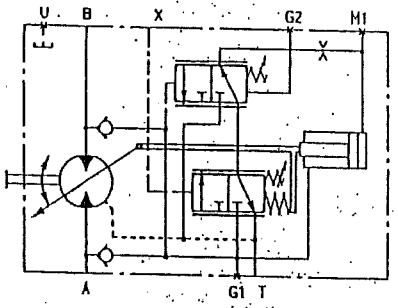
Sizes 250...1000 (HD.G)



Variation: pressure control with 2nd pressure setting (HD.E)

Through input of an external control pressure at port G2 the setting of the pressure regulator can be overridden and a 2nd pressure setting can be realised. The pressure signal at port G2 must be between 20 and 50 bar (when ordering please state the 2nd pressure setting in clear text).

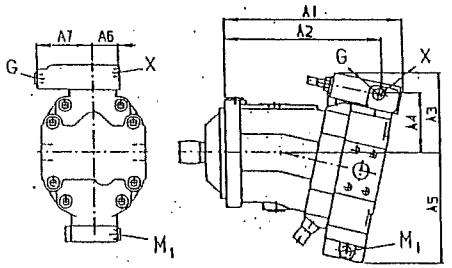
Sizes 28...200 (HD.E)



Unit Dimensions HD

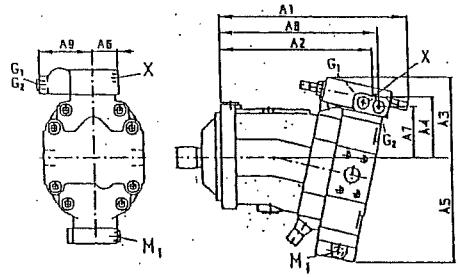
Before finalising your design, please request a certified drawing.

Unit dimensions HD.D
Sizes 28...200



Size	A1	A2	A3	A4	A5	A6	A7
28	214	189	119	87	136	35,5	88,5
55	241	216	120	89	151	35,5	88,5
80	269	244	126	95	167	35,5	88,5
107	291	258	133	101	175	40,5	88,5
140	323	290	141	108	195	40,5	88,5
160	329	297	141	108	197	40,5	88,5
200	346	313	145	112	209	40,5	88,5

Unit dimensions HD.E
Sizes 28...200

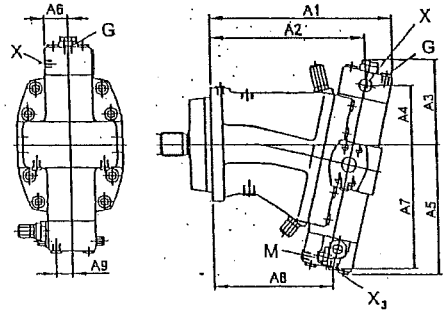


Size	A1	A2	A3	A4	A5	A6	A7	A8	A9
28									
55	272	216	126	89	151	35,5	76	232	88,5
80	301	244	129	95	167	35,5	79	259	88,5
107	311	258	136	101	175	40,5	86	270	88,5
140									
160	349	297	144	108	197	40,5	93	309	88,5
200	369	313	147	112	209	40,5	98	324	88,5

G1: port for synchronous control of a number of units and for remote control pressure — M 14x1,5 (plugged)

G2: port for 2nd pressure setting — M 14x1,5 (plugged)

Unit dimensions HD.D, HD.G
Sizes 250...1000



Size	A1	A2	A3	A4	A5	A6	A7	A8	A9
250	385	327	188	123	272	48,5	266	276	35
355	432	366	203	137	288	54	271	287	33
500	490	417	215	148	306	61,5	287	314	23
1000	618	537	274	189	388	70	373	420	51

pilot pressure port X_3: M 14x1,5 (open at HD.G, plugged at HD.D)

Unit dimensions of control HD1 and HD2: see pages 22...32

HZ Hydraulic Two-Position Control

Before finalising your design, please request a certified drawing.

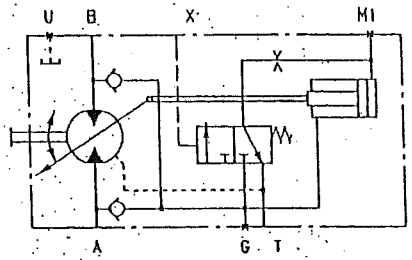
The hydraulic two-position control allows the displacement to be set to $V_{g\,min}$ or $V_{g\,max}$ by application or non-application of pilot pressure to port X.

without control pressure — motor set to $V_{g\,max}$

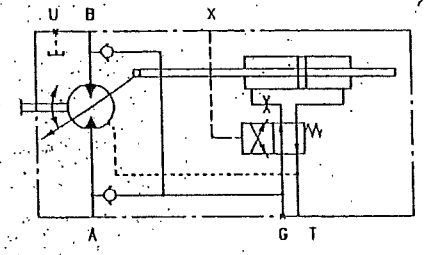
with control pressure (> 10 bar) — motor set to $V_{g\,min}$

The required control oil is taken from the high pressure side; for this, a minimum operating pressure of 15 bar is necessary. If it is necessary to operate the control at an operating pressure of <15 bar, a boost pressure of min. 15 bar must be applied at port G via an external check valve.

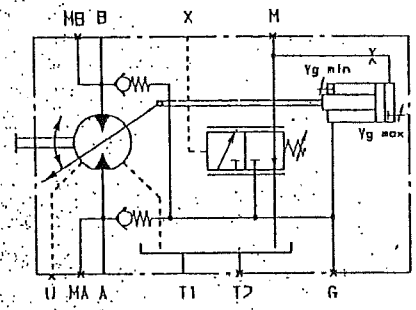
Hydraulic two-position control HZ1
Sizes 28, 140, 160, 200



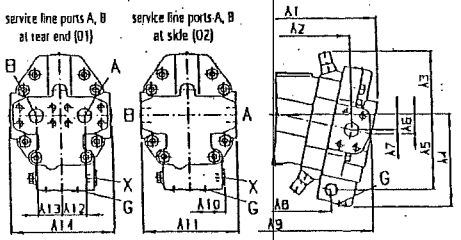
Hydraulic two-position control HZ3
Sizes 55, 80, 107



Hydraulic two-position control HZ
Sizes 250...1000



Unit dimensions HZ3 *)
Sizes 55, 80, 107

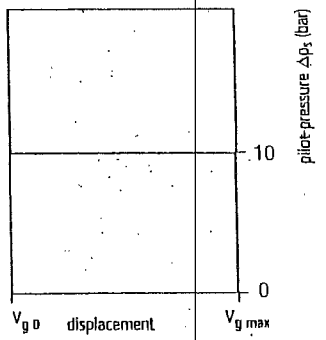


Size	A1	A2	A3	A4	A5	A6	A7	A8	A9
55	227	183	100	146	117	31	24	151	215
80	255	208	114	161	132	35	27	172	242
107	270	220	122	173	143	38	30	182	256

Size	A10	A11	A12	A13	A14	ports A, B	port X
55	61	152	37,5	37,5	160	SAE 3/4"	M14x1,5
80	61	164	42	42	172	SAE 1	M14x1,5
107	61	180	42	42	188	SAE 1	M14x1,5

*) unit dimensions of control HZ (sizes 250...1000) and HZ1 (sizes 28, 140, 160, 200) see pages 22-32

Standard version:
- start of control at $V_{g\,max}$ (max. torque, min. speed)
- end of control at $V_{g\,min}$ (min. torque, max. perm. speed)



EZ ... rical Two-Position Control with Switching Solenoid

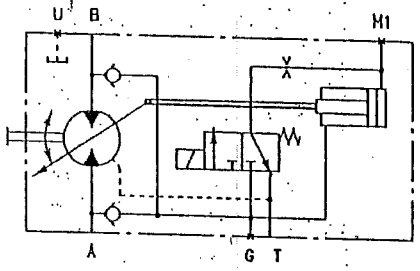
The electrical two-position control with switching solenoid allows the displacement to be set to $V_{g\,max}$ or $V_{g\,min}$ by energising or de-energising the solenoid.

Solenoid de-ernergised ≙ motor set to $V_{g\,max}$
Solenoid ernergised ≙ motor set to $V_{g\,min}$

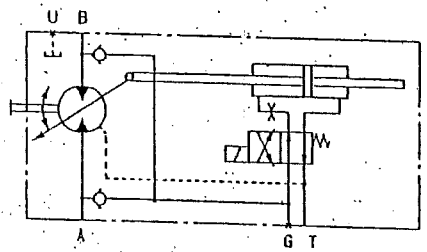
EZ1, EZ3	switching solenoid 12 V DC, 26W (EZ1) 30W (EZ3)
EZ2, EZ4	switching solenoid 24 V DC, 26W (EZ2) 30W (EZ4)

The required control oil is taken from the high pressure side; for this, a minimum operating pressure of 15 bar is necessary. If it is necessary to operate the control at an operating pressure of <15 bar, a boost pressure of min. 15 bar must be applied at port G via an external check valve.

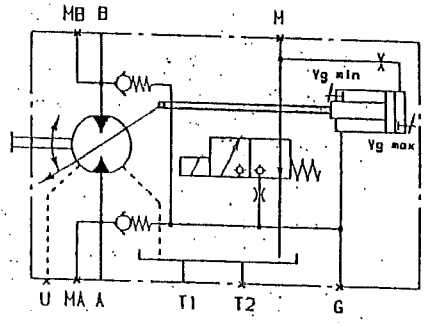
Electrical two-position control EZ1, EZ2
Sizes 28, 140, 160, 200



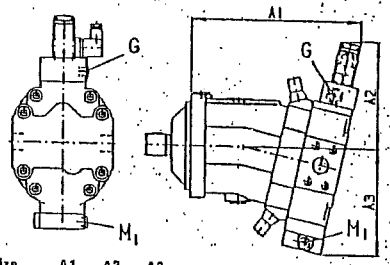
Electrical two-position control EZ3, EZ4
Sizes 55, 80, 107



Electrical two-position control EZ1, EZ2
Sizes 250...1000

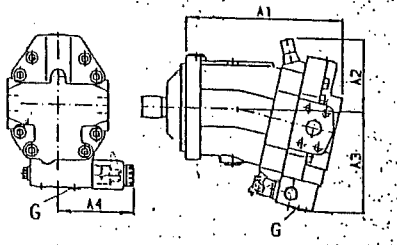


Unit dimensions EZ1, EZ2
Sizes 28, 140, 160, 200



Size	A1	A2	A3
28	216	163	136
140	321	184	195
160	328	184	197
200	344	188	209

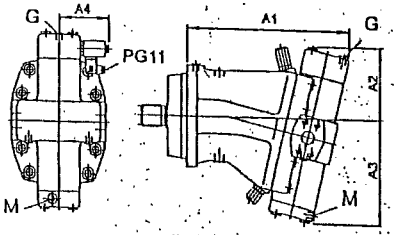
Unit dimensions EZ3, EZ4
Sizes 55, 80, 107



Size	A1	A2	A3	A4
55	227	100	146	124
80	255	114	161	124
107	270	122	173	124

(additional dimensions of the port plate see page 18, HZ3-control)

Unit dimensions EZ1, EZ2
Sizes 250...1000



Size	A1	A2	A3	A4
250	385	171	248	125
355	432	182	279	128,5
500	490	197	306	135,5
1000				

EP Electrical Control, with Proportional Solenoid

The electrical control with proportional solenoid or proportional valve (sizes 250...1000) allows infinite variation of the motor displacement in relation to an electrical signal.

The control function is proportional to the electrical control current applied.

For the sizes 250...1000 an external pressure of p_{min} = 30 bar is necessary (p_{max} = 100 bar) at port P for the control oil supply.

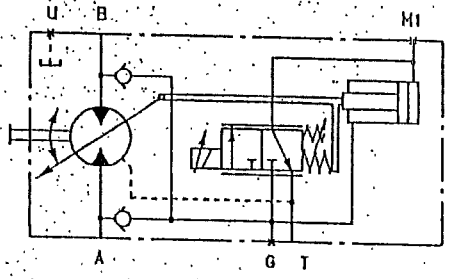
Sizes 28...200

	control voltage (DC)	control current start of control ($V_{g\,max}$)	end of control ($V_{g\,min}$ = 0)
EP1	12 V	400 mA	1200 mA
EP2	24 V	200 mA	600 mA

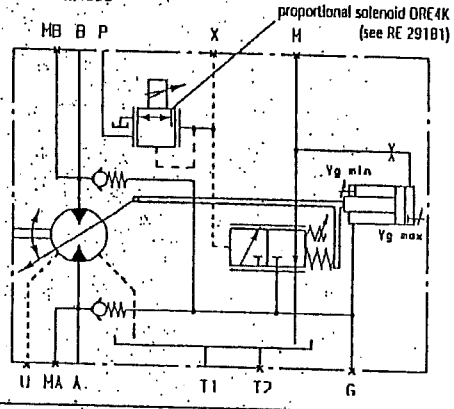
Sizes 250...1000

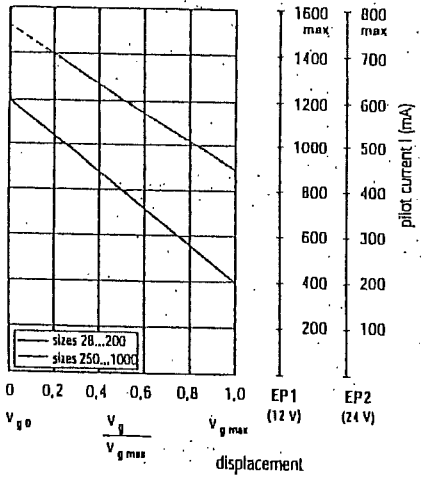
	control voltage (DC)	control current start of control ($V_{g\,max}$)	end of control ($V_{g\,min}$ = 0,2 $V_{g\,max}$)
EP1	12 V	900 mA	1400 mA
EP2	24 V	450 mA	700 mA

Electrical control with proportional solenoid EP1, EP2
Sizes 28...200



Electrical control with proportional solenoid EP1, EP2
Sizes 250...1000





Standard version:
- start of control at $V_{g\,max}$ (max. torque, min. speed)
- end of control at $V_{g\,min}$ (min. torque, max. perm. speed)

The required control oil is taken from the high pressure side; for this, a minimum operating pressure of 15 bar is necessary. If it is necessary to operate the control at an operating pressure of <15 bar, a boost pressure of min. 15 bar must be applied at port G via an external check valve (max. perm. pilot pressure: 100 bar).

Adjustment of the control speed or limiting of the displacement (limiting of swivel) range by electrical means is possible using the following control devices:

Proportional amplifier PV ____ see RE 95023
Chopper amplifier CV ____ see RE 95029
Electrical amplifier 2014/15 ____ see RE 95027
Electrical amplifier VT 2000, series 40 ____ see RE 29908

EP Electrical Control, with Proportional Solenoid

Variation: Direct constant pressure control (EP.D)

The constant pressure control is superimposed on the EP function. Should system pressure rise as a result of the load torque or reduction of the motor swivel angle, when the setting of the constant pressure control is reached the motor is swivelled out to a higher angle.

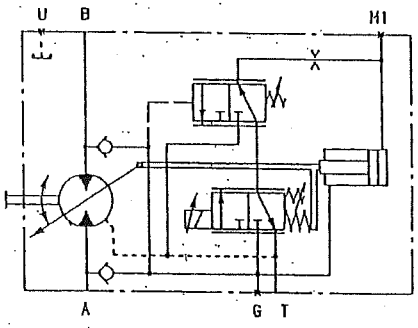
As a result of the increased displacement and consequent pressure reduction, the control deviation is eliminated. By increasing the displacement the motor produces a higher torque at a constant pressure.

Setting range of constant pressure control valve:

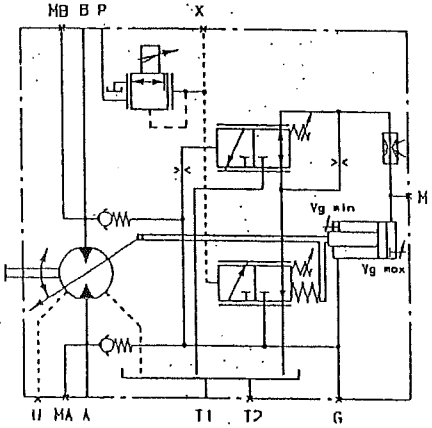
Sizes 28...200 _____ 80 - 400 bar

Sizes 250...1000 _____ 80 - 350 bar

Sizes 28...200 (EP.D)



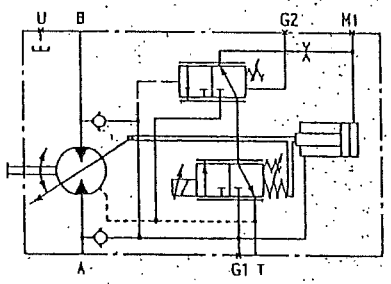
Sizes 250...1000 (EP.D)



Variation: pressure control with 2nd pressure setting (EP.E)

Through input of an external control pressure at port G2 the setting of the pressure regulator can be overridden and a 2nd pressure setting can be realised. The pressure signal at port G2 must be between 20 and 50 bar (when ordering please state the 2nd pressure setting in clear text).

Sizes 28...200 (EP.E)



Variation: Remote constant pressure control (EP.G)

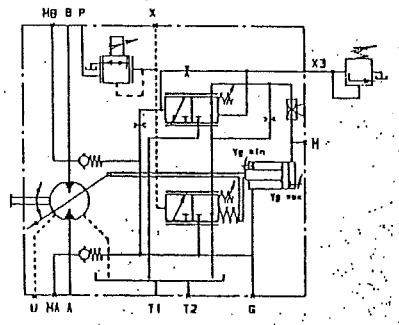
The remote pressure control controls the motor when reaching the set pressure command signal continuously until it reaches the max. displacement $V_{g\,max}$. A pressure relief valve (not supplied), which is separate to the motor, is responsible for the control of the internal pressure cut-off valve.

As long as the pressure command signal has not been obtained, the valve is, in addition to the spring force, pressurised from both sides, and is held closed. The pressure command signal is between 80 bar and 350 bar. On reaching the pressure command signal at the separate pressure relief valve, this opens, whereby the pressure on the spring side is allowed to flow to tank. The internal pilot valve operates and the motor swivels to maximum displacement $V_{g\,max}$. The pressure difference at the pilot valve is set as standard to 25 bar. We recommend the following as a separate pressure relief valve:

DBD 6 (hydraulic) to RE 25402

The max. line length should not exceed 2 m.

Sizes 250...1000 (EP.G)

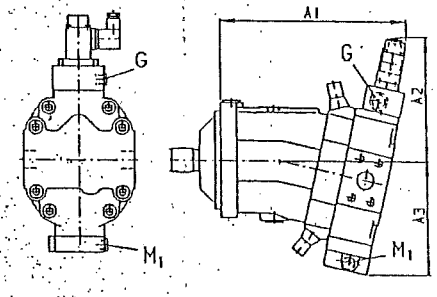


Unit Dimensions EP

Before finalising your design, please request a certified drawing.

Unit dimensions EP1, EP2

Sizes 28...200



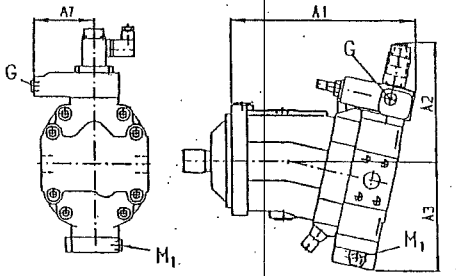
Size	A1	A2	A3	A4	A5	A6	A7
28	214	166	136				88,5
55	241	167	151	231	73	271	88,5
80	269	173	167	259	79	299	88,5
107	290	179	175				88,5
140	322	187	195				88,5
160	329	187	197	309	93	351	88,5
200	345	191	209	325	97	368	88,5

G1: port for synchronous control of a number of units and for remote control pressure M 14x1,5 (plugged)

G2: port for 2nd pressure setting M 14x1,5 (plugged)

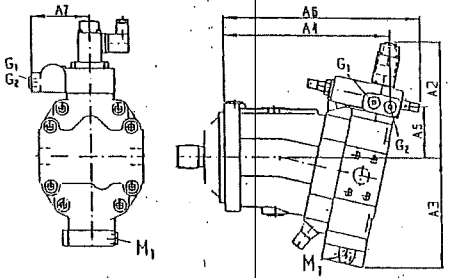
Unit dimensions EP.D

Sizes 28...200



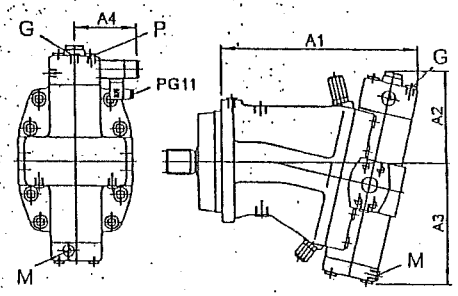
Unit dimensions EP.E

Sizes 28...200



Unit dimensions EP1, EP2

Sizes 250...1000

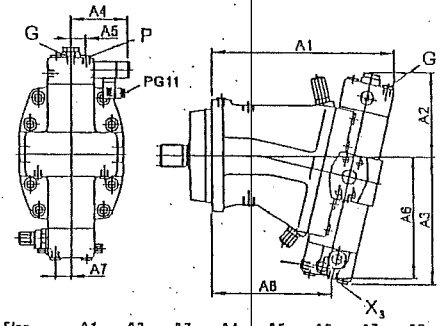


Size	A1	A2	A3	A4
250	385	188	272	124
355	432	203	288	125
500	490	215	306	132
1000				

pilot pressure port P: M 14x1,5

Unit dimensions EP.D, EP.G

Sizes 250...1000



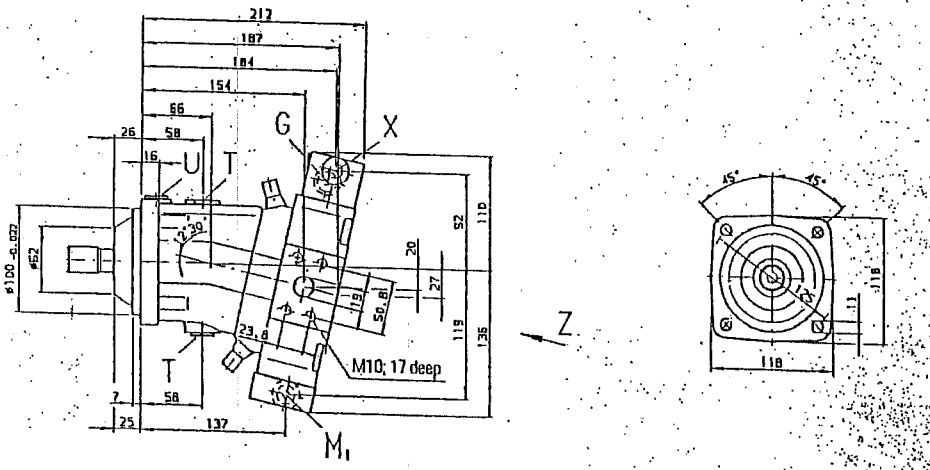
Size	A1	A2	A3	A4	A5	A6	A7	A8
250	385	188	272	124	36	256	35	267
355	432	203	288	125	36	271	33	287
500	490	215	306	132	43	287	32	314
1000								

pilot pressure port P: M 14x1,5

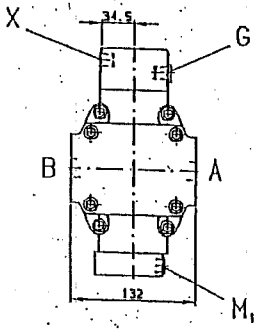
pilot pressure port X_3: M 14x1,5 (open at EP.G, plugged at EP.D)

Before finalising your design, please request a certified drawing.

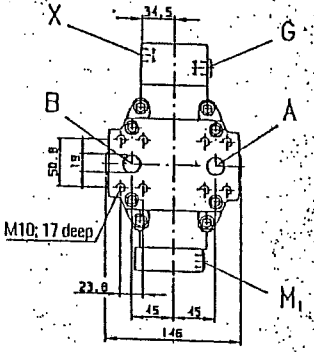
Hydraulic control, pilot pressure related HD1, HD2
Hydraulic two-position control HZ1
Service line ports A/B on (opposite) sides (02)



Service line ports A/B
on (opposite) sides (02)

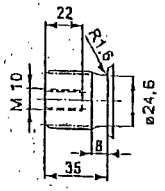


Service line ports A/B
at rear end (01)

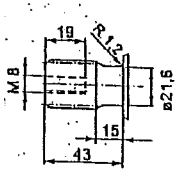


Shaft ends

A
Splined shaft
W 30x2x30x14x9g
DIN 5480



Z
Splined shaft,
W 25x1,25x30x18x9g
DIN 5480

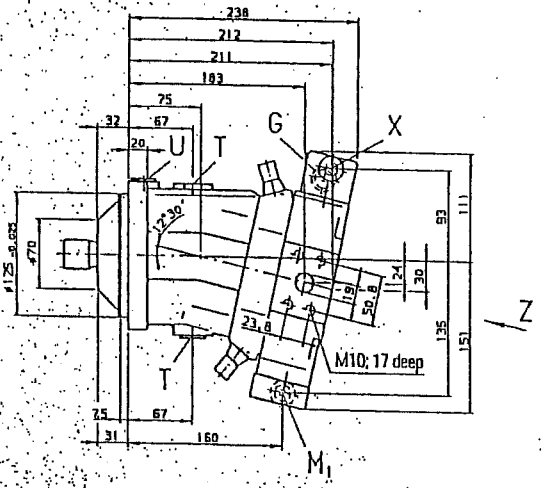


Connections

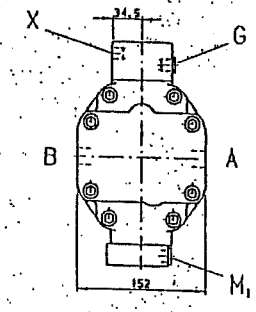
A; B	Service line ports 420 bar (6000 psi) high pressure series	SAE 3/4"
G	Port for synchronous control of a number of units and for remote control pressure (plugged)	M 14x1,5
X	Pilot pressure port	M 14x1,5
T	Case drain port	M 18x1,5
U	Flushing port (plugged)	M 16x1,5
M_1	Test port for control pressure (plugged)	M 14x1,5

Before finalising your design, please request a certified drawing.

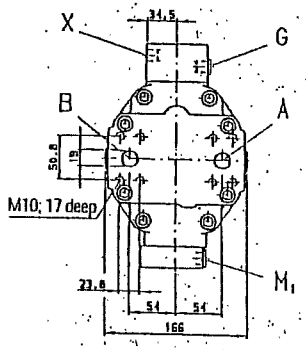
Hydraulic control, pilot pressure related HD1, HD2
Service line ports A/B on (opposite) sides (02)



Service line ports A/B
on (opposite) sides (02)

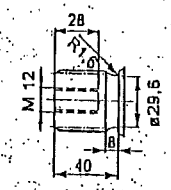


Service line ports A/B
at rear end (01)

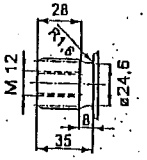


Shaft ends

A
Splined shaft
W 35x2x30x16x9g
DIN 5480



Z
Splined shaft
W 30x2x30x14x9g
DIN 5480



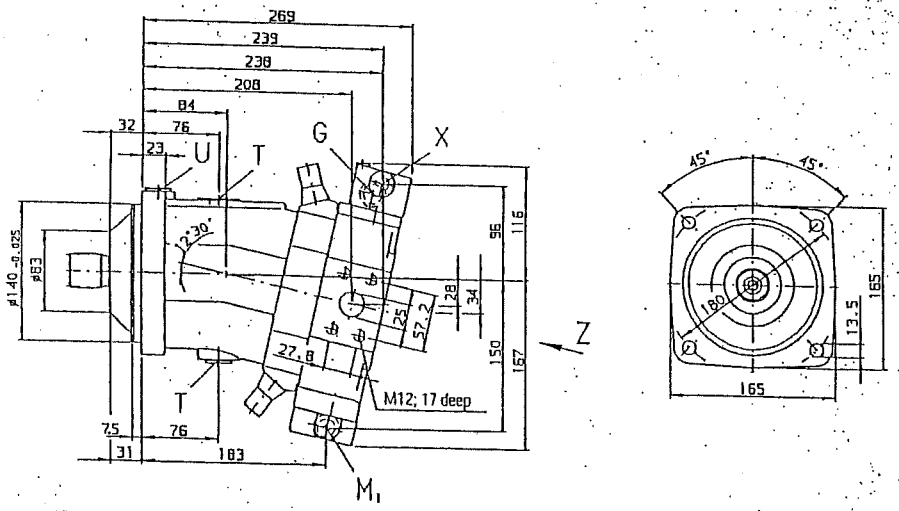
Connections

A; B	Service line ports 420 bar (6000 psi) high pressure series	SAE 3/4"
G	Port for synchronous control of a number of units and for remote control pressure (plugged)	M 14x1,5
X	Pilot pressure port	M 14x1,5
T	Case drain port	M 18x1,5
U	Flushing port (plugged)	M 18x1,5
M_1	Test port for control pressure (plugged)	M 14x1,5

Unit Dimensions Size 80

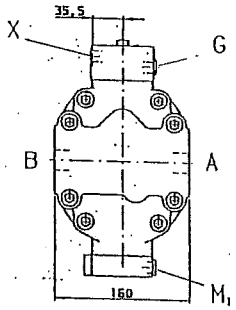
Before finalising your design, please request a certified drawing.

Hydraulic control, pilot pressure related HD1, HD2
Service line ports A/B on (opposite) sides (02)

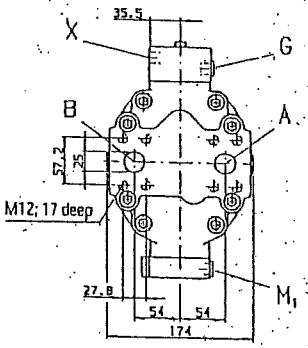


View Z

Service line ports A/B on (opposite) sides (02)

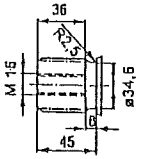


Service line ports A/B at rear end (01)

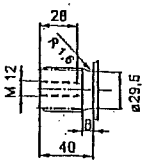


Shaft ends

A
Splined shaft
W 40x2x30x18x9g
DIN 5480



Z
Splined shaft
W 35x2x30x16x9g
DIN 5480



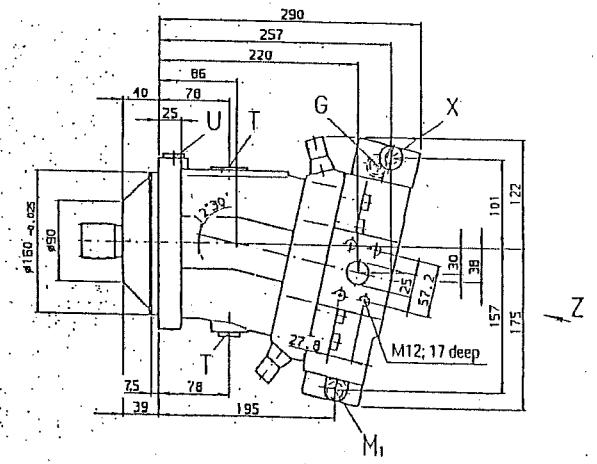
Connections

A; B	Service line ports 420 bar (6000 psi) high pressure series	SAE 1"
G	Port for synchronous control of a number of units and for remote control pressure (plugged)	M 14x1,5
X	Pilot pressure port	M 14x1,5
T	Case drain port	M 18x1,5
U	Flushing port (plugged)	M 18x1,5
M_1	Test port for control pressure (plugged)	M 14x1,5

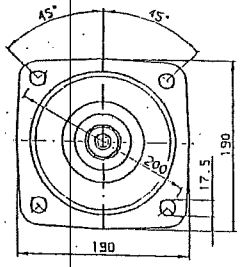
Unit Dimensions Size 107

Before finalising your design, please request a certified drawing.

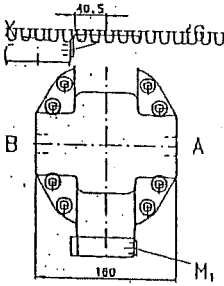
Hydraulic control, pilot pressure related HD1, HD2
Service line ports A/B on (opposite) sides (02)



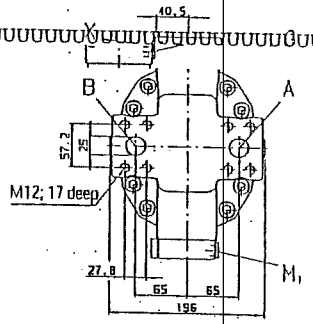
View Z



Service line ports A/B on (opposite) sides (02)

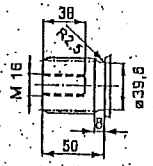


Service line ports A/B at rear end (01)

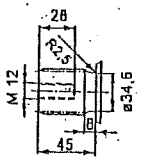


Shaft ends

A
Splined shaft
W 45x2x30x21x9g
DIN 5480



Z
Splined shaft,
W 40x2x30x18x9g
DIN 5480



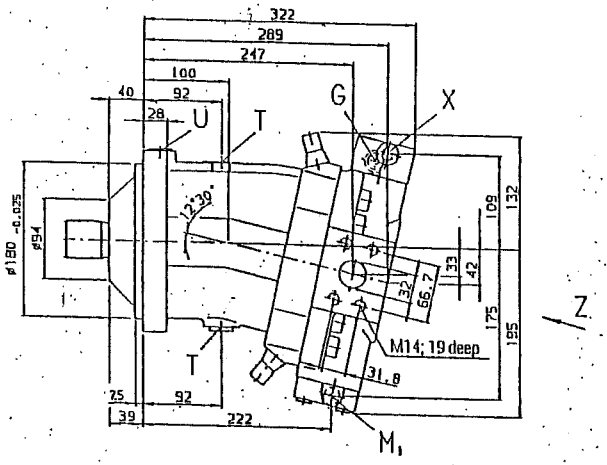
Connections

A; B	Service line ports 420 bar (6000 psi) high pressure series	SAE 1"
G	Port for synchronous control of a number of units and for remote control pressure (plugged)	M 14x1,5
X	Pilot pressure port	M 14x1,5
T	Case drain port	M 18x1,5
U	Flushing port (plugged)	M 18x1,5
M_1	Test port for control pressure (plugged)	M 14x1,5

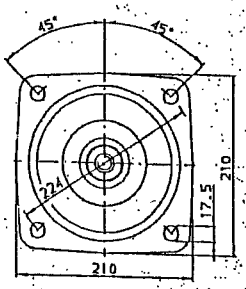
Unit Dimensions Size 140

Before finalising your design, please request a certified drawing.

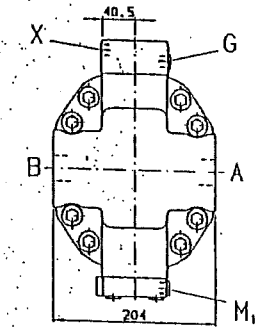
Hydraulic control, pilot pressure related HD1, HD2
Hydraulic two-position control HZ1
Service line ports A/B on (opposite) sides (02)



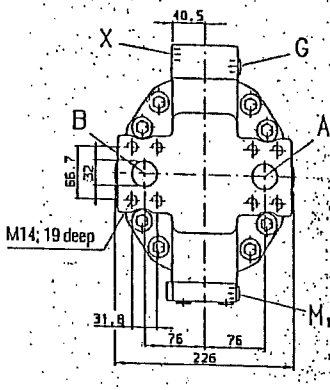
View Z



Service line ports A/B
on (opposite) sides (02)

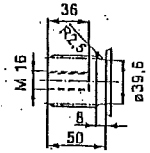


Service line ports A/B
at rear end (01)



Shaft ends

Z
Splined shaft,
W 45x2x30x21x9g
DIN 5480



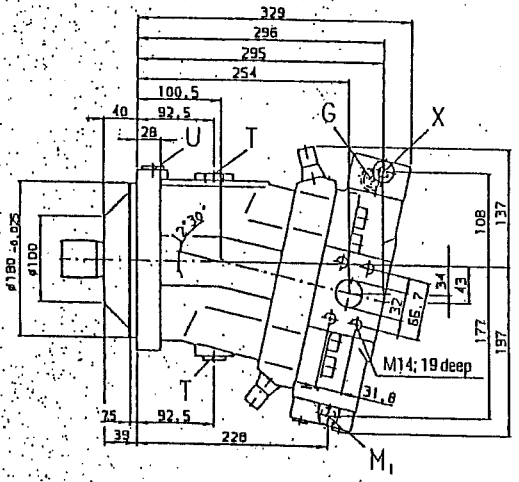
Connections

A; B	Service line ports 420 bar (6000 psi) high pressure series	SAE 1¼"
G	Port for synchronous control of a number of units and for remote control pressure (plugged)	M 14x1,5
X	Pilot pressure port	M 14x1,5
T	Case drain port	M 26x1,5
U	Flushing port (plugged)	M 22x1,5
M_1	Test port for control pressure (plugged)	M 14x1,5

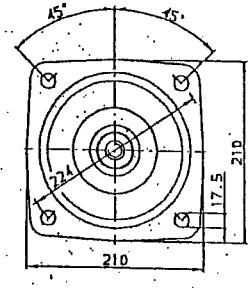
Unit Dimensions Size 160

Before finalising your design, please request a certified drawing.

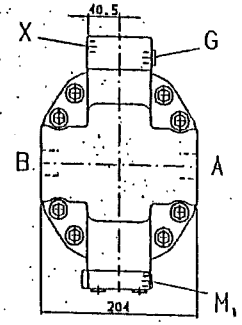
Hydraulic control, pilot pressure related HD1, HD2
Hydraulic two-position control HZ1
Service line ports A/B on (opposite) sides (02)



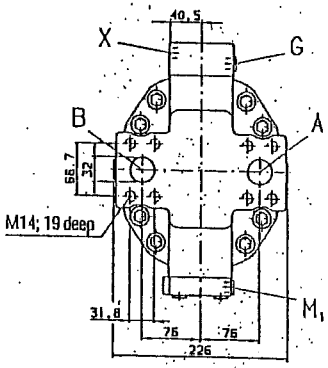
View Z



Service line ports A/B
on (opposite) sides (02)

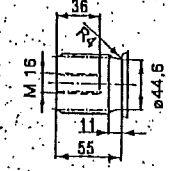


Service line ports A/B
at rear end (01)

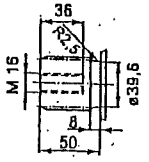


Shaft ends

A
Splined shaft
W 50x2x30x24x9g
DIN 5480



Z
Splined shaft,
W 45x2x30x21x9g
DIN 5480



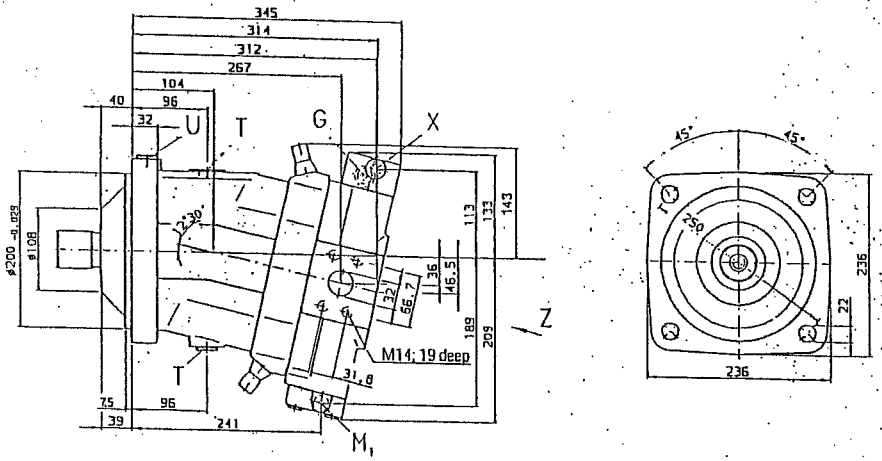
Connections

A; B	Service line ports 420 bar (6000 psi) high pressure series	SAE 1¼"
G	Port for synchronous control of a number of units and for remote control pressure (plugged)	M 14x1,5
X	Pilot pressure port	M 14x1,5
T	Case drain port	M 26x1,5
U	Flushing port (plugged)	M 22x1,5
M_1	Test port for control pressure (plugged)	M 14x1,5

Unit Dimensions Size 200

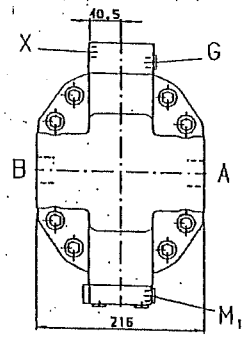
Before finalising your design, please request a certified drawing.

Hydraulic control, pilot pressure related HD1, HD2
Hydraulic two-position control HZ1
Service line ports A/B on (opposite) sides (02)

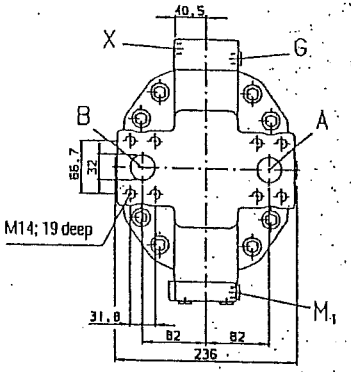


View Z

Service line ports A/B on (opposite) sides (02)

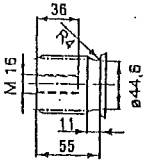


Service line ports A/B at rear end (01)



Shaft ends

A
Splined shaft
W 50x2x30x24x9g
DIN 5480



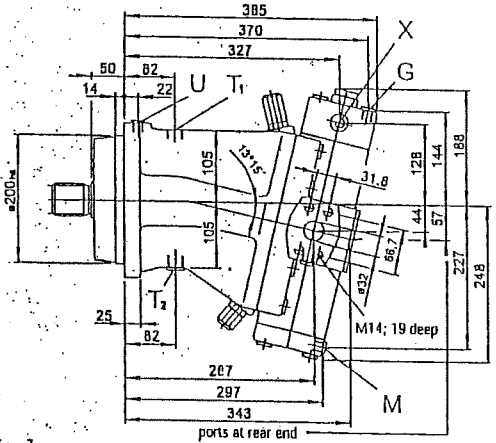
Connections

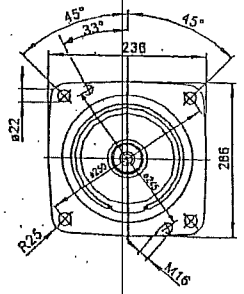
A; B	Service line ports 420 bar (6000 psi) high pressure series	SAE 1¼"
G	Port for synchronous control of a number of units and for remote control pressure (plugged)	M 14x1,5
X	Pilot pressure port	M 14x1,5
T	Case drain port	M 26x1,5
U	Flushing port (plugged)	M 22x1,5
M_1	Test port for control pressure (plugged)	M 14x1,5

Unit Dimensions Size 250

Before finalising your design, please request a certified drawing.

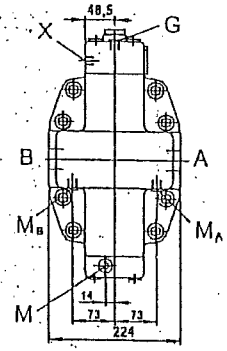
Hydraulic control, pilot pressure related HD1, HD2, HD3
Hydraulic two-position control HZ
Service line ports A/B on (opposite) sides (02); on (opposite) sides + at rear end (15)



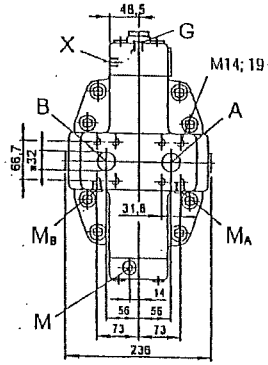


View Z

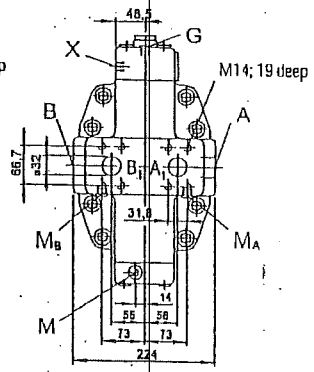
Service line ports A/B on (opposite) sides (02)



Service line ports A/B at rear end (01)

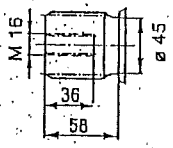


Service line ports A/B/A_1/B_1 on (opposite) sides + at rear end (15)

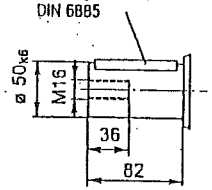


Shaft ends

Z
Splined shaft
W 50x2x30x24x9g
DIN 5480



P
Parallel shaft
with key AS 14x9x80
DIN 6885



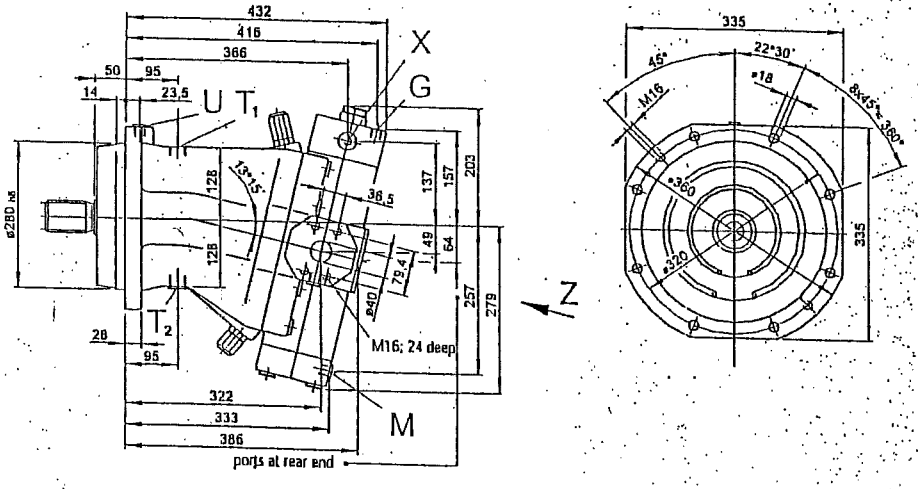
Connections

A; B	Service line ports high pressure series	SAE 1¼"
A_1; B_1	Additional service line ports at port plate 15	SAE 1¼"
G	Port for synchronous control of a number of units and for remote control pressure (plugged)	M 14x1,5
X	Pilot pressure port	M 14x1,5
T_1; T_2	Case drain ports	M 22x1,5
U	Flushing port	M 14x1,5
M_A; M_B	Test ports	M 14x1,5
M	Test port for control pressure (plugged)	M 14x1,5

Before finalising your design, please request a certified drawing.

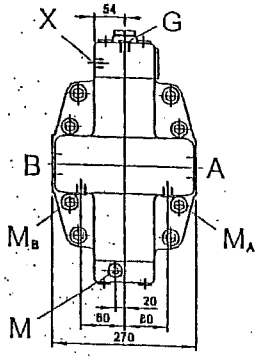
Hydraulic control, pilot pressure related HD1, HD2
Hydraulic two-position control HZ

Service line ports A/B on (opposite) sides (02)

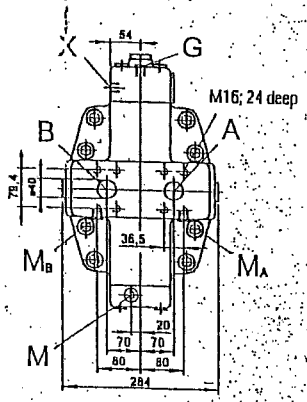


View Z

Service line ports A/B on (opposite) sides (02)

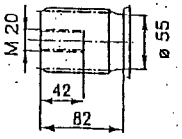


Service line ports A/B at rear end (01)

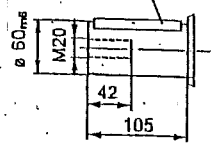


Shaft ends

Z
Splined shaft
W 60x2x30x28x9g
DIN 5480



P
Parallel shaft
with key AS 18x11x100
DIN 6885



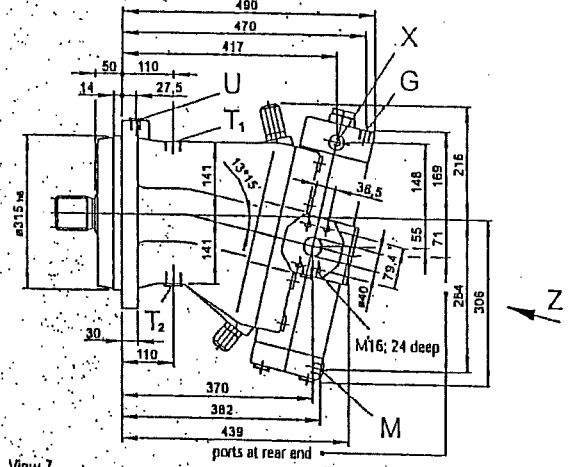
Connections

A,B	Service line ports high pressure series	SAE 1 1/2"
G	Port for synchronous control of a number of units and for remote control pressure (plugged)	M 14x1,5
X	Pilot pressure port	M 14x1,5
T_1, T_2	Case drain ports	M 33x2
U	Flushing port	M 14x1,5
M_A, M_B	Test ports	M 14x1,5
M	Test port for control pressure (plugged)	M 14x1,5

Before finalising your design, please request a certified drawing.

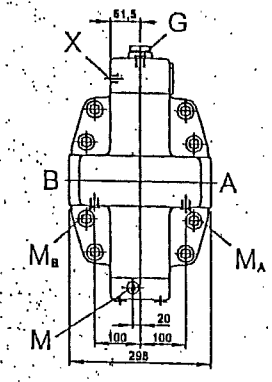
Hydraulic control, pilot pressure related HD1, HD2, HD3
Hydraulic two-position control HZ

Service line ports A/B on (opposite) sides (02); . on (opposite) sides + at rear end (15)

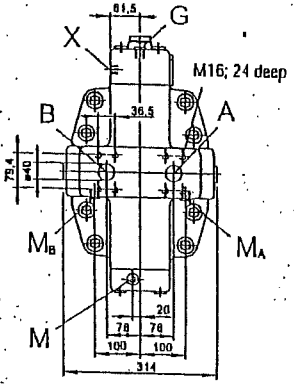


View Z

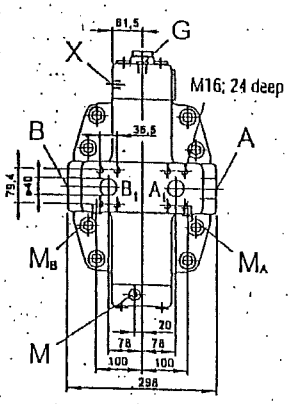
Service line ports A/B on (opposite) sides (02)



Service line ports A/B at rear end (01)

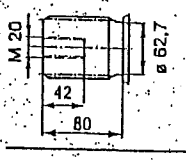


Service line ports A/B/A_1/B_1 on (opposite) sides + at rear end (15)

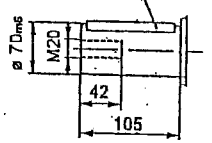


Shaft ends

Z
Splined shaft
W 70x3x30x22x9g
DIN 5480



P
Parallel shaft
with key AS 20x12x100
Din 6885

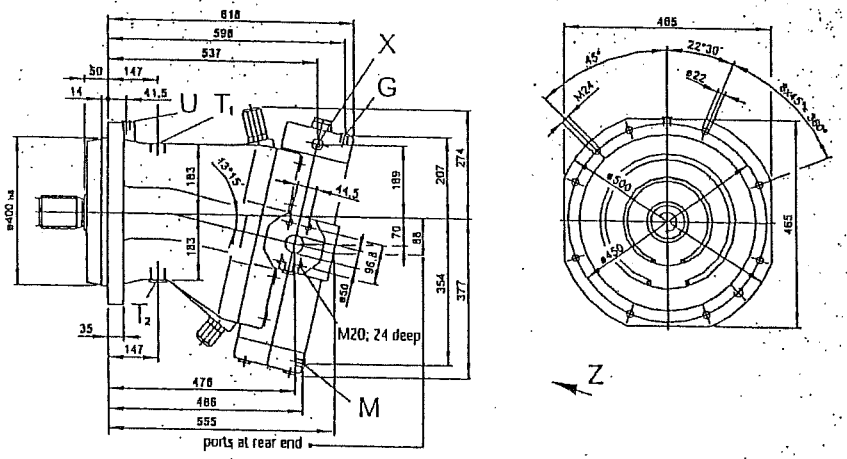


Connections

A,B	Service line ports high pressure series	SAE 1 1/2"
A_1; B_1	Additional service line ports at port plate 15	SAE 1 1/2"
G	Port for synchronous control of a number of units and for remote control pressure (plugged)	M 18x1
X	Pilot pressure port	M 14x1,5
T_1, T_2	Case drain ports	M 33x2
U	Flushing port	M 18x1,5
M_A, M_B	Test ports	M 14x1,5
M	Test port for control pressure (plugged)	M 14x1,5

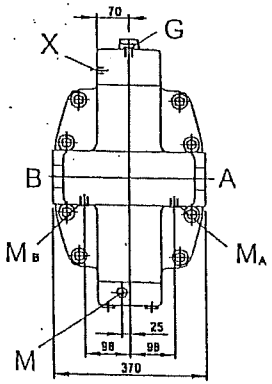
Before finalising your design, please request a certified drawing.

Hydraulic control, pilot pressure related HD1, HD2
Hydraulic two-position control HZ
Service line ports A/B on (opposite) sides (02)

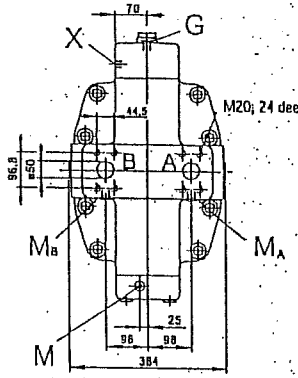


View Z

Service line ports A/B on (opposite) sides (02)

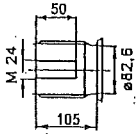


Service line ports A/B at rear end (01)

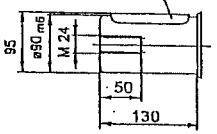


Shaft ends

Z
Splined shaft
W 90x3x30x20x9g
DIN 5480



P
Parallel shaft
with key A8 25x14x125
DIN 6885



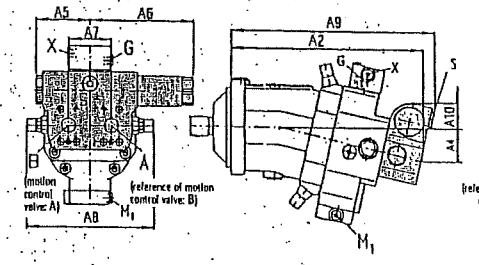
Connections

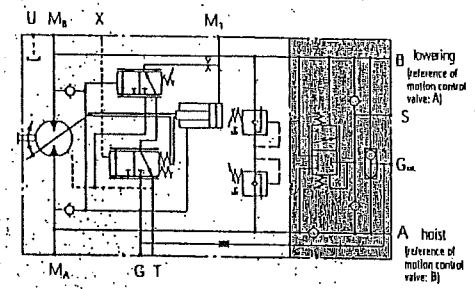
A,B	Service line ports high pressure series	SAE 2"
G	Port for synchronous control of a number of units and for remote control pressure (plugged)	M 18x1,5
X	Pilot pressure port	M 14x1,5
T_1, T_2	Case drain ports	M 42x2
U	Flushing port	M 18x1,5
M_A, M_B	Test ports	M 14x1,5
M	Test port for control pressure (plugged)	M 14x1,5

Winch Motion Control Valve MHB...E, Simple Funciton

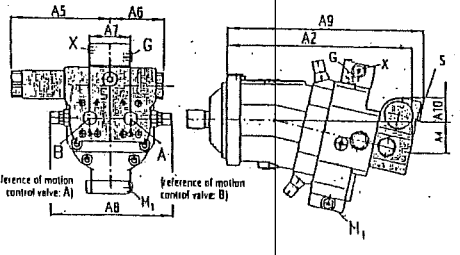
Before finalising your design, please request a certified drawing.

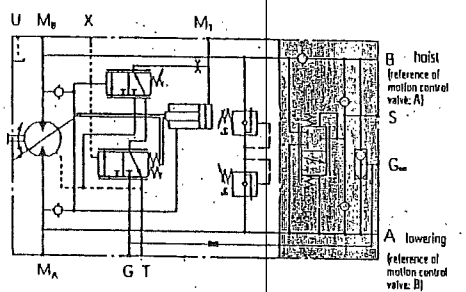
Variable motor A6VM, with winch motion control valve MHB..E
Design with start of control at $V_{g\,max}$ (standard for HD, EP)
Hoist: direction of rotation of the motor "clockwise"
(with vue on the drive shaft)





Variable motor A6VM, with winch motion control valve MHB..E
Design with start of control at $V_{g\,max}$ (standard for HD, EP)
Hoist: direction of rotation of the motor "anti-clockwise"
(with vue on the drive shaft)





Note:

- Because of safety reasons hoist winch drives are not allowed with control devices with start of control at $V_{g\,min}$ (standard design for HA)!
- For the assembly of a motion control valve on a variable motor with the start of control at $V_{g\,max}$ (standard design for HD, EP) the port A of the motion control valve is mounted on the port B of the variable motor. This has to be taken into consideration when a motion control valve is used (direction of hoisting, design BR or AL) see table below.

Hoist: direction of rotation of the motor "clockwise" "anti-clockwise"

reference of motion control valve*)			
	control HD, EP	BR	AL
	control HA	AL	BR

*) see RE 64318

Connections

A, B Service line ports SAE, 420 bar (6000 psi) high pressure series

S Boosting (plugged)

The motion control valve is not included in the type references, please order seperately! We recommend total supply through Brueninghaus Hydromatik.

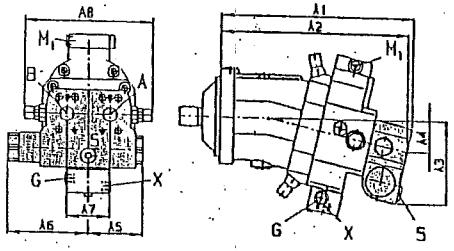
Further informations for motion control valve MHB:
- MHB20, MHB25 (for A6VM 55...160) RE 64318

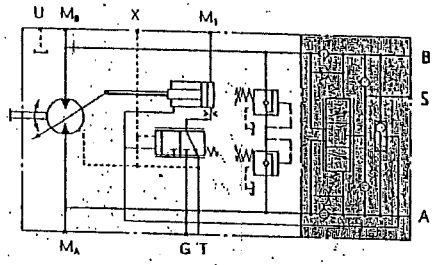
Unit dimensions (Variable displacement motor A6VM with winch motion control valve MHB...E)

motor A6VM		motion control valve MHB...E			dimensions									
size	plate	type	ports A, B	port S	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
55	38	MHB20...11	SAE ¾"	M22x1,5	311	302	143	50	98	187	75	222	325	
80	38	MHB20...18	SAE 1"	M22x1,5	340	331	148	55	98	187	75	222		
107	37	MHB20...18E	SAE 1"	M22x1,5	362	353	152	59	98	187	84	234		
107	38	MHB25...18	SAE 1¼"	M27x2	380	370	165	63	120,5	214	84	234		
140	38	MHB25...18	SAE 1¼"	M27x2					120,5	214	84			
160	38	MHB25...18	SAE 1¼"	M27x2	417	407	169	68	120,5	214	84			
250		on demand												

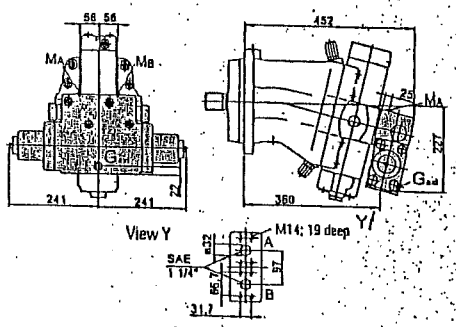
Before finalising your design, please request a certified drawing.

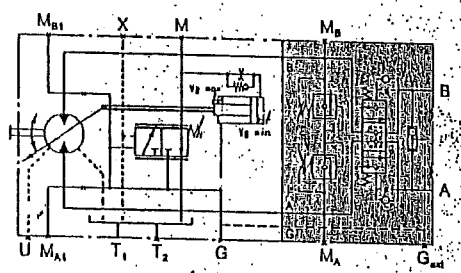
Variable motor A6VM, with drive motion control valve MHB...R
Design with start of control at $V_{g\,min}$ (standard for HA)
Sizes 55...160





Variable motor A6VM, with drive motion control valve MHB
Design with start of control at $V_{g\,min}$ (standard for HA)
Size 250





Connections

A, B Service line ports SAE, 420 bar (6000 psi) high pressure series

S Boosting (plugged)

The motion control valve is not included in the type references, please order seperately! We recommend total supply through Brueninghaus Hydromatik.

1) Exception: A6VM 250../63..088 (design with mounted motion control valve MHB 30, please state the design of the motion control valve in clear text)!

Further informations for motion control valve MHB:

- MHB20, MHB25 (für A6VM 55...160) ..... RE 64318
- MHB30 (für A6VM 250) ..... RE 64316

Unit dimensions (Variable displacement motor A6VM with drive motion control valve MHB...R)

motor A6VM		motion control valve MHB...E			dimensions							
size	plate	type	ports A, B	port S	A1	A2	A3	A4	A5	A6	A7	A8
55	38	MHB20...11	SAE ¾"	M22x1,5	311	302	143	50	96	139	75	222
80	38	MHB20...18	SAE 1"	M22x1,5	340	331	148	55	96	139	75	222
107	37	MHB20...18E	SAE 1"	M22x1,5	362	353	152	59	96	139	84	234
107	38	MHB25...18	SAE 1¼"	M27x2	380	370	165	63	120,5	165,5	84	234
140	38	MHB25...18	SAE 1¼"	M27x2					120,5	214	84	
160	38	MHB25...18	SAE 1¼"	M27x2	417	407	169	68	120,5	165,5	84	
250	08	MHB30	SAE 1¼"	–	see above							

Flushing and Boost Pressure Valve

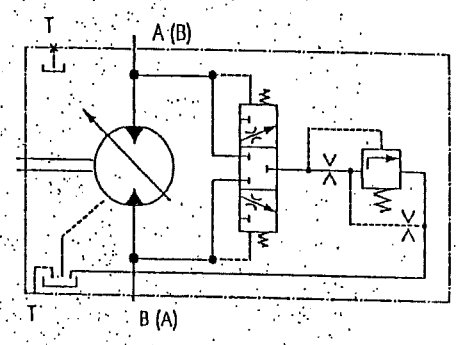
Before finalising your design, please request a certified drawing.

The flushing and boost pressure valve is set at a fixed opening pressure of 16 bar and serves to maintain the minimum boost pressure (set primary valve accordingly).

A fixed flow of fluid is taken via an orifice from the low pressure side of the circuit and fed into the motor housing. This flow is then passed back to tank with the case drain fluid. Fluid thus removed from the closed circuit must be made up by means of the boost pump.

The valve is mounted onto the variable motor or integrated in the control device.

Different orifice sizes may be used to select varying flows of flushing fluid.



Flows (at low pressure Δp_{ND} = 25 bar)*

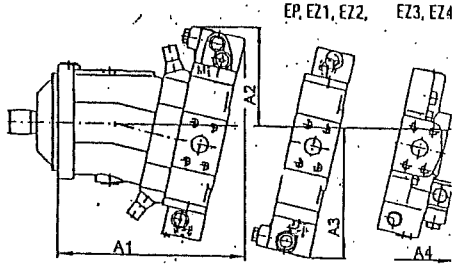
Size	Flow	Orifice No.
28, 55	3,5 L/min	651766/503.12.01.01
80	5 L/min	419695/503.12.01.01
107	8 L/min	419696/503.12.01.01
160, 200	10 L/min	419697/503.12.01.01
250	10 L/min	
355	16 L/min	
500	20 L/min	
1000	25 L/min	

* standard flushing volumes

(For sizes 28...200 flushing volumes of 3,5 - 10 L/min can be supplied. If a flushing volume different from the standard flushing volume is required, please indicate the requested orifice in clear text when ordering.)

Sizes 28...200

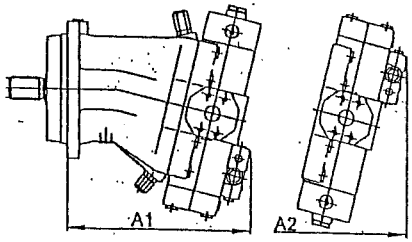
HA1, HA2 — HD, HZ1, DA EP, EZ1, EZ2, — HZ3 EZ3, EZ4



Size	A1	A2	A3	A4
28	214	125	161	—
55	243	133	176	236
80	273	142	193	254
107	288	144	200	269
140	321	154	218	—
160	328	154	220	—
200	345	160	231	—

Sizes 250...1000

HD, HZ, DA EP, EZ — HA1, HA2



Size	A1	A2
250	357	402
355	397	446
500	440	504
1000	552	

Speed sensor

Version A6VM...D ("suitable for fitting speed sensor") includes gearing on the rotary group.

A speed-proportional signal is produced by means of the rotating, splinded rotary group which can be picked up by a suitable sensor and fed back for evaluation..

The sensor is screwed into the upper leakage port T (sizes 28...200) respectively in the additional port for the rotational speed sensor (sizes 250...1000). For the sizes 140...200 the port T is equipped with an adapter piece (M18x1,5) for the installation of the sensors.

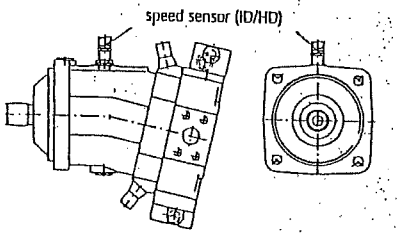
Size	28	55	80	107	140	160	200
No. of teath	40	54	58	67	72	75	80
length of thread (mm)	19,9	19,9	19,9	19,9	31,9	31,9	31,9

Size	250	355	500	1000
No. of teath	78	90	99	
length of thread (mm)	sensor with variable length of thread			

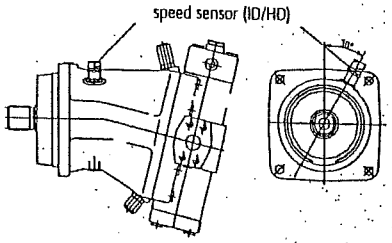
The speed sensor is not included in standard supply.

Suitable sensors (order seperately!):
- induktive impulse detector ID (see RE 95130)
- hall effect speed sensor HD (see RE 95134)

Sizes 28...200



Sizes 250...1000



Swivel Angle Indicator

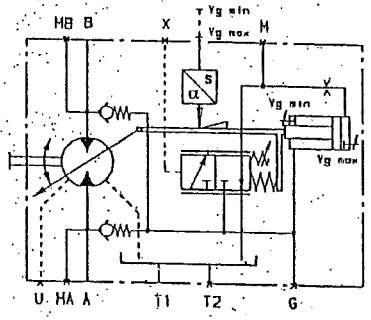
Before finalising your design, please request a certified drawing.

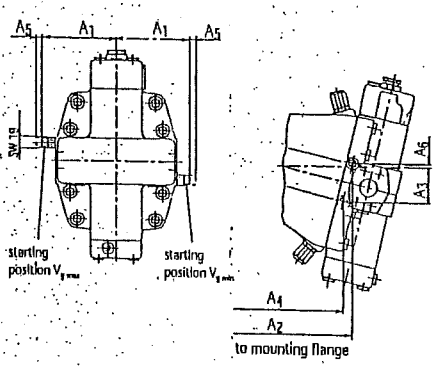
Optical swivel angle indicator (V)

The swivel position is indicated by a pin on the side of the housing. (Disassemble of the head nut necessary.) The length of the outstanding pin depends upon the position of the control lense.

If it is flush with the housing the motor is at zero. At max. swivel $V_{g\,max}$ the length of the pin is 8 mm (Display is still possible if the protective cap is removed).

Sizes 250...1000 (Example: A6VM...HD, starting position $V_{g\,max}$)





Size	A1	A2	A3	A4	A5*)	A6
250	136,5	256	73	238	11	5
355	159,5	288	84	266	11	8
500	172,5	331	89	309	11	3
1000	208,5	430	114	402	11	3

*) space required to remove protective cap

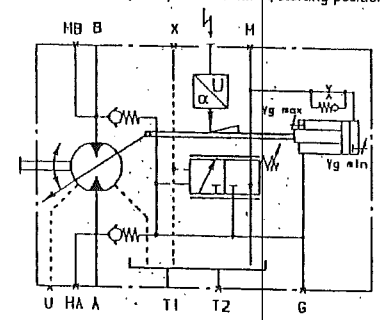
Electronical swivel angle indicator (E)

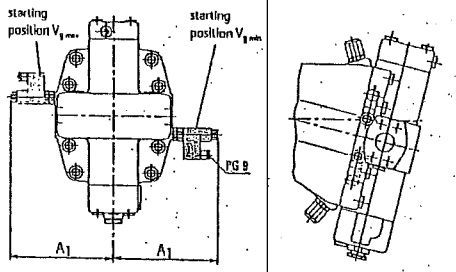
The motor position is fed back here by means of an inductive positional transducer. It converts the displacement of the variable unit into an electrical signal.

The swivel position may be further processed by means of this signal, eg. it may be fed to an amplifier card.

Inductive positional transducer type IW9-03-01

Sizes 250...1000 (Example: A6VM...HA, starting position $V_{g\,min}$)





Size	A1
250	182
355	205
500	218
1000	254

RE 91 604/05.99

Preferred types

Type	Ident-No.
A6VM28DA1/63W-VZB020B	9604014
A6VM28DA2/63W-VZB020B	9604015
A6VM28EP1/63W-VZB020B	9604063
A6VM28EZ1/63W-VZB020B	9604250
A6VM28HA1/63W-VZB020A	9604219
A6VM28HA1R2/63W-VZB020A	2036653
A6VM28HA1U2/63W-VZB020A	9604665
A6VM28HD1/63W-VZB020B	9603912
A6VM28HZ1/63W-VZB020B	9604249
A6VM55DA1/63W-VZB020B	9604017
A6VM55DA2/63W-VZB020B	9604018
A6VM55EP1/63W-VZB020B	9604065
A6VM55EZ3/63W-VZB020B	9604523
A6VM55HA1/63W-VZB020A	9604223
A6VM55HA1R2/63W-VZB020A	2036655
A6VM55HA1U2/63W-VZB020A	9605637
A6VM55HD1/63W-VZB020B	9603911
A6VM55HZ3/63W-VZB020B	9604517
A6VM80DA1/63W-VZB020B	9604020
A6VM80DA2/63W-VZB020B	9604021
A6VM80EP1/63W-VZB020B	9604067
A6VM80EZ3/63W-VZB020B	9604522
A6VM80HA1/63W-VZB020A	9604227
A6VM80HA1R2/63W-VZB020A	9610911
A6VM80HA1U2/63W-VZB020A	9605641
A6VM80HD1/63W-VZB020B	9603720
A6VM80HZ3/63W-VZB020B	9604516
A6VM107DA1/63W-VZB020B	9604023
A6VM107DA2/63W-VZB020B	9604024
A6VM107EP1/63W-VZB020B	9604069
A6VM107EZ3/63W-VZB020B	9604521
A6VM107EZ4/63W-VZB020B	9611133
A6VM107HA1/63W-VZB020A	9604231
A6VM107HA1R2/63W-VZB020A	2011699
A6VM107HA1U2/63W-VZB020A	9605644
A6VM107HD1/63W-VZB020B	9603804
A6VM107HZ3/63W-VZB020B	9604515

Type	Ident-No.
A6VM140DA1/63W-VZB020B	9603559
A6VM140DA3/63W-VZB020B	9610778
A6VM140EP2/63W-VZB020B	9605666
A6VM140EZ2/63W-VZB020B	9610772
A6VM140HA1/63W-VZB020A	9610774
A6VM140HA1R2/63W-VZB020A	9610776
A6VM140HA1U2/63W-VZB020A	9605670
A6VM140HD1/63W-VZB020B	9605664
A6VM140HZ1/63W-VZB020B	9605648
A6VM160DA1/63W-VZB020B	9604026
A6VM160DA3/63W-VZB020B	9604794
A6VM160EP2/63W-VZB020B	9604072
A6VM160EZ2/63W-VZB020B	9604254
A6VM160HA1/63W-VZB020A	9604235
A6VM160HA1R2/63W-VZB020A	2036656
A6VM160HA1U2/63W-VZB020A	9604666
A6VM160HD1/63W-VZB020B	9603805
A6VM160HZ1/63W-VZB020B	9604252
A6VM200DA1/63W-VAB020B	9604029
A6VM200DA3/63W-VAB020B	9610785
A6VM200EP2/63W-VAB020B	9604074
A6VM200EZ2/63W-VAB020B	9604257
A6VM200HA1/63W-VAB020A	9604239
A6VM200HA1R2/63W-VAB020A	9610792
A6VM200HA1U2/63W-VAB020A	9604667
A6VM200HD1/63W-VAB020B	9603913
A6VM200HZ1/63W-VAB020B	9604255
A6VM250EP2D/63W2-VZB020B	978 736
A6VM250HD2D/63W1-VZB020B	983 132
A6VM250HZ/63W2-VZB027B	999 277

Sizes 28...200: production plant Elchingen
Sizes 250...1000: production plant Horb

Please state type and ident-no. when ordering

Brueninghaus Hydromatik GmbH

Plant Elchingen
Glockeraustraße 2 • D-89275 Elchingen
Phone +49 (0) 73 08 82-0
Telefax +49 (0) 73 08 72 74

Plant Horb
An den Kelterwiesen 14 • D-72160 Horb
Phone +49 (0) 74 51 92-0
Telefax +49 (0) 74 51 82 21

The specified data is for product description purposes only and may not be deemed to be guaranteed unless expressly confirmed in the contract.

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RE 91 [illegible] 00

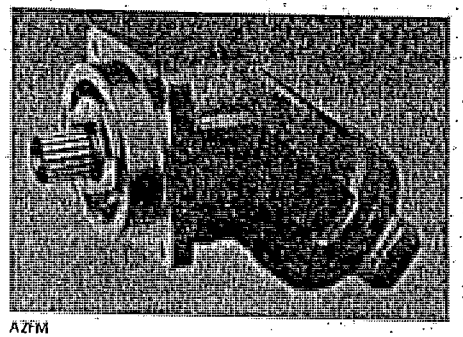
replaces: 01.97

engineering
mannesmann
Rexroth

Fixed Displacement Motor A2FM

open and closed circuits

Sizes 5...1000
Series 6
Nom. Pressure up to 400 bar
Peak Pressure up to 450 bar



A2FM

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Features

- Fixed displacement motor A2FM of axial piston, bent axis design, suitable for hydrostatic drives in open and closed circuits
- Use in mobile and industrial applications
- Output speed is proportional to input flow and inversely proportional to displacement
- Drive torque increases with the pressure drop across the unit
- Careful selection of the displacements offered, permit sizes to be matched to practically every application
- Favourable power / weight ratio
- Compact design
- Optimum efficiency
- Economical conception
- One piece pistons with piston rings

Ordering Code / Standard Program

(Ordering code size 5 see page 8)

Hydraulic fluid

Mineral oil (no code)		
HFB-, HFC-, HFD-Hydraulic fluid	sizes 10...200 (no code)	
	sizes 250...1000 (only in connection with drive shaft bearings "L")	E-

Axial piston unit

Bent axis design, fixed displacement	A2F

Drive shaft bearings

	10...200	250...500	710...1000	
Mechanical bearings (no code)	●	●	–	
Long-Life bearings	–	●	●	L

Mode of operation

Motor (Plug-in motor A2FE see RE 91008)	M

Size

≙ Displacement V_g (cm³)																					
5	10	12	16	23	28	32	45	56	63	80	90	107	125	160	180	200	250	355	500	710	1000

Sizes 5...200: production Elchingen Plant; Sizes 250...1000: production Horb Plant

Series

	6

Index

sizes 10...180	1
size 200	3
sizes 250...1000	0

Direction of rotation

viewed on shaft end	alternating	W

Seals

FKM (flour-caoutchouc)	V

Shaft end

	10	12	16	23	28	32	45	56	63	80	90	107	125	160	180	200	250	355	500	710	1000	
Splined shaft DIN 5480	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	–	–	–	–	–	A
	●	●	–	●	●	–	●	●	–	●	–	●	–	●	–	–	●	●	●	●	●	Z
Parallel shaft with key, DIN 6885	●	●	●	●	●	●	–	●	●	●	●	●	●	●	●	●	–	–	–	–	–	B
	●	●	–	●	●	–	●	●	–	●	–	●	–	●	–	–	●	●	●	●	●	P

Mounting flange

	10...250	355...1000	
ISO 4-hole	●	–	B
ISO 8-hole	–	●	H

● = available
– = not available

▦ = preferred program (preferred types see page 13)

A2F | | M | | / | 6 | | W | - | V | | | | |

- Hydraulic fluid
- Axial piston unit
- Drive shaft bearings
- Mode of operation
- Size
- Series
- Index
- Direction of rotation
- Seals
- Shaft end
- Mounting flange

Service line connections[1]

		10	12	16	23	28	32	45	56	63	80	90	107	125	160	180	200	250	355	500	710	1000	
Ports A and B SAE, at rear end	01	0	–	–	–	●	●	●	●	●	●	●	●	–	–	–	–	–	–	–	–	–	010
		6	–	–	–	●	●	●	●	●	●	●	●	–	–	–	–	–	–	–	–	–	016
Ports A and B SAE, opposite side	02	0	–	–	–	●	●	●	●	●	●	●	●	–	–	–	–	–	–	–	–	–	020
		6	–	–	–	●	●	●	●	●	●	●	●	–	–	–	–	–	–	–	–	–	026
		7	–	–	–	–	–	–	●	●	●	●	●	●	●	●	–	–	–	–	–	–	027
Ports A and B threads, at side, opposite side	03	0	●	●	●	●	●	●	–	–	–	–	–	–	–	–	–	●	–	–	–	–	030
		6	–	–	–	●	●	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	036
Ports A and B threads, at side and rear end	04	0		●	●	●	●	●	●	●	–	–	–	–	–	–	–	● [2]	–	–	–	–	040
		6	–	–	–	●	●	●	●	●	●	–	–	–	–	–	–	–	–	–	–	–	046
Ports A and B SAE, at side, same side	10	0	–	–	–	–	●	●	●	●	●	●	●	●	●	●	●	–	●	–	–	–	100
		6	–	–	–	–	●	●	●	●	●	●	–	–	–	–	–	–	–	–	–	–	106
port plate with press. relief valve and built-on motion control valve	18	1	–	–	–	–	●	●	●	●	●	●	●	●	●	●	–	–	–	–	–	–	181
Port plate with integrated pressure relief valves	19	1	–	–	–	–	●	●	●	●	●	●	●	●	●	●	–	–	–	–	–	–	191
		2	–	–	–	–	●	●	●	●	●	●	●	●	●	●	–	–	–	–	–	–	192

Valves

without valves	0
with pressure relief valves (*without pressure sequence range*)	1
with pressure relief valves (*with pressure sequence range*)	2
with integrated flushing valve	6
with built-on flushing and boost valve	7

Speed sensing control

	10...16	23...180	200	250...1000	
without speed sensing control (no code)	●	●	●	●	
prepared for speed sensing control	—	●	—	●	D

Special design

without special design (standard type, no code)	
special design for slew drive applications (standard for port plate 19)	J

[1]) Threads of fixing screws and service lines are metric

[2]) ports at rear end are plugged

Technical Data

Fluid

To review the application of A2FM motors with the selected hydraulic fluid, detailed fluid compatibility and application data can be found in data sheets RE 90220 (mineral oil), RE 90221 (environmentally acceptable hydraulic fluids) and RE 90223 (fire resistant fluids, HF).

The fixed motor A2FM is not suitable for operation with HFA. When using HFB-, HFC-, HFD- or environmentally acceptable hydraulic fluids possible limitations for the technical data have to be taken into consideration. If necessary please consult our technical department (please indicate type of the hydraulic fluid used for your application on the order sheet).

Operating viscosity range

In order to obtain optimum efficiency and service life, we recommend that the operating viscosity (at operating temperature) be selected from within the range

v_{opt} = opt. operating viscosity 16...36 mm²/s

referred to the loop temperature (closed circuit) or tank temperature (open circuit).

Viscosity limits

The limiting values for viscosity are as follows:

sizes 5...200

v_{min} = 5 mm²/s, short term at a max. permissible temperature of t_{max} = 115°C

v_{max} = 1600 mm²/s, short term on cold start (t_{min} = -40°C)

sizes 250...1000

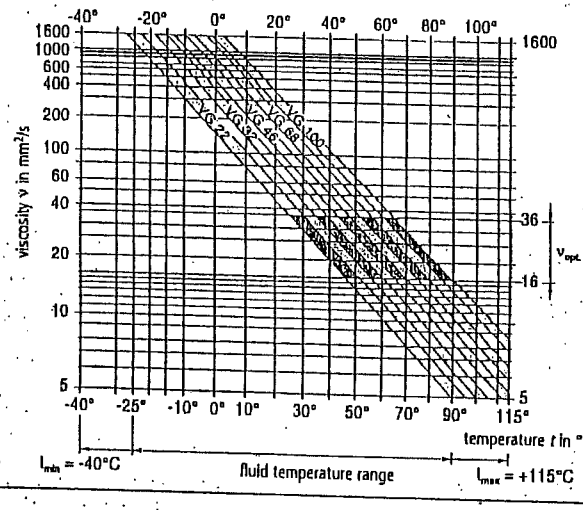
v_{min} = 10 mm²/s, short term at a max. permissible leakage oil temp. of t_{max} = 90°C

v_{max} = 1000 mm²/s, short term on cold start (t_{min} = -25°C)

Please note that the max. fluid temperature is also not exceeded in certain areas (for instance bearing area).

At temperatures of -25°C up to -40°C special measures may be required for certain installation positions. Please contact us for further information.

Selection diagram



Notes on the selection of the hydraulic fluid

In order to select the correct fluid, it is necessary to know the operating temperature in the loop (closed circuit) or the tank temperature (open circuit) in relation to the ambient temperature.

The hydraulic fluid should be selected so that within the operating temperature range, the operating viscosity lies within the optimum range (v_{opt}) (see shaded section of the selection diagram). We recommend that the highest possible viscosity range should be chosen in each case.

Example: At an ambient temperature of X°C the operating temperature (closed circuit: loop temperature; open circuit: tank temperature) is 60°C. Within the operating viscosity range (v_{opt}; shaded area), this corresponds to viscosity ranges VG 46 or VG 68. VG 68 should be selected.

Important: The leakage oil (case drain oil) temperature is influenced by pressure and motor speed and is always higher than the circuit or tank temperature. However, at no point in the circuit may the temperature exceed 115°C for sizes 5...200 or 90°C for sizes 250...1000.

If it is not possible to comply with the above conditions because of extreme operating parameters or high ambient temperatures please consult us.

Filtration

The finer the filtration the better the achieved purity grade of the pressure fluid and the longer the life of the axial piston unit. To ensure the functioning of the axial piston unit a minimum purity grade of

9 to NAS 1638

18/15 to ISO/DIS 4406 is necessary.

At very high temperatures of the hydraulic fluid (90°C to max. 115°C) not permissible for sizes 250...1000) at least cleanless class

8 to NAS 1638

17/14 to ISO/DIS 4406 is necessary.

If above mentioned grades cannot be maintained please consult us.

Working pressure range

maximum pressure at port A or B (Pressure data to DIN 24312)

Size 5	Shaft end B	Shaft end C
Nominal pressure p_N	210 bar	315 bar
Peak pressure p_{max}	250 bar	350 bar

Size 10...200 [1]	Shaft end A, Z [2]	Shaft end B, P
Nominal pressure p_N	400 bar	350 bar
Peak pressure p_{max}	450 bar	400 bar

[1] Attention: shaft end Z and P with drives of radial force loads at the drive shaft necessitate reduction of the nominal pressure to p_N = 315 bar.

[2] Shaft end Z to size 56: p_N = 350 bar, p_{max} = 400 bar

Sizes 250...1000	
Nominal pressure p_N	350 bar
Peak pressure p_{max}	400 bar

With pulsating loads above 315 bar we recommend using the model with splined shaft, standard version A (sizes 10...200) or with splined shaft Z (sizes 250...1000).

The summ of the pressures at ports A und B may not exceed 700 bar (630 bar, A2F 5).

Direction of flow

Clockwise rotation	Anti-clockwise rotation
A to B	B to A

Speed range

There is no limitation on minimum speed n_{min}. If uniformity of rotation is required, however, speed n_{min} should not be allowed to fall below 50 rpm. See table on page 6 for max. permissible speeds.

Long-Life bearings (L) (sizes 250...1000)

(for high life expectancy and use of HF-fluids)

The outer dimensions of the axial piston motors are identical to standard design (without long life bearings). The change from standard design to long life bearing system is possible.

We recommend to apply bearing flushing at port U.

Bearing flushing

For sizes 250...1000 bearing and housing flushing is possible through port U.

Flows (recommendation)

Sizes	250	355	500	710	1000
q_{flush} (L/min)	10	16	20	25	25

Case drain pressure

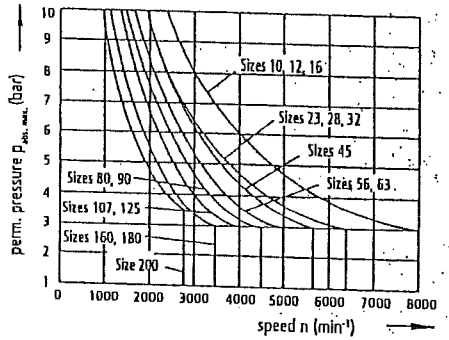
Shaft seal ring FKM (fluor-caoutchouc)

The lower the speed and the case drain pressure the higher the life expectation of the shaft seal ring. The values shown in the diagram are permissible loads of the seal ring and shall not be exceeded.

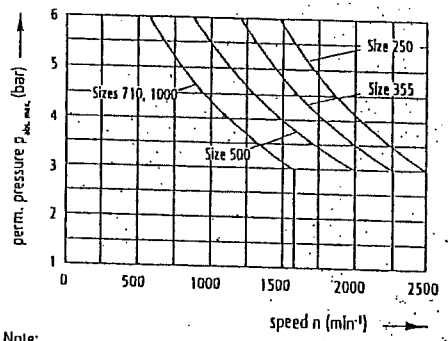
At stationary pressure loads in the range of the max. admissible leakage pressure a reduction of the life experience of the seal ring will result.

For a short period (t < 5 min.) are for the sizes 10...200 pressure loads up to 5 bar independent from rotational speeds are permissible.

Sizes 10...200



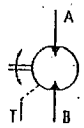
Sizes 250...1000



Note:

- max. permissible motor speeds are given in the table on page 6
- max. perm. housing pressure $p_{abs.max.}$ 10 bar (sizes 5...200)
  6 bar (sizes 250...1000)
- the pressure in the housing must be the same as or greater than the external pressure on the shaft seal.

Symbol



Connections

A, B Service line ports
T Drain port

Technical Data

Table of values (theoretical values, without considering η_{mh} and η_v; values rounded)

Size				5	10	12	16	20	28	32	45	56	63	80
Displacement		V_g	cm³	4,93	10,3	12	16	22,9	28,1	32	45,6	56,1	63	80,4
Max. Speed		n_{max}	min⁻¹	10 000	8000	8000	8000	6300	6300	6300	5600	5000	5000	4500
		$n_{max\ intermit.}$ [1]	min⁻¹	11 000	8800	8800	8800	6900	6900	6900	6200	5500	5500	5000
Max. flow	n_{max}	$q_{V\ max}$	L/min	49	82	96	128	144	176	201	255	280	315	360
Torque constants		T_K	Nm/bar	0,076	0,164	0,19	0,25	0,36	0,445	0,509	0,725	0,89	1,0	1,27
Torque at	Δp = 350 bar	T	Nm	24,7 [2]	57	67	88	126	156	178	254	312	350	445
	Δp = 400 bar	T	Nm	–	65	76	100	144	178	204	290	356	400	508
Case volume			L		0,17	0,17	0,17	0,20	0,20	0,20	0,33	0,45	0,45	0,55
Moment of inertia about drive axis		J	kgm²	0,00008	0,0004	0,0004	0,0004	0,0012	0,0012	0,0012	0,0024	0,0042	0,0042	0,0072
Weight (approx.)		m	kg	2,5	5,4	5,4	5,4	9,5	9,5	9,5	13,5	18	18	23

Size				90	107	125	160	180	200	250	355	500	710	1000
Displacement		V_g	cm³	90	106,7	125	160,4	180	200	250	355	500	710	1000
Max. Speed		n_{max}	min⁻¹	4500	4000	4000	3600	3600	2750	2500	2240	2000	1600	1600
		$n_{max\ intermit.}$ [1]	min⁻¹	5000	4400	4400	4000	4000	3000	–	–	–	–	–
Max. flow	n_{max}	$q_{V\ max}$	L/min	405	427	500	577	648	550	625	795	1000	1136	1600
Torque constants	T_K		Nm/bar	1,43	1,70	1,99	2,54	2,86	3,18	3,98	5,65	7,96	11,3	15,9
Torque at	Δp = 350 bar	T	Nm	501	595	697	889	1001	1114	1393	1978	2785	3955	5570
	Δp = 400 bar	T	Nm	572	680	796	1016	1144	1272	–	–	–	–	–
Case volume			L	0,55	0,8	0,8	1,1	1,1		2,5	3,5			7,8
Moment of inertia about drive axis		J	kgm²	0,0072	0,0116	0,0116	0,0220	0,0220	0,0378	0,061	0,102	0,178	0,55	0,55
Weight (approx.)		m	kg	23	32	32	45	45	66	73	110	155	322	336

[1] Intermittent max. speed: overspeed at discharge and overtaking travel operations, t < 5 sek. and Δp < 150 bar

[2] Δp = 315 bar

Calculation of size

Flow $q_V = \dfrac{V_g \cdot n}{1000 \cdot \eta_v}$ in L/min

Output speed $n = \dfrac{q_V \cdot 1000 \cdot \eta_v}{V_g}$ in min⁻¹

Outout torque $T = \dfrac{V_g \cdot \Delta p \cdot \eta_{mh}}{20 \cdot \pi}$

or $T = T_K \cdot \Delta p \cdot \eta_{mh}$ in Nm

Output power $P = \dfrac{2\pi \cdot T \cdot n}{60\,000} = \dfrac{T \cdot n}{9549}$

$= \dfrac{q_V \cdot \Delta p}{600} \cdot \eta_t$ in kW

V_g = geometric displacement per rev. in cm³
T = torque in Nm
Δp = pressure differential in bar
n = speed in min⁻¹
T_K = torque constants in Nm/bar
η_v = volumetric efficiency
η_{mh} = mech.-hyd. efficiency
η_t = overall efficiency

Output drive

Permissible axial and radial loads on drive shaft

The values given are maximum values and do not apply to continuous operation

Size		10	12	16	16	16	16	16	18	18	18	20
a	mm	12	16	16	16	16	16	16	18	18	18	20
$F_{q\,max}$	N	710	2350	2750	3700	4300	5400	6100	8150	9200	10300	11500
$\pm F_{ax\,max}$	N	180	320	320	320	500	500	500	630	800	800	1000
$\pm F_{ax\,perm.}$/bar	N/bar	1,5	3,0	3,0	3,0	5,2	5,2	5,2	7,0	8,7	8,7	10,6

Size		28	40	40	56	56	56	80	107	125	160	180	200	250	355	500	710	1000
a	mm	20	20	20	25	25	25	41	52,5	52,5	67,5	67,5						
$F_{q\,max}$	N	12900	13600	15900	18400	20600	22900	1200[1]	1500[1]	1900[1]	3000[1]	2600[1]						
$\pm F_{ax\,max}$	N $+F_{ax\,max}$	1000	1250	1250	1600	1600	1600	4000	5000	6250	10000	10000						
	$-F_{ax\,max}$	1000	1250	1250	1600	1600	1600	1200	1500	1900	3000	2600						
$\pm F_{ax\,perm.}$/bar	N/bar	10,6	12,9	12,9	16,7	16,7	16,7	[2]	[2]	[2]	[2]	[2]						

[1]) Axial piston unit stationary or in bypass operation, please contact us when appearing higher forces!

[2]) Please contact us!

Code explanation

a = distance of F_q from shaft shoulder

$F_{q\,max}$ = max. perm. radial force at distance a (at intermittent operation)

$\pm F_{ax\,max}$ = max. perm. axial force when stationary or when axial piston unit is running at zero pressure

$\pm F_{ax\,perm.}$/bar = perm. axial force/bar operating pressure



The direction of the max. perm. axial force must be noted by sizes 28...200:

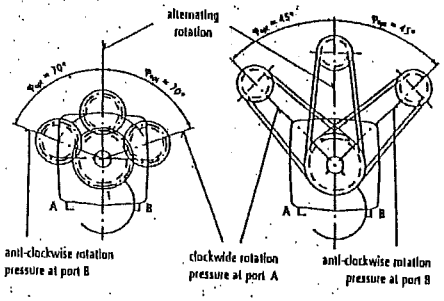
$-F_{ax}$ = increases bearing life

$+F_{ax}$ = reduces bearing life (avoid if possible)



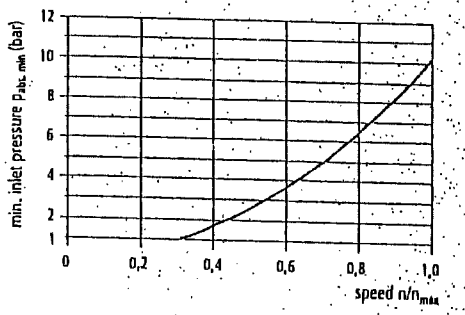
Optimal force direction of F_q (valid for sizes 10...180)

By means of appropriate force directions of F_q the bearing load caused by inside rotary group forces can be reduced. An optimal life expectation of the bearing can be reached.



Minimum inlet pressure at port A (B)

In order to avoid damage of the variable motor a minimum inlet pressure at the inlet zone must be assured. The minimum inlet pressure is related to the rotational speed of the fixed motor.



Ordering Code / Standard Program - Size 5

A2F | 5 | W | 6.0 | | 3

Axial piston unit
- Bent axis design, fixed displacement: A2F

Size
- ≙ Displacement V_g (cm³): 5

Direction of rotation
- viewed on shaft end: alternating: W

Series
- 6.0

Shaft end
- Parallel shaft with key DIN 6885: B
- Tapered shaft with spigot and spring washer DIN 6888: C

Service line connections
- Threads at side, metric: 3

Additional instructions in text form

Seals

The fixed motor A2F5 is equipped with NBR- (Nitril-caoutchouc) Seals in standard design.

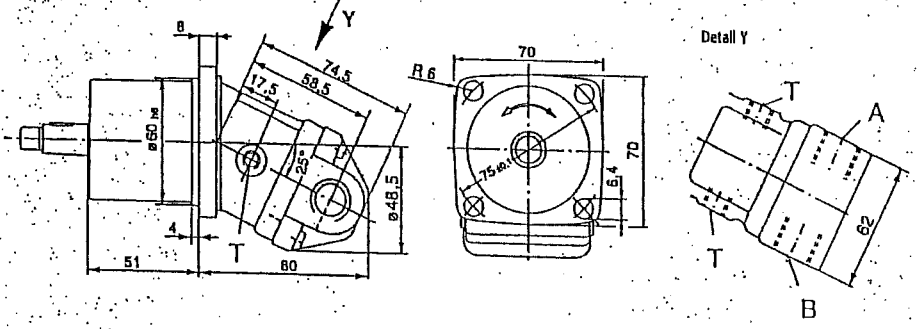
In case of need FKM- (fluor-caoutchouc) seals please indicate when ordering in clear text:

"with FKM-seals"

= preferred program (preferred types see page 13)

Unit Dimensions, Size 5

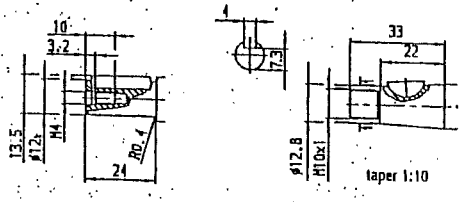
Before finalising your design, please request a certified drawing.



Shaft ends

B Parallel shaft with key, DIN 6885 A4x4x20 p_N = 210 bar

C Tapered shaft with spigot and spring washer 3x5 DIN 6888, p_N = 315 bar

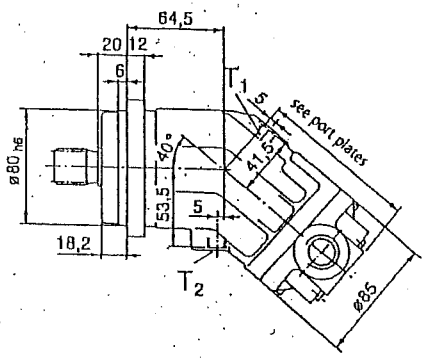


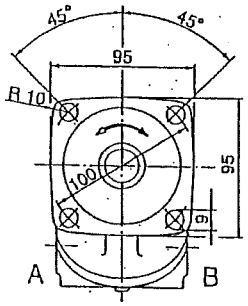
Connections

B, (A)	Service line ports	M 18x1,5
T	Drain port	M 10x1, both sides

Unit Dimensions, Sizes 10,12,16

Before finalising your design, please request a certified drawing.





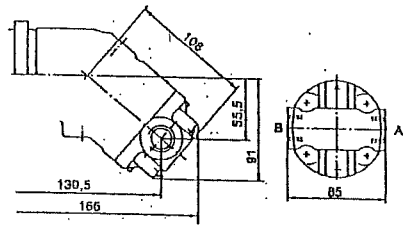
Connections

A, B Service line ports (see port plates)

T_1, T_2 Drain ports (1 port plugged) M 12x1,5

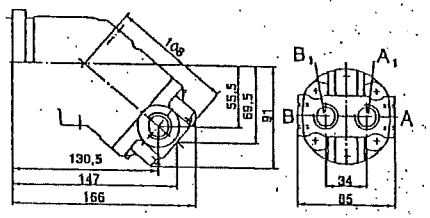
Port plates

03 Threaded ports, at side



A, B Service line ports M 22x1,5

04 Threaded ports, at side and rear end

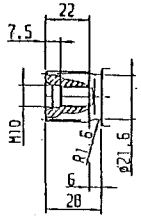


A, B, A_1, B_1 Service line ports M 22x1,5

Shaft ends

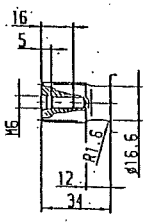
Sizes 10, 12, 16

A Splined shaft, DIN 5480
W 25x1,25x30x18x9g
p_N = 400 bar



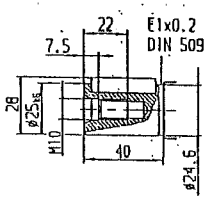
Sizes 10, 12

Z Splined shaft, DIN 5480
W 20x1,25x30x14x9g
p_N = 400 bar



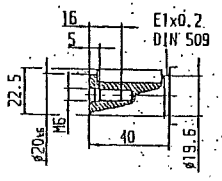
Sizes 10, 12, 16

B Parallel shaft with key,
DIN 6885, AS 8x7x32
p_N = 350 bar



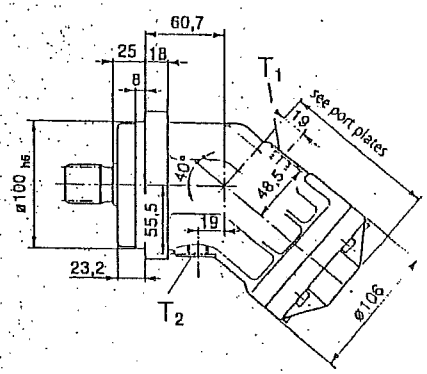
Sizes 10, 12

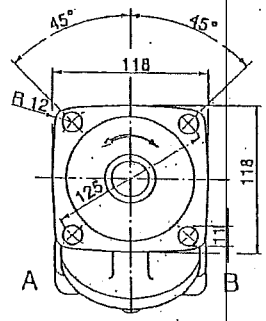
P Parallel shaft with key,
DIN 6885, AS 6x6x32
p_N = 350 bar



Unit Dimensions, Sizes 23, 28, 32

Before finalising your design, please request a certified drawing.





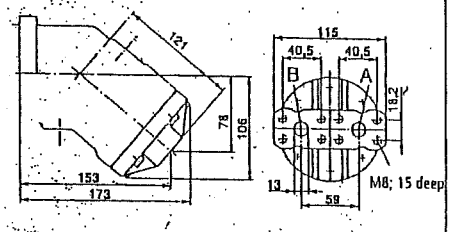
Connections

A, B Service line ports (see port plates)

T_1, T_2 Drain ports (1 port plugged) M 16x1,5

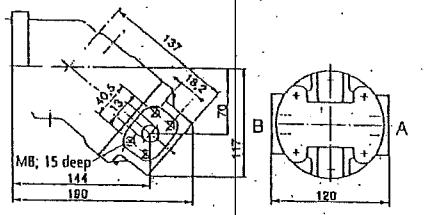
Port plates

01 SAE-ports, at rear end



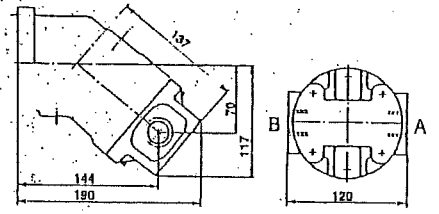
A, B Service line ports
420 bar (6000 psi) high pressure series SAE 1/2"

02 SAE-ports, at side



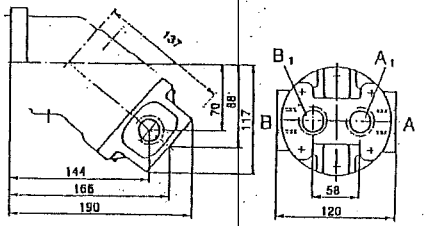
A, B Service line ports
420 bar (6000 psi) high pressure series SAE 1/2"

03 Threaded ports, at side



A, B Service line ports M 27x2

04 Threaded ports, at side and rear end



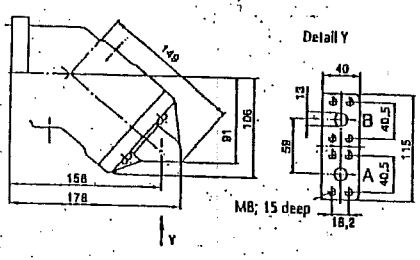
A, B, A_1, B_1 Service line ports M 27x2

Before finalising your design, please request a certified drawing.

Page 856

Port plates

10 SAE-ports, at side, same side

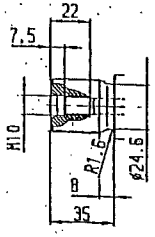


A, B Service line ports
420 bar (6000 psi) high pressure series

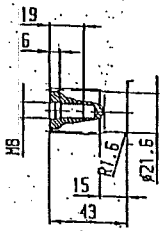
SAE 1/2"

Shaft ends

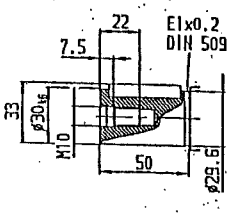
Sizes 23, 28, 32
A Splined shaft, DIN 5480
W 30x2x30x14x9g
p_N = 400 bar



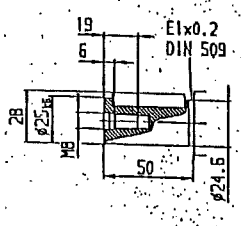
Sizes 23, 28
Z Splined shaft, DIN 5480
W 25x1,25x30x18x9g
p_N = 400 bar



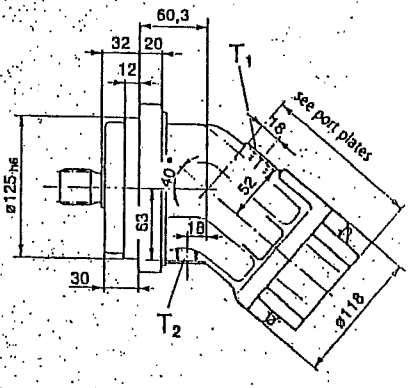
Sizes 23, 28, 32
B Parallel shaft with key,
DIN 6885, AS 8x7x40
p_N = 350 bar

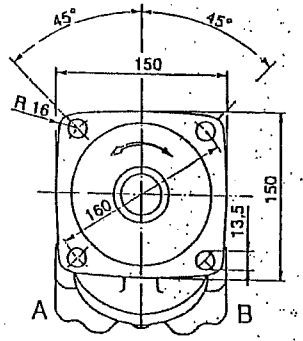


Sizes 23, 28
P Parallel shaft with key,
DIN 6885, AS 8x7x40
p_H = 350 bar



Before finalising your design, please request a certified drawing.



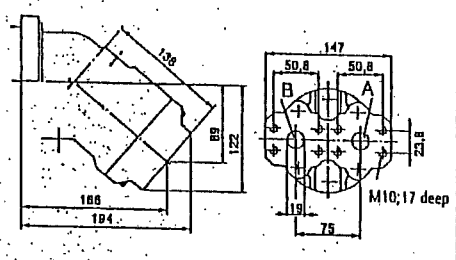


Connections
A, B Service line ports (see port plates)
T_1, T_2 Drain ports (1 port plugged)

M 18x1,5

Port plates

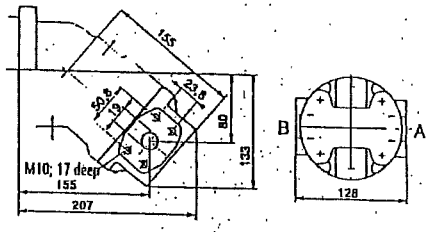
01 SAE-ports, at rear end



A, B Service line ports
420 bar (6000 psi) high pressure series

SAE 3/4"

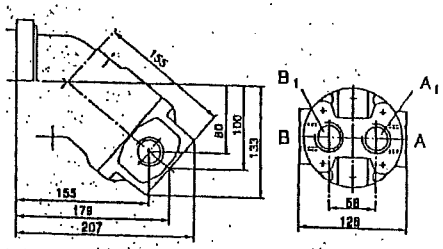
02 SAE-ports, at side



A, B Service line ports
420 bar (6000 psi) high pressure series

SAE 3/4"

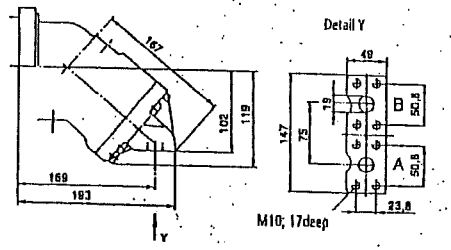
04 Threaded ports, at side and rear end



A, B, A_1, B_1 Service line ports

M 33x2

10 SAE-ports, at side, same side



A, B Service line ports
420 bar (6000 psi) high pressure series

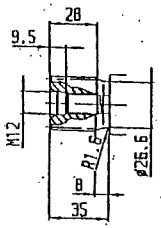
SAE 3/4"

Unit Dimensions, Size 45

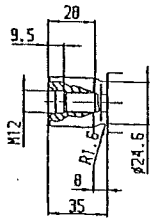
Before finalizing your design, please request a certified drawing.

Shaft ends

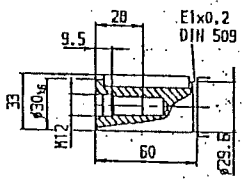
A Splined shaft, DIN 5480
W 32x2x30x14x9g
p_N = 400 bar



Z Splined shaft, DIN 5480
W 30x2x30x14x9g
p_N = 400 bar



P Parallel shaft with key,
DIN 6885, AS 8x7x50
p_N = 350 bar



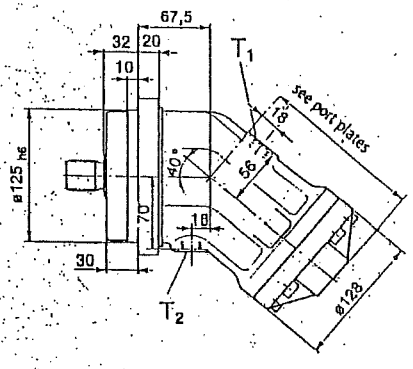
Preferred types (please state type and Ident-no. when ordering)

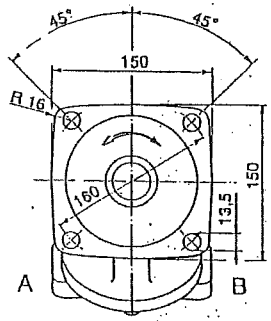
Type	Ident-No.
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A2FM10/61W-VAB030	9423386
A2FM10/61W-VBB030	9610656
A2FM12/61W-VAB030	9424240
A2FM12/61W-VBB030	9610657
A2FM16/61W-VAB030	9411111
A2FM16/61W-VBB030	9411119
A2FM23/61W-VAB010	9427351
A2FM23/61W-VAB020	9422092
A2FM23/61W-VAB040	9428415
A2FM23/61W-VBB010	9610658
A2FM23/61W-VBB020	9610659
A2FM23/61W-VBB040	9610660
A2FM28/61W-VAB010	9424853
A2FM28/61W-VAB020	9422548
A2FM28/61W-VAB040	9421629
A2FM28/61W-VBB010	9610661
A2FM28/61W-VBB020	9610662
A2FM28/61W-VBB040	9610663
A2FM32/61W-VAB010	9410189
A2FM32/61W-VAB020	9410190
A2FM32/61W-VAB040	9410192
A2FM32/61W-VBB010	9410194
A2FM32/61W-VBB020	9410195
A2FM32/61W-VBB040	9410197
A2FM45/61W-VZB010	9411581
A2FM45/61W-VZB020	9411582
A2FM45/61W-VZB040	9411584
A2FM56/61W-VAB010	9424905
A2FM56/61W-VAB020	9422129
A2FM56/61W-VAB040	9429251
A2FM56/61W-VBB010	9610664
A2FM56/61W-VBB020	9610665
A2FM56/61W-VBB040	9605544
A2FM63/61W-VAB010	9408523
A2FM63/61W-VAB020	9408524
A2FM63/61W-VAB040	9408526
A2FM63/61W-VBB010	9408514
A2FM63/61W-VBB020	9408549
A2FM63/61W-VBB040	9408551

Type	Ident-No.
A2FM80/61W-VAB010	9422638
A2FM80/61W-VAB020	9422089
A2FM80/61W-VBB010	9610666
A2FM80/61W-VBB020	9610667
A2FM90/61W-VAB010	9408463
A2FM90/61W-VAB020	9408464
A2FM90/61W-VBB010	9408468
A2FM90/61W-VBB020	9408469
A2FM107/61W-VAB010	9424300
A2FM107/61W-VAB020	9424093
A2FM107/61W-VBB010	9610668
A2FM107/61W-VBB020	9610669
A2FM125/61W-VAB010	9409630
A2FM125/61W-VAB020	9409634
A2FM125/61W-VBB010	9409637
A2FM125/61W-VBB020	9409638
A2FM160/61W-VAB010	9425163
A2FM160/61W-VAB020	9424094
A2FM160/61W-VBB010	9610670
A2FM160/61W-VBB020	9610671
A2FM180/61W-VAB010	9409189
A2FM180/61W-VAB020	9409190
A2FM180/61W-VBB010	9409372
A2FM180/61W-VBB020	9409373
A2FM200/63W-VAB010	2011528
A2FM250/60W-VZB010	915383
A2FM250/60W-VZB020	910653
A2FM355/60W-VZH010	920780
A2FM500/60W-VPH010	943251
A2FM500/60W-VZH010	968982
A2FLM710/60W-VPH010	969815
A2FLM710/60W-VZH010	965974
A2FM1000/60W-VPH010	949444
A2FM1000/60W-VZH010	944773

Unit Dimensions, Sizes 56, 63

Before finalizing your design, please request a certified drawing.



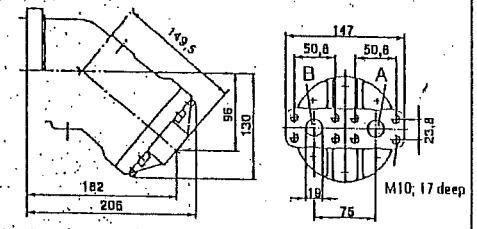


Connections

A, B Service line ports (see port plates)
T_1, T_2 Drain ports (1 port plugged) M 18x1,5

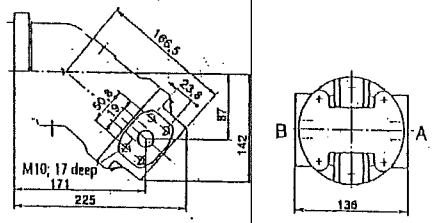
Port plates

01 SAE-ports, at rear end



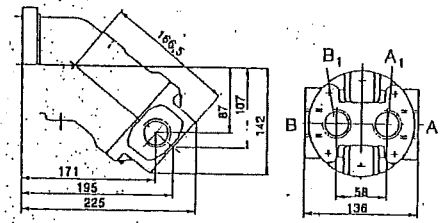
A, B Service line ports SAE 3/4"
420 bar (6000 psi) high pressure series

02 SAE-ports, at side



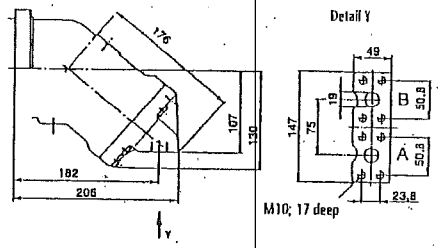
A, B Service line ports SAE 3/4"
420 bar (6000 psi) high pressure series

04 Threaded ports, at side and rear end



A, B, A_1, B_1 Service line ports M 33x2

10 SAE-ports, at side, same side



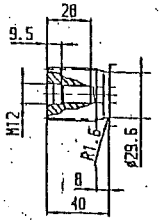
A, B Service line ports SAE 3/4"
420 bar (6000 psi) high pressure series

Unit ' sions, Sizes 56, 63

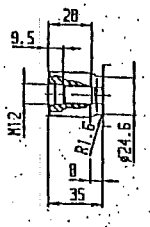
Before finalizing your design, please request a certified drawing.

Shaft ends

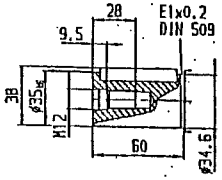
Sizes 56, 63
A Splined shaft, DIN 5480
W 35x2x30x16x9g
p_H = 400 bar



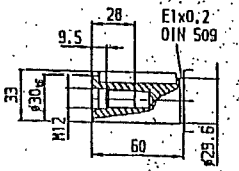
Size 56
Z Splined shaft, DIN 5480
W 30x2x30x14x9g
p_N = 350 bar



Sizes 56, 63
B Parallel shaft with key,
DIN 6885, AS 10x8x50
p_N = 350 bar

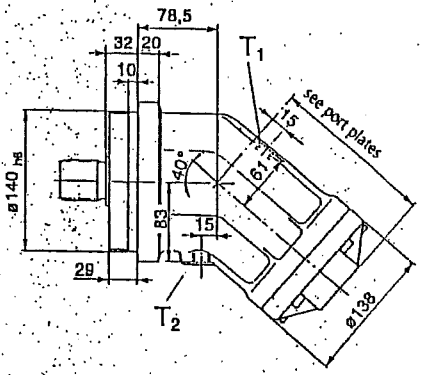


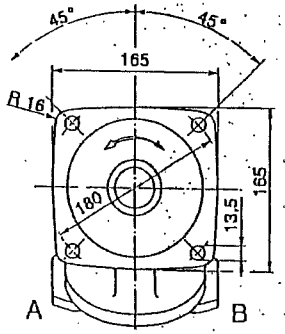
Size 56
P Parallel shaft with key,
DIN 6885, AS 8x7x50
p_N = 350 bar



Unit Dimensions, ...s 80, 90

Before finalizing your design, please request a certified drawing.





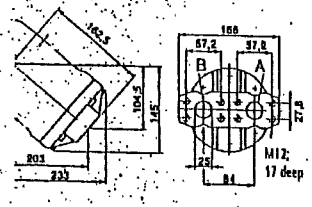
Connections

A, B	Service line ports (see port plates)
T_1, T_2	Drain ports (1 port plugged)

M 18x1,5

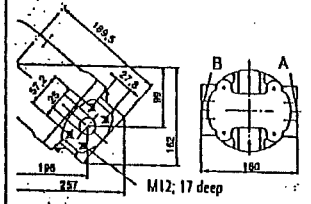
Port plates

01 SAE-ports, at rear end



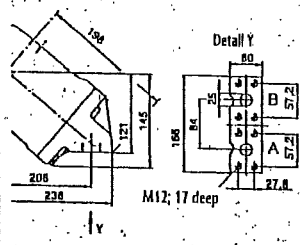
A, B Service line ports SAE 1"
420 bar (6000 psi) high pressure series

02 SAE-ports, at side



A, B Service line ports SAE 1"
420 bar (6000 psi) high pressure series

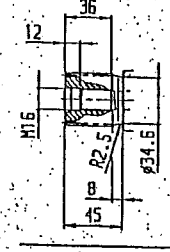
10 SAE-ports, at side, same side



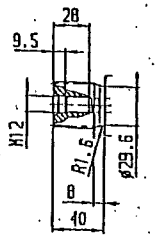
A, B Service line ports SAE 1"
420 bar (6000 psi) high pressure series

Shaft ends

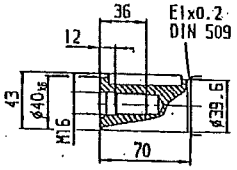
Sizes 80, 90
A Splined shaft, DIN 5480
W 40x2x30x18x9g
p_N = 400 bar



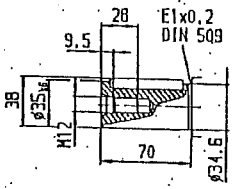
Size 80
Z Splined shaft, DIN 5480
W 35x2x30x16x9g
p_N = 400 bar



Sizes 80, 90
B Parallel shaft with key,
DIN 6885, AS 12x8x56
p_N = 350 bar

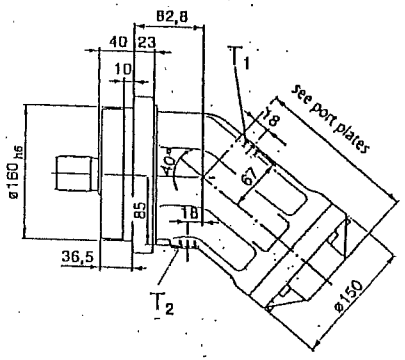


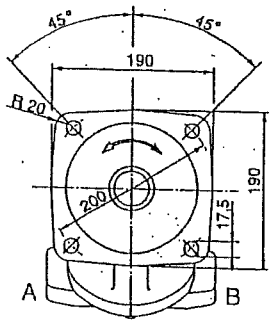
Size 80
P Parallel shaft with key,
DIN 6885, AS 10x8x56
p_N = 350 bar



Unit Dimensions, Sizes 107, 125

Before finalising your design, please request a certified drawing.





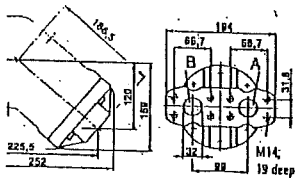
Connections

A, B Service line ports (see port plates)

T_1, T_2 Drain ports (1 port plugged) M 18x1,5

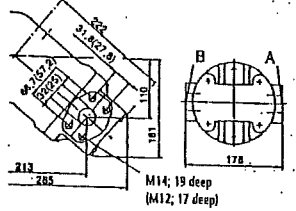
Port plates

01 SAE-ports, at rear end



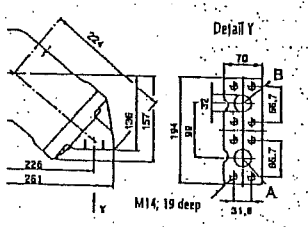
A, B Service line ports SAE 1¼"
420 bar (6000 psi) high pressure series

02 SAE-ports, at side
(Klammermaße für NG 107!)



A, B Service line ports SAE 1¼"(1")
420 bar (6000 psi) high pressure series

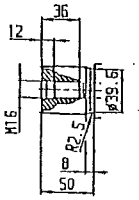
10 SAE-ports, at side, same side



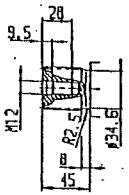
A, B Service line ports SAE 1¼"
420 bar (6000 psi) high pressure series

Shaft ends

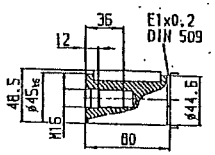
Sizes 107, 125
A Splined shaft, DIN 5480
W 45x2x30x21x9g
p_N = 400 bar



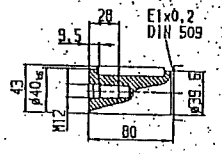
Size 107
Z Splined shaft, DIN 5480
W 40x2x30x18x9g
p_N = 400 bar



Sizes 107, 125
B Parallel shaft with key,
DIN 6885, AS 14x9x63
p_N = 350 bar

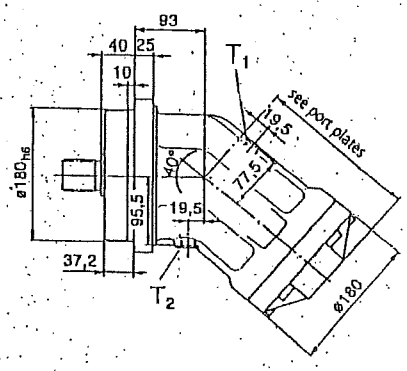


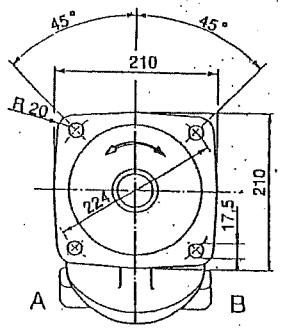
Size 107
P Parallel shaft with key,
DIN 6885, AS 12x8x63
p_N = 350 bar



Unit Dimensions, Sizes 160, 180

Before finalising your design, please request a certified drawing.





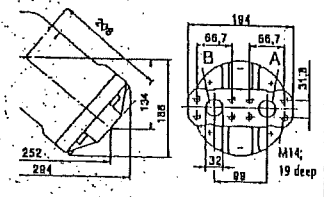
Connections

A, B Service line ports (see port plates)

T_1, T_2 Drain ports (1 port plugged) M 22x1,5

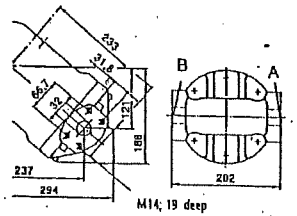
Port plates

01 SAE-ports, at rear end



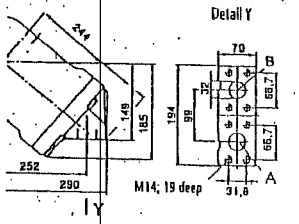
A, B Service line ports SAE 1¼"
420 bar (6000 psi) high pressure series

02 SAE-ports, at side



A, B Service line ports SAE 1¼"
420 bar (6000 psi) high pressure series

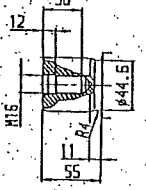
10 SAE-ports, at side, same side



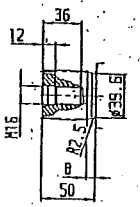
A, B Service line ports SAE 1¼"
420 bar (6000 psi) high pressure series

Shaft ends

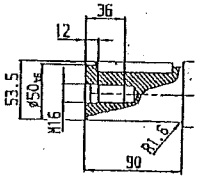
Sizes 160, 180
A Splined shaft, DIN 5480
W 50x2x30x24x9g
p_N = 400 bar



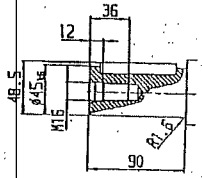
Size160
Z Splined shaft, DIN 5480
W 45x2x30x21x9g
p_N = 400 bar



Sizes 160, 180
B Parallel shaft with key,
DIN 6885, AS 14x9x70
p_N = 350 bar

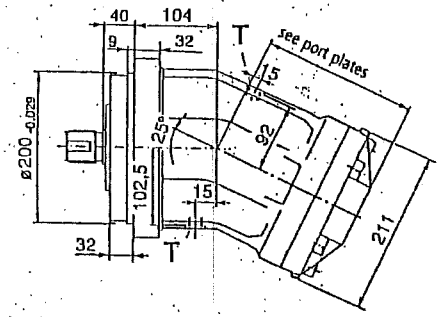


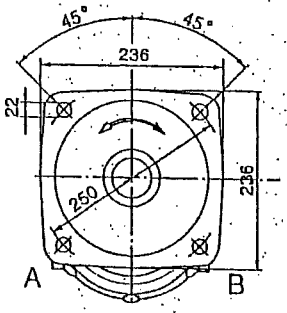
Size 160
P Parallel shaft with key,
DIN 6885, AS 14x9x70
p_N = 350 bar



Unit ...isions, Size 200

Before finalising your design, please request a certified drawing.



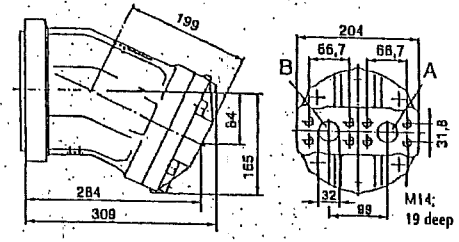


Connections

A, B	Service line ports (see port plates)	
T_1, T_2	Drain ports (1 port plugged)	M 22x1,5

Port plates

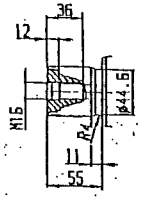
01 SAE-ports, at rear end



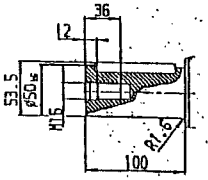
A, B Service line ports
420 bar (6000 psi) high pressure series — SAE 1¼"

Shaft ends

A Splined shaft, DIN 5480
W 50x2x30x24x9g
p_N = 400 bar

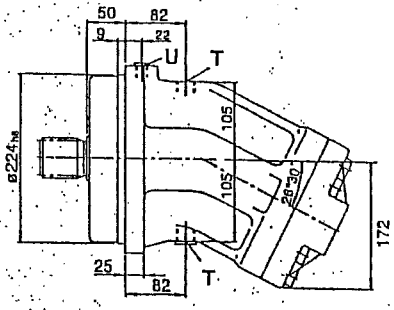


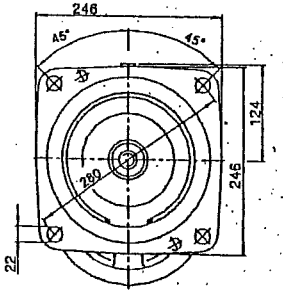
B Parallel shaft with key,
DIN 6885, AS 14x9x80
p_N = 350 bar



Unit Dimensions, Size 250

Before finalising your design, please request a certified drawing.



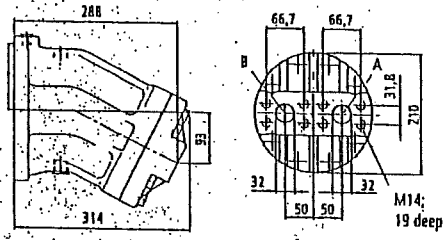


Connections

A, B	Service line ports (see port plates)	
T_1, T_2	Drain ports (1 port plugged)	M 22x1,5
U	Port for bearing flushing (plugged)	M 14x1,5

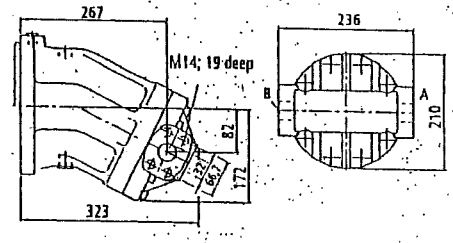
Port plates

01 SAE-ports, at rear end



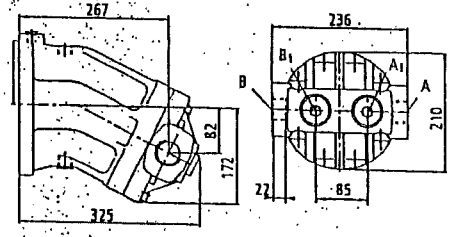
A, B Service line ports
high pressure series — SAE 1¼"

02 SAE-ports, at side



A, B Service line ports
high pressure series — SAE 1¼"

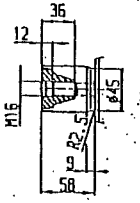
04 Threaded ports, at side and rear end



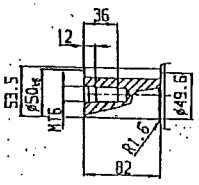
A, B	Service line ports	M 48x2
A_1, B_1	Service line ports (plugged)	M 48x2

Shaft ends

Z Splined shaft, DIN 5480
W 50x2x30x24x9g
p_N = 350 bar



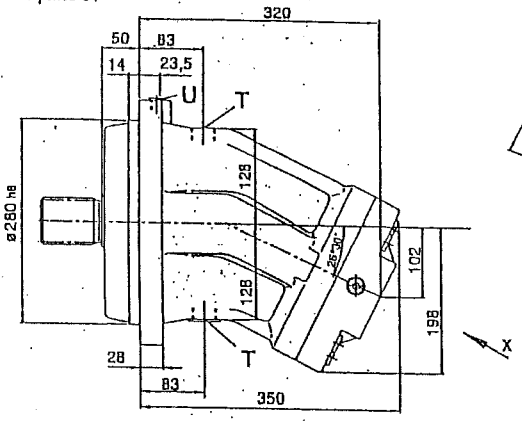
P Parallel shaft with key,
DIN 6885, AS 14x9x80
p_N = 350 bar

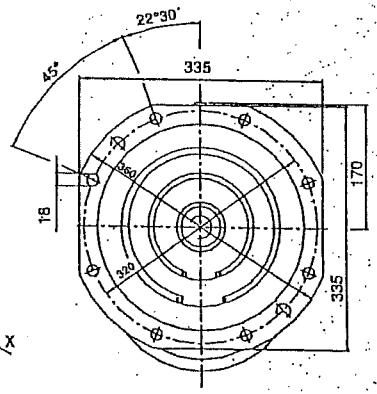


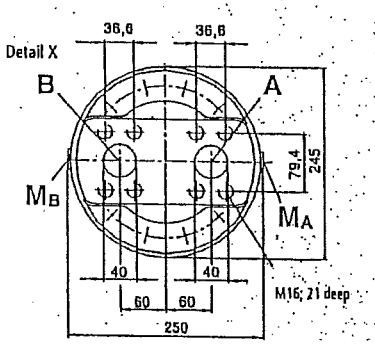
Unit Dimensions, Size 355

Before finalizing your design, please request a certified drawing.

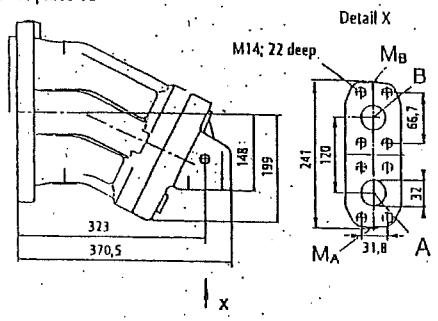
Port plate 01







Port plate 10

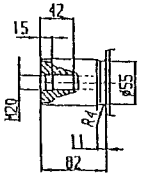


Connections

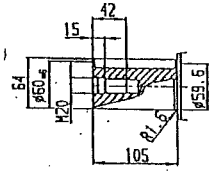
A, B	Service line ports	port plate 01	SAE 1½"
		port plate 10	SAE 1¼"
T	Drain ports (1 port plugged)		M 33x2
U	Port for bearing flushing (plugged)		M 14x1,5
M_A, M_B	Test ports operating pressure (plugged)		M 14x1,5

Shaft ends

Z Splined shaft, DIN 5480
W 60x2x30x28x9g
p_N = 350 bar

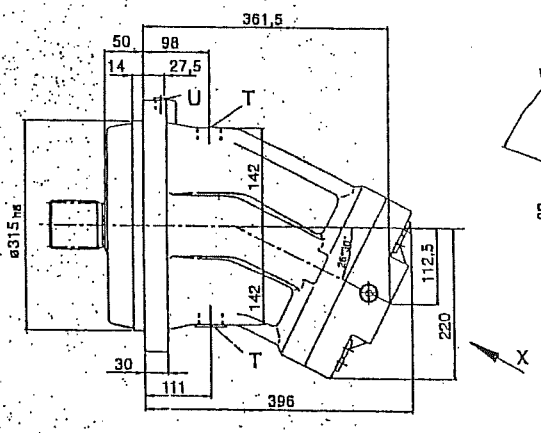


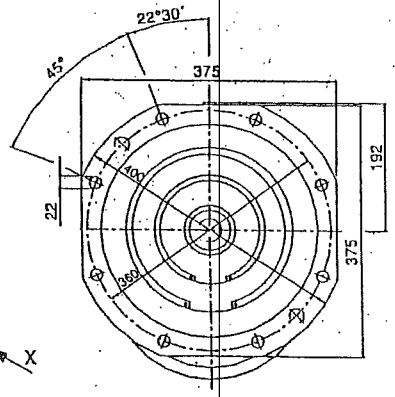
P Parallel shaft with key,
DIN 6885, AS 18x11x100
p_N = 350 bar

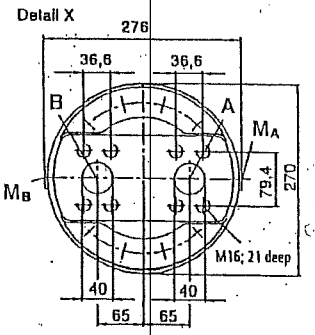


Unit Dimensions, Size 500

Before finalizing your design, please request a certified drawing.





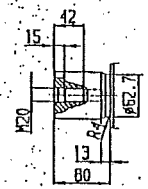


Connections

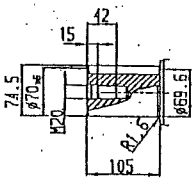
A, B	Service line ports high pressure series		SAE 1½"
T	Drain ports (1 port plugged)		M 33x2
U	Port for bearing flushing (plugged)		M 18x1,5
M_A, M_B	Test ports operating pressure (plugged)		M 14x1,5

Shaft ends

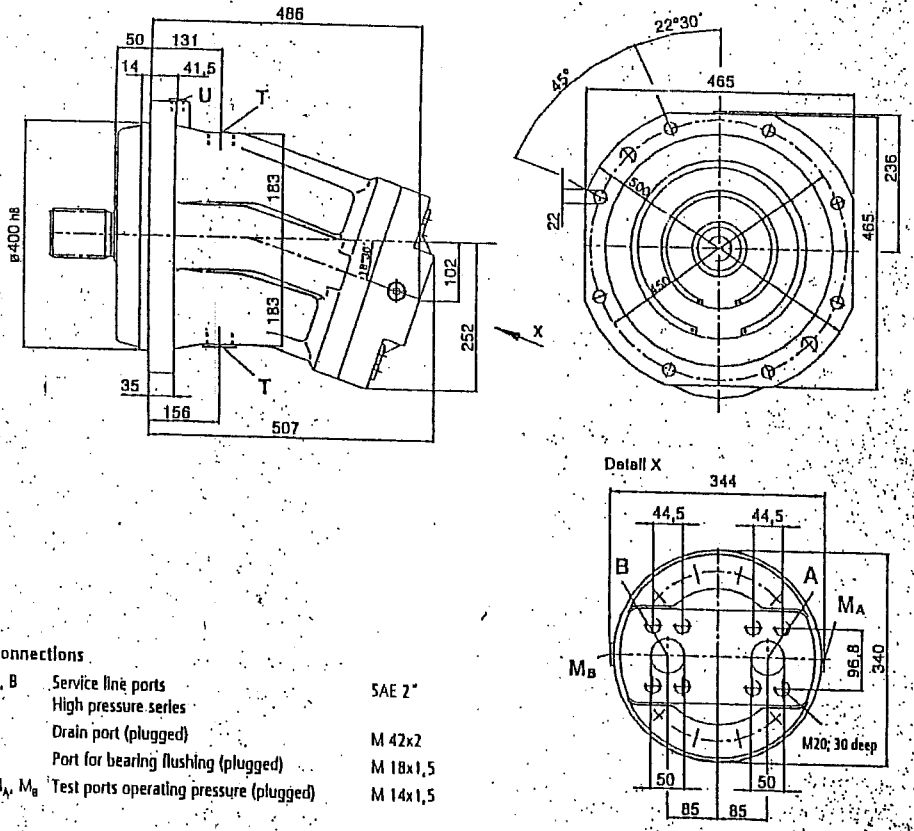
Z Splined shaft, DIN 5480
W 70x3x30x22x9g
p_N = 350 bar



P Parallel shaft with key,
DIN 6885, AS 20x12x100
p_N = 350 bar



Before finalising your design, please request a certified drawing.

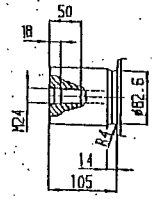


Connections

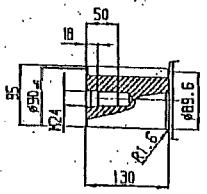
A, B	Service line ports High pressure series	SAE 2"
T	Drain port (plugged)	M 42x2
U	Port for bearing flushing (plugged)	M 18x1,5
M_A, M_B	Test ports operating pressure (plugged)	M 14x1,5

Shaft ends

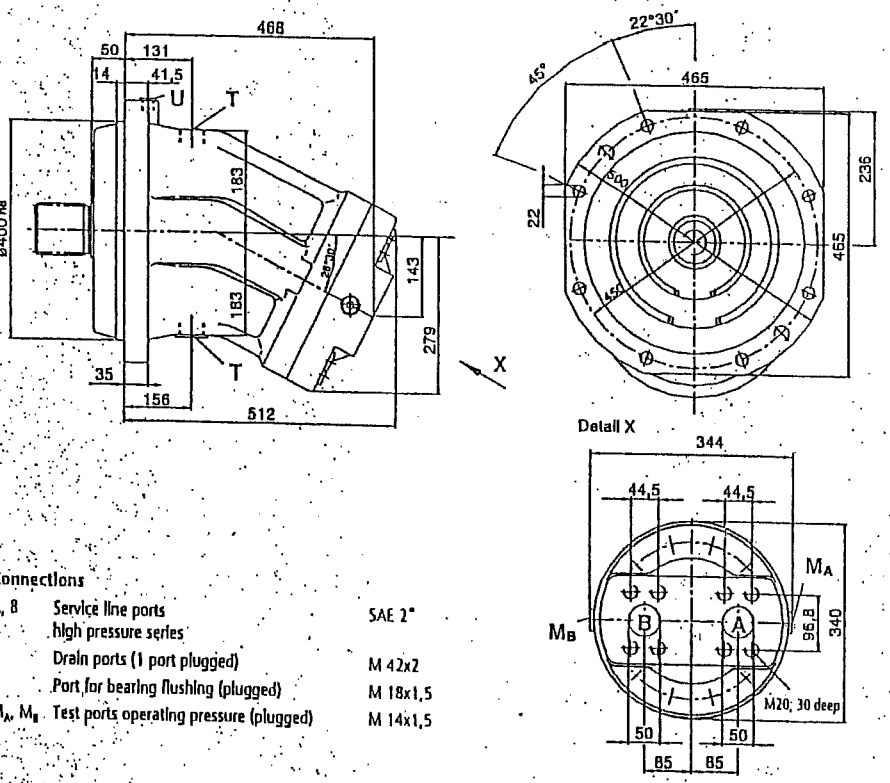
Z Splined shaft, DIN 5480
W 90x3x30x28x9g
p_N = 350 bar



P Parallel shaft with key,
DIN 6885, AS 25x14x125
p_N = 350 bar



Before finalising your design, please request a certified drawing.

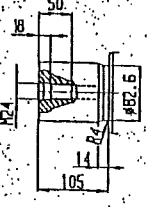


Connections

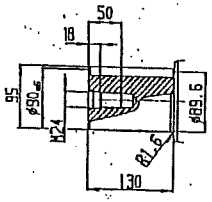
A, B	Service line ports high pressure series	SAE 2"
T	Drain ports (1 port plugged)	M 42x2
U	Port for bearing flushing (plugged)	M 18x1,5
M_A, M_B	Test ports operating pressure (plugged)	M 14x1,5

Shaft ends

Z Splined shaft, DIN 5480
W 90x3x30x28x9g
p_N = 350 bar



P Parallel shaft with key,
DIN 6885, AS 25x14x125
p_N = 350 bar

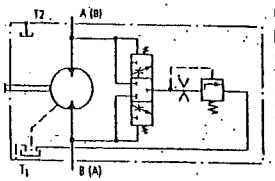


Flushing valves

Built-on flushing and boost pressure relief valve (7)

This valve is built on to the fixed displacement motor. It must then be noted that only a port plate with ports at side is then available (port plate 02).

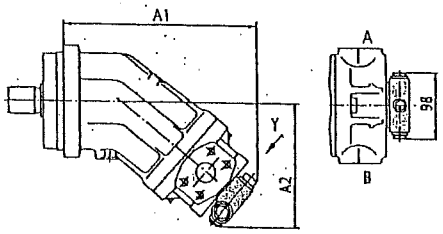
The flushing and boost pressure relief valve has a fixed setting of 16 bar (the setting of the primary boost pressure relief valve must be noted) and is used to safeguard the minimum boost pressure. A fixed flow of fluid is taken via an orifice from the low pressure side of the circuit and fed into the motor housing. This flow is then passed back to tank with the case drain fluid. Fluid thus removed from the closed circuit must be made up by means of the boost pump.



Size	Flushing flow (at low pressure Δp = 25 bar) *	
45, 56, 63	3,5 L/min	Orifice-No.: 651766/503.12.01.01
80, 90	5 L/min	Orifice-No.: 419695/503.12.01.01
107, 125	8 L/min	Orifice-No.: 419696/503.12.01.01
160, 180	10 L/min	Orifice-No.: 419697/503.12.01.01
250	10 L/min	

* Standard flushing volumes

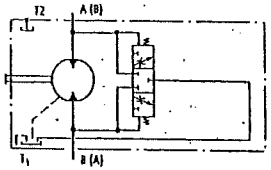
(for sizes 45...180 flushing volumes of 3,5 - 10 L/min can be supplied. If a flushing volume different from the standard flushing volume is required, please indicate the requested orifice in clear text when ordering).



Size	45	56, 63	80, 90	107, 125	160, 180	250
A1	223	239	268	294	315	344
A2	151	159	173,5	192	201	154

Integrated flushing valve (6) (Size 23...90)

The valve is integrated into the port plate.



- switching pressure Δp ≥ 8 bar (this value is lower than the starting pressure of an unloaded motor).
- closed in centre position (Δp < 8 bar).

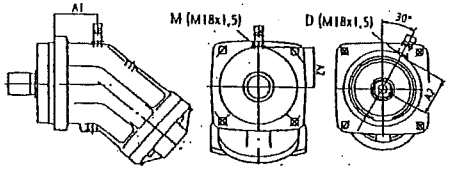
Size	Flushing flow (at low pressure Δp = 25 bar)
23, 32	2,5 L/min
45, 56, 63	3,1 L/min
80, 90	4,1 L/min

Speed sensor

Version A2FM...D ("suitable for fitting speed sensor") includes gearing on the rotary group and in addition the port M or D (M18x1,5), in which a speed sensor is screwed in.

A speed-proportional signal is produced by means of the rotating, splined rotary group which can be picked up by a suitable sensor and fed back for evaluation.

Sizes 23...180 Sizes 250...1000



Sizes	NO. of teath	length of thread	A1	A2
23, 28, 32	38	12,7	58,7	50
45	45	11,2	54,8	54,5
56, 63	47	14,7	61,5	60
80, 90	53	14,7	72,5	65,8
107, 125	59	14,7	74,8	75
160, 180	67	14,7	91	83
250	78	variable	82	103
355	90	variable	93	128
500	99	variable	110	140
710...1000	126	variable	160	163

The speed sensor is not included in standard supply.

Suitable sensors (order seperately!):
- Induktive impulse detector ID (see RE 95130) (only for sizes 23...180)
- Hall effect speed sensor HD (see RE 95134)

Pressure relief valves (for port plate 18 or 19 only)

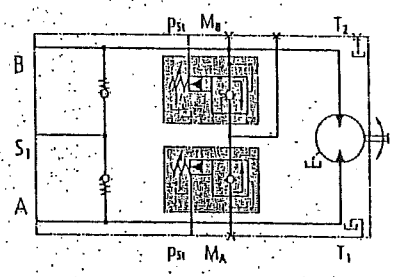
Before finalising your design, please request a certified drawing.

The pressure relief valves MHDB (as to RE 64642) are protecting the motor against overcharge. As soon as the set opening pressure is reached the oil is flowing from the high pressure side to the low pressure side.

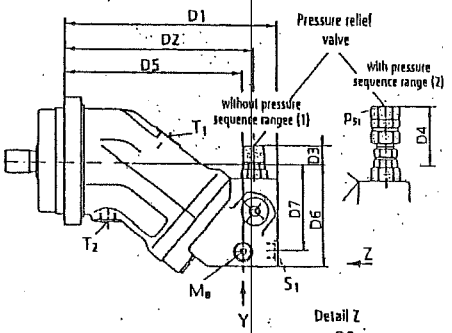
Setting range opening pressure _____ 50 – 420 bar

At design "with pressure sequence range (2)" a higher pressure setting can be realized by applying an external pilot pressure of 25 – 30 bar at port p_{St}.

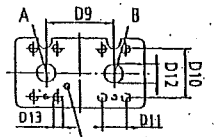
Please indicate in clear when ordering :
- opening pressure of the pressure relief valve
- opening pressure at pilot pressure applied at p_{St} (for design 2 only)



Fixed Displacement Motor A2FM, with integrated pressure relief valve (*with* pressure sequence range)

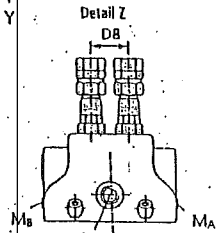


Detail Y



only for port plate 18

Detail Z



only for port plate 19

Connections

A, B	Service line ports	SAE
S_1	Boosting (only for port plate 19)	
M_A, M_B	Test ports (plugged)	
p_{St}	Pilot pressure port (only for design 2)	

Sizes	Ports	A, B	S_1	M_A, M_B	p_{St}
28, 32		SAE 3/4"	M 22x1,5	M 20x1,5	G 1/4
45		SAE 3/4"	M 22x1,5	M 20x1,5	G 1/4
56, 63		SAE 3/4"	M 26x1,5	M 26x1,5	G 1/4
80, 90		SAE 1"	M 26x1,5	M 26x1,5	G 1/4
107, 125		SAE 1 1/4"	M 26x1,5	M 26x1,5	G 1/4
160, 180		SAE 1 1/4"	M 26x1,5	M 30x1,5	G 1/4

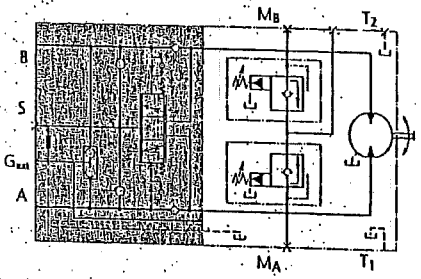
Sizes		D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13
28, 32	MHDB.16	209	186	25	63	174	102	87	36	66	50,8	23,8	19	M10; 17 deep
45	MHDB.16	222	198	22	60	187	113	98	36	66	50,8	23,8	19	M10; 17 deep
56, 63	MHDB.22	250	222	19	57	208	124	105	42	75	50,8	23,8	19	M10; 13 deep
80, 90	MHDB.22	271	243,5	17,5	55	229	134	114	42	75	57,2	27,8	25	M12; 18 deep
107, 125	MHDB.32	298	267	10	48	251	149,5	130	53	84	66,7	31,8	32	M14; 19 deep
160, 180	MHDB.32	332	301	5	43	285	170	149	53	84	66,7	31,8	32	M14; 19 deep

Motor control Valve (for port plate 18 only)

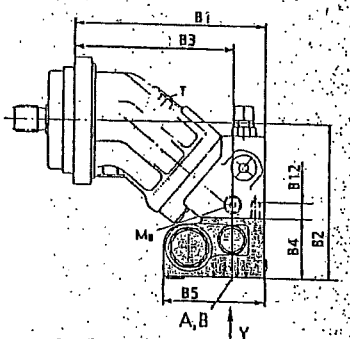
Before finalizing your design, please request a certified drawing.

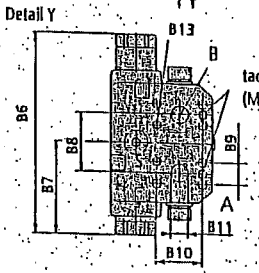
For hydro-motors operating in open loop the motion control valve BVD (as to RE 95522) is avoiding an overspeed and thus a lack of filling. A lack of filling occurs at the hydro-motors as soon as the speed of the drive from external is exceeding the speed corresponding to the added volume flow.

The motion control valve is not included in the type code of the A2FM motor and has to be indicated separately when ordering. At shipment it is fixed at the motor with 2 tacking bolts (do not remove the tacking bolts during fixing of the service lines). At separated shipment of motion control valve and motor the motion control valve has to be fixed in a first step with the added tacking bolts to the cover plate of the motor. The final fixing of the motion control valve at the motor is effected in both cases by fitting the service lines (observe screw-in depth B4 + B12 and B13)!



Fixed displacement motor A2FM, motion control valve BVD and integrated pressure relief valve





Sizes	ports	A, B	S	M_A,M_B
28, 32	BVD20..16	SAE 3/4"	M 22x1,5	M12x1,5
45	BVD20..16	SAE 3/4"	M 22x1,5	M12x1,5
56, 63	BVD20..17	SAE 3/4"	M 22x1,5	M12x1,5
80, 90	BVD20..27	SAE 1"	M 22x1,5	M12x1,5
107, 125	BVD25..38	SAE 1 1/4"	M 27x2	M12x1,5
160, 180	BVD25..38	SAE 1 1/4"	M 27x2	M12x1,5

Connections

A, B Service line ports SAE

S Boosting (plugged)

M_A,M_B Test ports (plugged).

Sizes		B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13
28, 32	BVD20..16	209	180	174	78 [1]	137	235	96	66	23,8	50,8	19	M10; 17 deep	M10; 14 deep
45	BVD20..16	229	191	187	78 [1]	137	235	96	66	23,8	50,8	19	M10; 17 deep	M10; 14 deep
56, 63	BVD20..17	250	192	208	68	137	235	96	75	23,8	50,8	19	M10; 17 deep	M10; 14 deep
80, 90	BVD20..27	271	202	229	68	137	235	96	75	27,8	57,2	25	M12; 18 deep	M12; 16 deep
107, 125	BVD25..38	298	234,5	251	85	151,5	286	120,5	84	31,8	66,7	32	M14; 19 deep	M14; 19 deep
160, 180	BVD25..38	332	255	285	85	151,5	286	120,5	84	31,8	66,7	32	M14; 19 deep	M14; 19 deep

[1] with adapting plate

Installation and Commissioning Guidelines

General

At start-up and during operation the motor housing has imperatively to be filled up with hydraulic fluid (filling of the case chamber). Start-up has to be carried out at low speed and without load till the system is completely bleeded.

At a longer standstill the case may discharge via operating line. At new start-up a sufficient filling of the housing has to be granted.

The leakage oil in the housing has to be discharged to the tank via highest positioned case drain port.

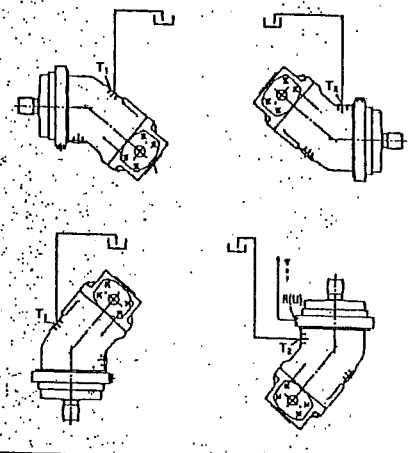
Installation position

Optional. At size 10 ... 200 with installation position "shaft to the top" use motor with bleeding port R (indicate in clear when ordering; the port U in the bearing section for bleeding is included in series at size 250 ... 1000).

Installation below tank level

Motors below min. oil level in the tank (standard)

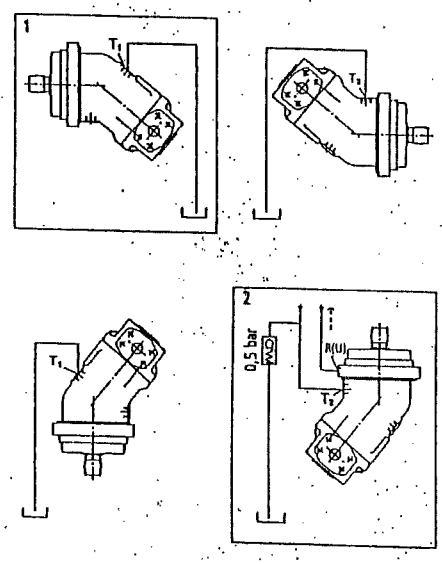
- → Fill up axial piston motor before start-up via highest positioned case drain port
- → Note for the "shaft on top" installation position: the motor case has to be filled up completely at start-up (bleeding at additional port R (size 10 ... 200) resp. U (size 250 ... 1000). An air pocket in the bearing area is leading to damage of the axial piston unit.
- → Operate motor at low speed (igniton speed) till motor system is completely filled up
- → Minimum immersion depth of the suction line or drain line in the tank: 200 mm (relative to the min. oil level in the tank).



Installation on top of tank level

Motor on top of min. oil level in the tank

- → Actions as installation below tank level
- → Installation position 1 and 2:
  If the motor is left at standstill for a long period, the oil in the housing chamber may fully drain out through the operating lines (air entering via the shaft seal). Consequently, on restarting, the bearings will be insufficiently lubricated. You should therefore refill the axial piston unit via the highest positioned drain port before restarting (installation position 2: air bleed via port R or U).
- → Installation position 2 (shaft on top)
  In this installation position, the bearings will be insufficiently lubricated even if the housing chamber is only partially drained. To prevent oil draining via the drain port, insert a check valve in the drain line (opening pressure 0.5 bar).



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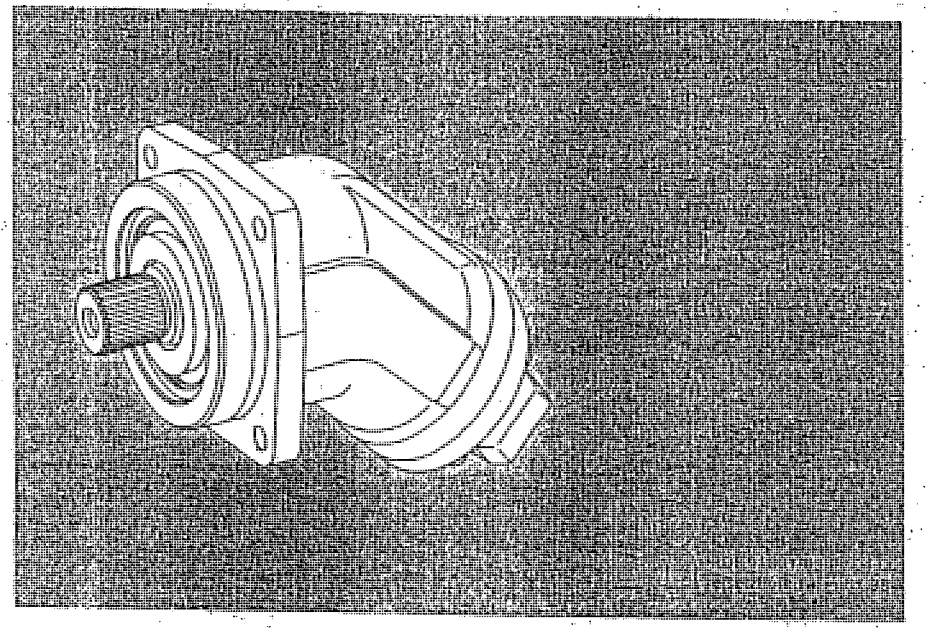
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Nachdruck verboten – Änderungen vorbehalten

mannesmann Rexroth



Reparaturanleitung - A2F Baureihe 61

Repair instructions - A2F Series 61

Brueninghaus Hydromatik

HINWEIS

Bezeichnungen, Beschreibungen und Darstellungen entsprechen dem Informationsstand zum Zeitpunkt der Drucklegung dieser Unterlage.

Änderungen können den Service am Produkt beeinflussen, Verpflichtungen entstehen uns daraus nicht.

Methoden und Vorrichtungen sind Empfehlungen, für deren Resultat wir keine Haftung übernehmen können.

BRUENINGHAUS HYDROMATIK- Baugruppen, mit Angabe der Fabrik-Nr. bestellt, sind die Basis guter Reparaturen.

Einstell- und Prüfarbeiten sind bei Betriebstemperatur auf dem Teststand vorzunehmen.

Schutz von Personen und Eigentum ist durch Vorkehrungen sicherzustellen.

Sachkenntnis, die Voraussetzung für jede Service-arbeit, vermitteln wir in unseren Schulungskursen.

NOTICE

Specifications, descriptions and illustrative material shown herein were as accurate as known at the time this publication was approved for printing.

Changes can influence the service of the products. We do not accept any obligations due to this.

Methods and tooling are suggestions, we cannot accept any liability for their results.

BRUENINGHAUS HYDROMATIK sub-assemblies ordered using the serial no. are the basis for good repairs.

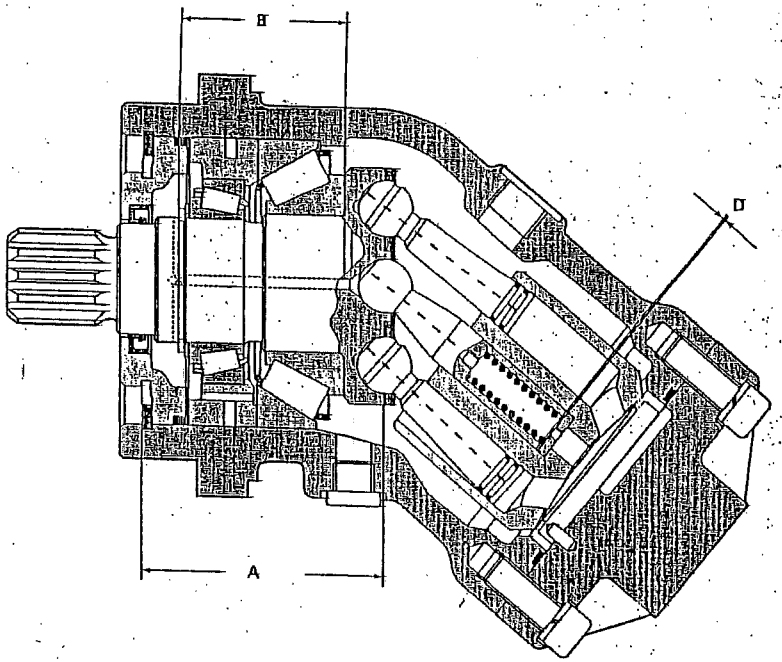
Adjustments and tests have to be carried out on the test bench under operating temperatures.

Protection of personnel and property has to be guaranteed by appropriate measures.

Expert knowledge, the precondition of any service work, can be obtained in our training courses.

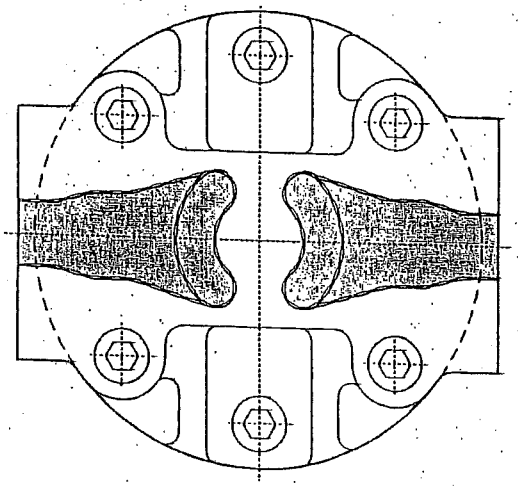
INHALT	Seite/ Page	CONTENTS
A2F		**A2F**
Schnittbild	3	Sectional view
Allgemeine Reparaturhinweise	4	General repair instructions
Dichtsätze und Baugruppen	5	Seal kits and sub-assemblies
Triebwelle abdichten	6-7	Sealing of the drive shaft
Anschlußplatte abdichten	8-10	Sealing of the cover plate
Triebwerk ausbauen	11-12	Removal the rotary group
Überprüfungshinweise	13-14	Inspection guidelines
Triebwerk einbauen	15-17	Installing rotary group
Anziehdrehmomente	18	Tightening torques
Sicherheitsbestimmungen	19-20	Safety regulations

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Meßpunkte:
Siehe Serviceinfo

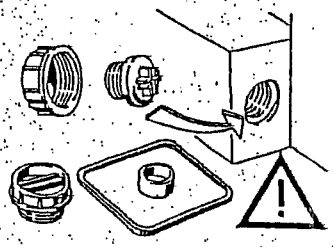
Measuring points:
See service information





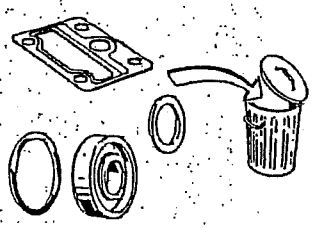
Achtung!
Nachfolgende Hinweise bei allen Reparaturarbeiten an Hydraulikaggregaten beachten!

Attention!
Please take into account the following guidelines when carrying out repair work on hydraulic units!



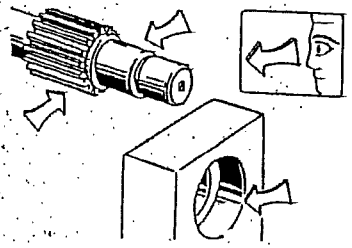
Alle Öffnungen der Hydraulikaggregate verschließen.

Close off all of the ports of the hydraulic unit.



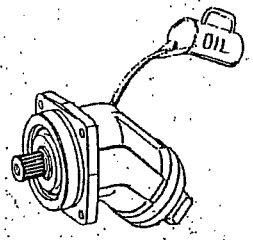
Alle Dichtungen erneuern.
Nur original BRUENINGHAUS HYDROMATIK Ersatzteile verwenden!

Replace all seals.
Use only original BRUENINGHAUS HYDROMATIK spare parts!



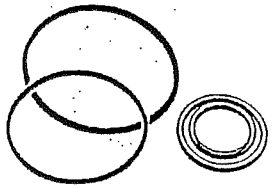
Alle Dicht- und Gleitflächen auf Verschleiß prüfen.
Achtung: Nacharbeiten an Dichtflächen z.B. durch Schleifpapier kann die Oberfläche beschädigen.

Check all seal and sliding surfaces for wear.
Attention: Rework of the sealing surfaces, using for example abrasive paper, can damage surface.



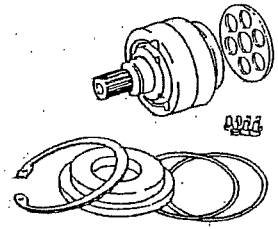
Hydraulikaggregate vor Inbetriebnahme mit Hydrauliköl befüllen.

Fill the hydraulic unit with hydraulic oil before commissioning.



Dichtsatz.

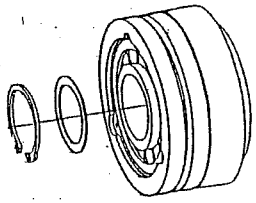
Seal kit.



(a)

⚠ Triebwerk, mechanischer Teil; mit Dichtsatz, muß abgestimmt werden auf Maß "A". (siehe Serviceinfo)

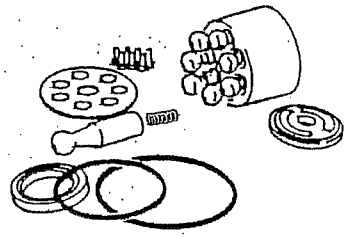
⚠ Rotary group, mechanical part; with seal kit, has to be adjusted to dimension "A". (see service info)



(b)

⚠ Lagersatz, komplett abgestimmt. Maß B (Stützscheibe und Sicherungsring nicht tauschbar) Abstimmung Maß "A". (siehe Serviceinfo)

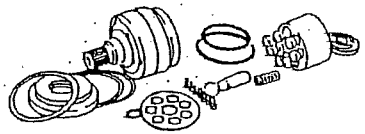
⚠ Bearing set, matched Dimension B (support disc and circlip are not exchangeable) Adjustment to dimension "A". (see service info)



(c)

⚠ Triebwerk, hydraulischer Teil; mit Dichtsatz, Abstimmung hydraulischer Teil Pos. "D". (siehe Serviceinfo)

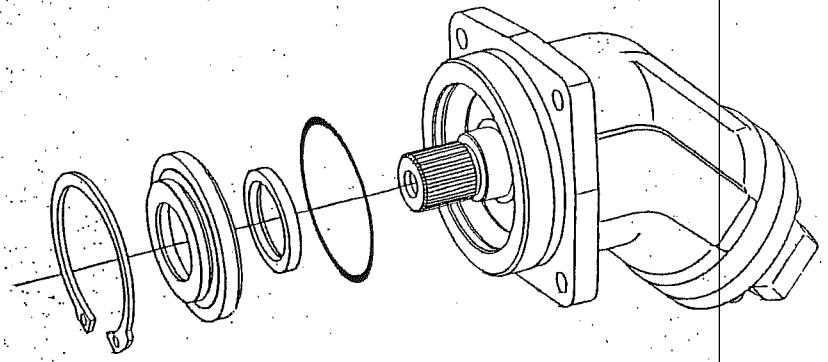
⚠ Rotary group, hydraulic part; with seal kit, Adjustment of the hydraulic part Pos. "D". (see service info)

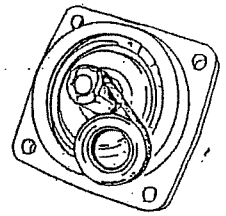


(d)

⚠ Triebwerk komplett; mit Dichtsatz, fertig vorabgestimmt. Abstimmung hydraulischer Teil Pos. "D". (siehe Serviceinfo)

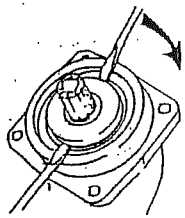
⚠ Complete rotary group, with seal kit, pre-adjusted. Adjustment of the hydraulic part Pos. "D". (see service info)





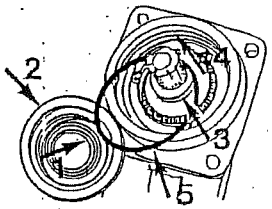
Bei nicht verzahnten Triebwellen: Paßfeder abnehmen. Triebwelle abkleben,

For non-splined shafts: remove key. Protect the drive shaft (e.g. tape).



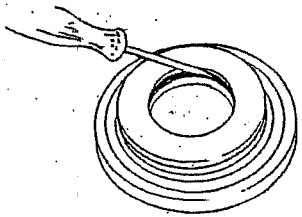
Sicherungsring ausbauen, Verschlußring abdrücken

Remove circlip, prise off cover.



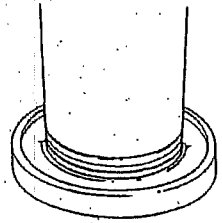
Sichtkontrolle
Wellendichtring (1), Verschlußring (2), Triebwelle (3), Gehäuse (4), O-Ring (5).

Visual check
Shaft seal (1), cover (2), drive shaft (3), housing (4), O-ring (5).



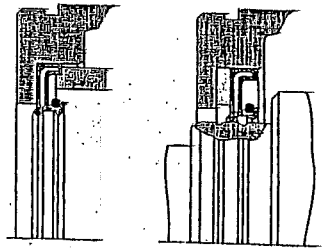
Wellendichtring demontieren.

Remove shaft seal.



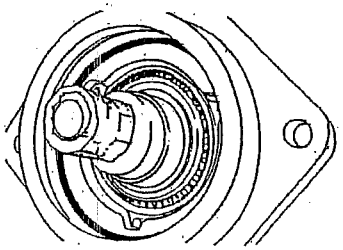
Neuen Wellendichtring lagerichtig mit passender Büchse einpressen.

Press in the new shaft seal, ensuring that it is correctly orientated, using a suitable bush.



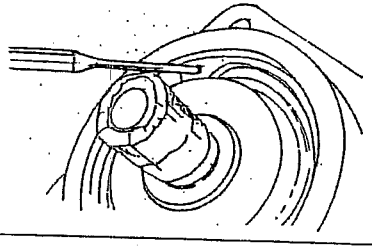
Bei tiefer Laufrille Scheibe vor den Wellendichtring einlegen (max. 1 mm).

If the drive shaft is deeply grooved, insert a shim in front of the shaft seal (max. 1 mm).



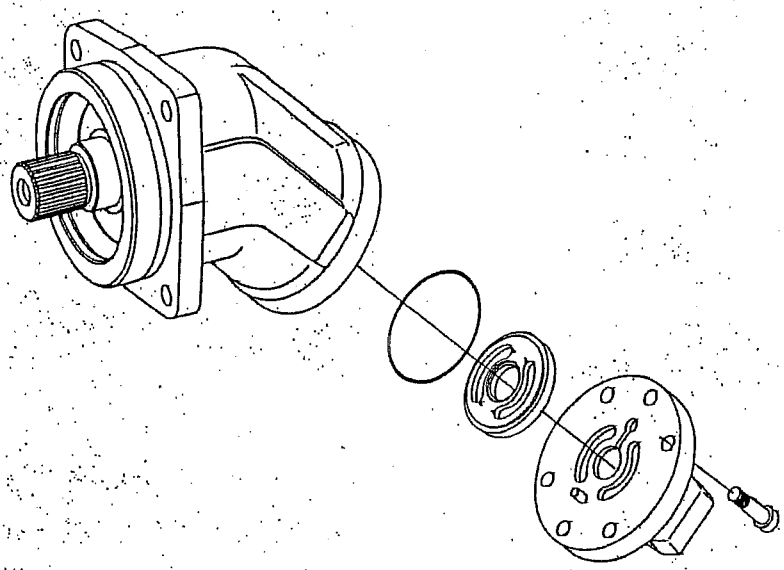
Neuen O-Ring einlegen, auf bündiges Anliegen achten. O-Ring sowie *Dicht- und Staublippe des Wellendichtringes einfetten.* (siehe Serviceinfo)

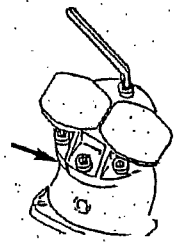
Fit new O-ring, ensure that it is correctly located. *Grease the O-ring as well as the seal and dust lips of the shaft seal.* (see service information)



Sicherungsring einbauen.
Sitzkontrolle des Sicherungsringes in der Nut.

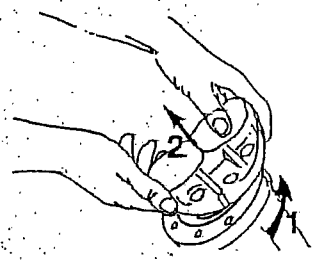
Fit circlip.
Check to ensure that the circlip is correctly located within the groove.





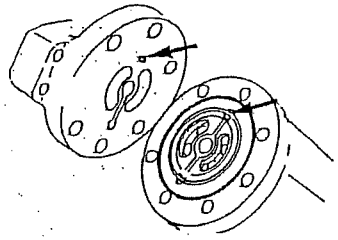
Lage der Anschlußplatte zum Gehäuse kennzeichnen (Pfeil), Befestigungsschrauben lösen.

Mark the position of the cover plate with regard to the housing (arrow), loosen the fixing screws.



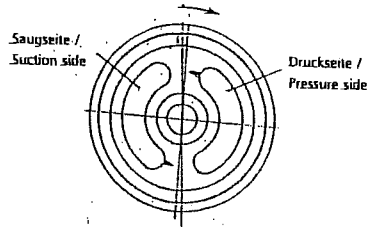
Anschlußplatte um Verdrillstift schwenken (1)
und abheben (2).

Swing the connection plate about the locating pin (1) and lift off (2).



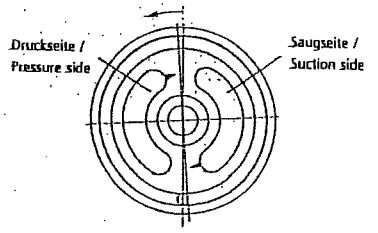
Auf Montagestellung des Verdrillstiftes achten (Pfeile).

Take the assembly position of the locating pin (arrow) into account.



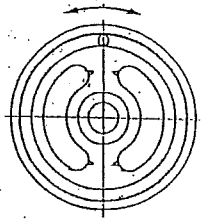
Pumpe, Drehrichtung rechts.
(Blick auf sphärische Fläche.)

Pump, clockwise rotation.
(viewed on spherical surface.)



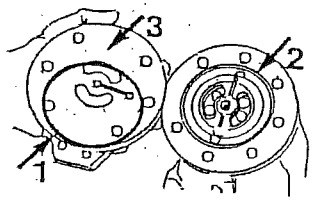
Pumpe, Drehrichtung links.
(Blick auf sphärische Fläche.)

Pump, anti-clockwise rotation.
(viewed on spherical surface.)



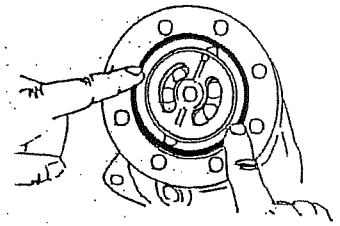
Motor, beide Drehrichtungen.
(Blick auf sphärische Fläche.)

Motor, bi-directional.
(Viewed on spherical surface.)



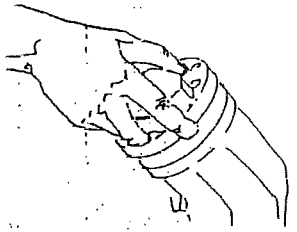
Sichtkontrolle
O-Ring (1), Einstich (2), Platte (3).

Visual check
O-ring (1), Groove (2), Plate (3).



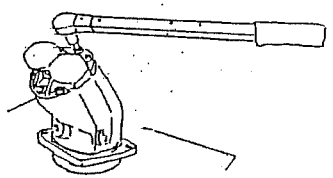
Neuen O-Ring einlegen, zuvor leicht einfetten.

Lightly grease and fit O-ring.



Anschlußplatte aufsetzen, auf Kennzeichnung und Lage des Verdrillstiftes achten.

Place the cover plate onto the housing taking into account the location mark and position of the locating pin.

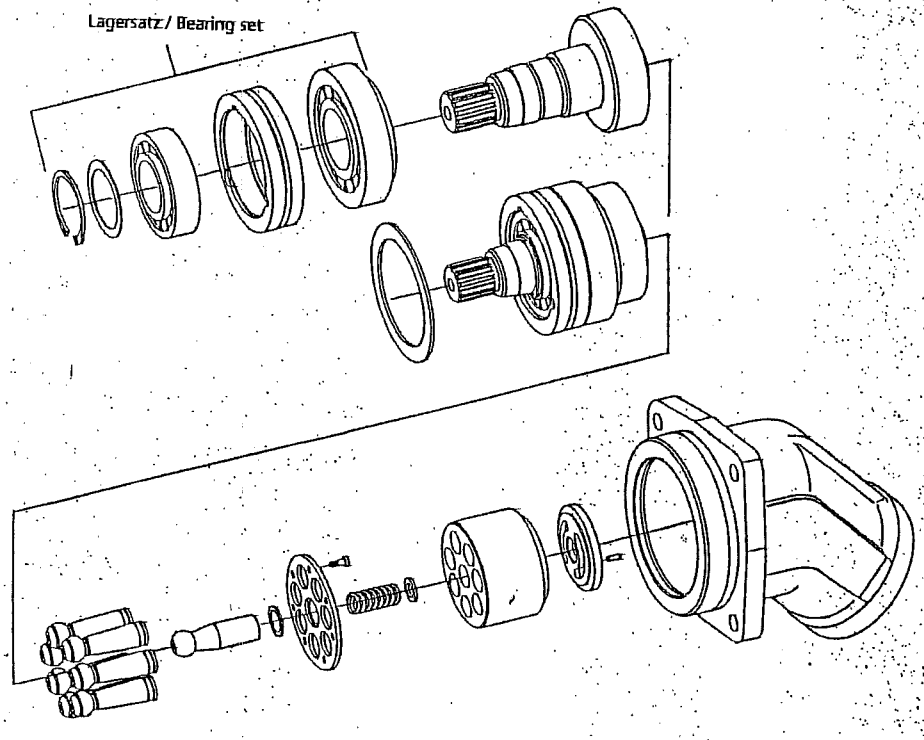


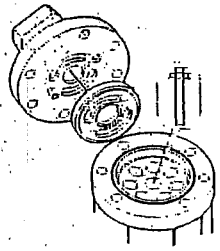
Befestigungsschrauben mit Drehmomentenschlüsselanziehen.

Tighten fixing screws using a torque wrench.

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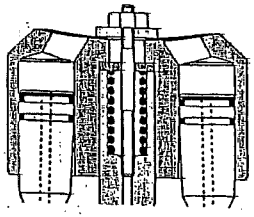
Lagersatz / Bearing set





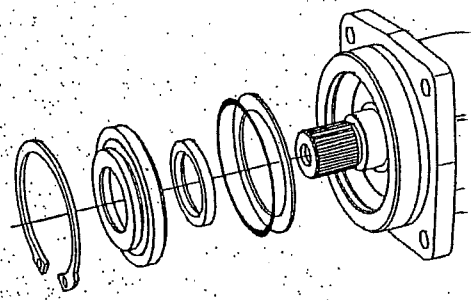
Demontage der Anschlußplatte. Steuerplatte abheben.
Zylinder am Mittelzapfen mit Schraube befestigen.

Removal of the connection plate. Lift off the control plate.
Secure the cylinder to the centre pin using a screw.



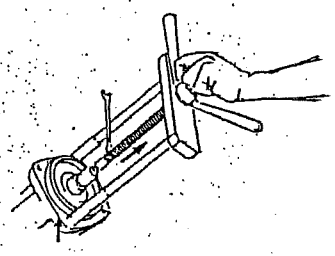
Gewindestift,Zylinderschraube /
Threaded pin,socket head screw

NG / Size	(mm)
10; 12; 16	M3 x 35
23; 28; 32	M5 x 45
45	M5 x 50
56; 63	M5 x 55
80; 90	M5 x 60
107; 125; 131	M6 x 70
160; 180	M6 x 85



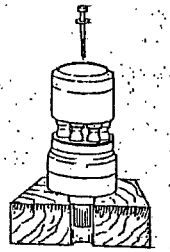
Verschlußring, O-Ring und Paßscheibe ausbauen.

Remove the cover, O-ring and shim.



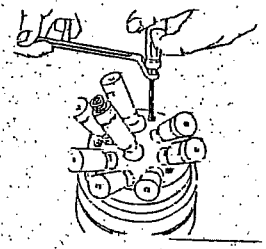
Triebwerk mit Vorrichtung ausbauen.

Withdraw the rotary group using an extractor.



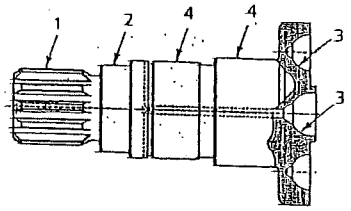
Befestigungsschraube ausbauen.
Zylinder abheben.

Remove the fixing screw.
Lift off the cylinder.



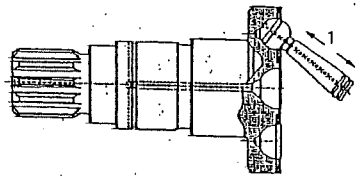
Rückzugplatte demontieren, Schrauben sind eingeklebt.
Komplettes Triebwerk bei ca. 120° C im Ölbad erwärmen. Danach Befestigungsschrauben lösen!

Disassemble the retaining plate, screws are locked with an adhesive.
Heat up the complete rotary group in an oil bath to approx 120° C, then remove the fixing screws.



Triebwelle
1. kein Passungsrost, nicht ausgeschlagen.
2. keine Einlaufspuren, riefenfrei.
3. Kalotten riefenfrei und keine Pittings.
4. Keine Laufspuren (Lagerdreher).

Drive shaft
1. No wear, or fretting
2. No traces of wear, free of scratches.
3. Cups free of wear and no pitting.
4. No traces of wear, (bearing rotation).

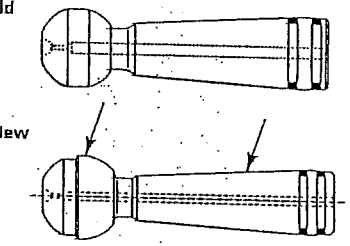


1. Axiales Kolbenspiel

1. Axial play of piston.

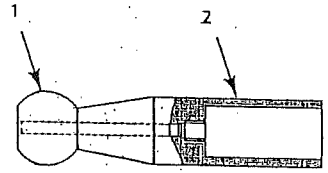
Alt / Old

Neu / New



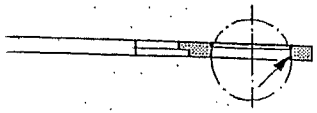
Kolben
Riefenfrei, keine Pittings.

Piston
Free of scratches, no pitting.



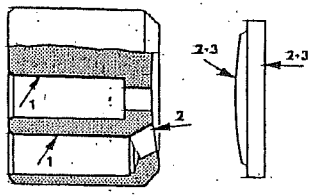
Mittelzapfen
1. Riefenfrei, ohne Pittings.
2. Riefenfrei.

Center pin
1. Free of scratches, no pittings.
2. Free of scratches.



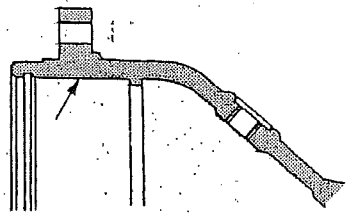
Rückzugplatte
Riefenfrei, keine Ausbrüche.

Retaining plate
Free of scratches, no wear.



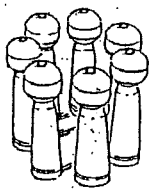
Zylinder/Steuerplatte
1. Bohrungen riefenfrei, nicht ausgelaufen.
2. Gleichmäßiges Tragbild, riß- und riefenfrei.
3. Mindesthärte 700 HV 10.

Cylinder / control plate
1. Bores unscratched, and no traces of wear.
2. Even load distribution, free of cracks and grooves.
3. Min. hardness 700 HV 10.



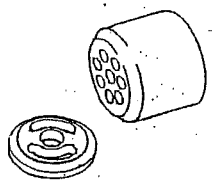
Gehäuse
Im Lagerbereich riefenfrei und keine Einlaufspuren.

Housing
No traces of wear in the bearing area.



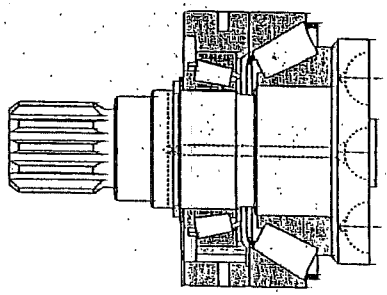
Nur kompletten Kolbensatz austauschen.

Only exchange the pistons as a complete set.



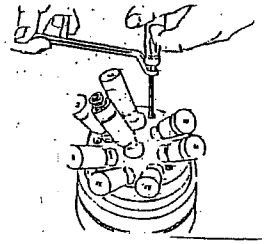
Zylinder und Steuerplatte nur gemeinsam austauschen.

Only replace the cylinder and control plate as a pair.



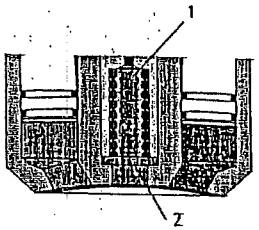
Triebwelle mit Lager vormontiert verwenden.

Use a pre-assembled drive shaft with bearings.



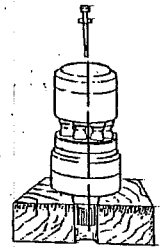
Rückzugplatte mit Kolben und Mittelzapfen einsetzen.
⚠ Schrauben mit Precote-Beschichtung verwenden.

Fit retaining plate complete with pistons and centre pin.
⚠ Uses screws with a Precote coating.



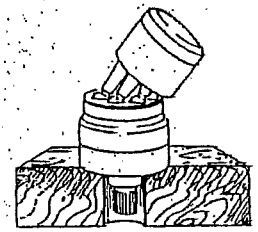
⚠ Druckfeder (1) und Abstimmscheibe (2) einbauen.

⚠ Fit the compression spring (1) and shim(2).



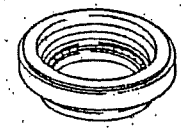
⚠ Zylinder in Neutralposition befestigen.

⚠ Fix the cylinder in the neutral position.



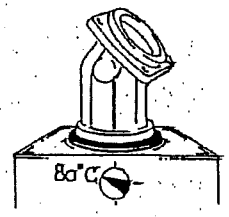
Triebwerk max. ausschwenken.

Swivel the rotary group to max.



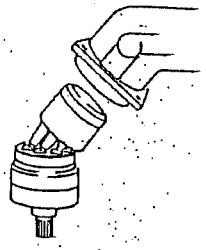
Neuer Radialwellendichtring montiert?

Is the new shaft seal fitted?



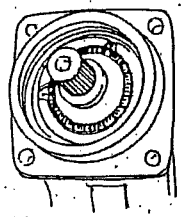
Gehäuse auf ca. 80° C erwärmen.

Heat the housing to approx. 80° C.



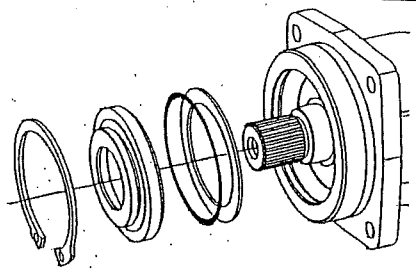
Heißes Gehäuse bis zum Anschlag aufsetzen.

Push on the hot housing until the stop is reached.



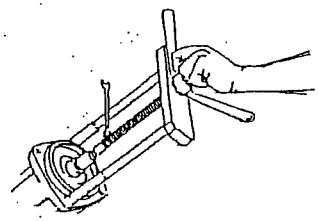
Neue Montagestellung.

New assembly position.



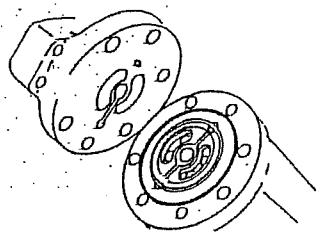
Paßscheibe, O-Ring einlegen. Verschlußring montieren.
⚠ O-Ring, Zwischenraum Wellendichtring einfetten (siehe Serviceinfo).

Fit the shim and O-ring. Then fit the cover.
⚠ Grease the O-ring as well as the seal and dust lipsof the shaft seal.



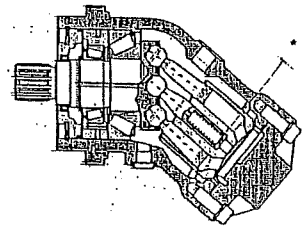
Triebwerk gegen Verschlußring ziehen.
Kontrolle: Verschlußring spielfrei.

Pull the rotary group against the cover.
Check: to see that the cover is free of play.

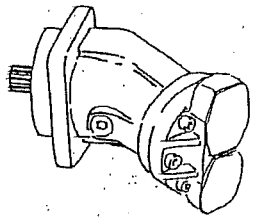


Befestigungsschraube ausbauen.
Steuerplatte lagerichtig aufsetzen.
Fertigmontage
⚠ Abstimmung Pos. D - siehe Serviceinfo

Remove fixing screw. Fit the control plate into its correct location.
Final assembly
⚠ For adjustment of Pos. D - see service info



* Pos.D



Anschlüsse mit Staubschutz abdichten.
Korrosionsschutz (innen/außen). Fertig!

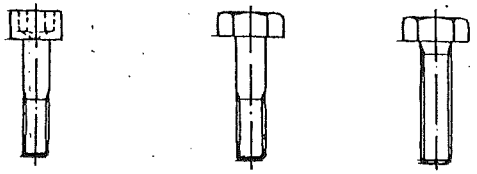
Seal connections to protect against dust.
Corrosion proctection (internal/external).
Assembly complete.

1. Schaftschrauben (nach N 08.001)

Die Werte gelten für Schaftschrauben mit metrischem ISO-Gewinde nach DIN 13 Teil 13, sowie Kopfauflagemaßen nach DIN 912 Zylinderschrauben, DIN 931 Sechskantschrauben mit Schaft bzw. DIN 933 Sechskantschrauben mit Gewinde bis Kopf.

1. Bolts (to N 08.001)

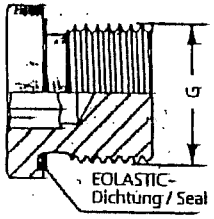
The values stated are valid for bolts with metric ISO threads to DIN 13 part 13, as well as head areas to DIN 912 socked head cap screws, DIN 931 hexagon bolt or DIN 933 hexagon bolts with threads up to the head.



Gewinde / Thread	Festigkeitsklassen / Tensile strength class		
	8.8	10.9	12.9
	Anziehdrehmoment / Tightening torque M_A in Nm		
M 3	1,1	1,6	1,9
M 4	3,1	4,5	5,3
M 5	6,1	8,9	10,4
M 6	10,4	15,5	18
M 8	25	37	43
M 10	51	75	87
M 12	87	130	150
M 14	140	205	240
M 16	215	310	370
M 18	300	430	510
M 20	430	620	720
M 22	580	830	970
M 24	740	1060	1240

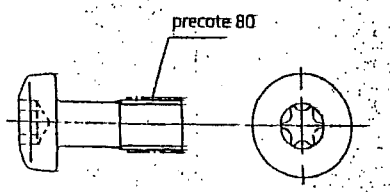
Page 875

2. Verschlußschrauben mit Innensechskant und Profildichtring (nach N 0Z.009).
Plugs with internal hexagon and profile seal ring (to N 0Z.009).



Gewinde / Thread	Anziehdrehmoment / Tightening torque M_A in Nm	Gewinde / Thread	Anziehdrehmoment Tightening torque M_A in Nm
M8 x 1	5	G 1/8 A	10
M10 x 1	10	G 1/4 A	30
M12 x 1,5	20	G 3/8 A	35
M14 x 1,5	30	G 1/2 A	60
M16 x 1,5	35	G 3/4 A	90
M18 x 1,5	40	G 1 A	140
M20 x 1,5	50	G 1 1/4 A	240
M22 x 1,5	60	G 1 1/2 A	300
M26 x 1,5	70		
M27 x 2	90		
M30 x 1,5	100		
M33 x 2	140		
M42 x 2	240		
M48 x 2	300		

7. Linsenschrauben mit Innen-TORX, Gewindevorbeschichtung mit "precote 80" (nach N 0Z.119)
Oval head screw with inner TORX, thread precoated with "precote 80" (to N 0Z.119)



Gewinde / Thread	Festigkeitsklasse / Tensile strength class	
	10.9	11.9
	Anziehdrehmoment M_A in Nm Tightening torque M_A in Nm	
M3	2,1	—
M4	4,7	—
M5	9,1	9,5
M6	15,8	—
M8	37,7	—

Allgemein

- Machen Sie sich mit der Ausstattung der Maschine vertraut.
- Fahren Sie die Maschine nur, wenn Sie sich völlig mit den Bedien- und Steuerelementen sowie der Arbeitsweise der Maschine vertraut gemacht haben.
- Benutzen Sie Ihre Schutzausrüstung wie Schutzhelm, Sicherheitsschuhe und Gehörschutz.
- Machen Sie sich mit Ihrem Arbeitsgebiet vertraut.
- Benutzen Sie die Maschine nur für den ihr zugedachten Zweck.

Beachten Sie bitte die Richtlinien der Berufsgenossenschaft und des Maschinenherstellers

Hydraulikanlage

1. Hydraulikanlage steht unter hohem Druck!

⚠ Unter hohem Druck austretende Hochdruck-Flüssigkeiten (Kraftstoff, Hydrauliköl) können die Haut durchdringen und schwere Verletzungen verursachen. Daher sofort einen Arzt aufsuchen, da anderenfalls schwere Infektionen entstehen können!

2. Bei der Suche nach Leckstellen wegen Verletzungsgefahr geeignete Hilfsmittel verwenden!
3. Vor Arbeiten an der Hydraulikanlage diese unbedingt drucklos machen und angebaute Geräte absenken!
4. Bei Arbeiten an der Hydraulikanlage unbedingt Motor abstellen und Traktor gegen Wegrollen sichern (Feststellbremse, Unterlegkeil)!
5. Beim Anschließen von Hydraulikzylindern und -motoren ist auf vorgeschriebenen Anschluß der Hydraulikschläuche zu achten!
6. Bei Vertauschen der Anschlüsse umgekehrte Funktionen (z.B. Heben/Senken) - Unfallgefahr!
7. Hydraulikschlauchleitungen regelmäßig kontrollieren und bei Beschädigung und Alterung austauschen! Die Austauschschlauchleitungen müssen den technischen Anforderungen des Geräteherstellers entsprechen!

⚠ Öle, Kraftstoffe und Filter ordnungsgemäß entsorgen!

General advice

- Make yourself familiar with the equipment of the machine.
- Only operate the machine if your are completely familiar with the operating and control elements as well as the functioning of the machine.
- Use your safety equipment like helmet, safety shoes and hearing protection.
- Make yourself familiar with your working field.
- Only operate the machine for its intended purpose.

Please observe the guidelines of the Professional Association and the machine manufacturer.

Hydraulic equipment

1. Hydraulic equipment is standing under high pressure.

⚠ High pressure fluids (fuel, hydraulic oil) which escape under high pressure can penetrate the skin and cause heavy injuries.
Therefore immediately consult a doctor as otherwise heavy infections can be caused.

2. When searching leakages use appropriate auxiliary devices because of the danger of accidents.
3. Before working at the hydraulic equipment, lower pressure to zero and lower working arms of the machine.
4. When working at the hydraulic equipment, absolutely stop motor and secure tractor against rolling away (parking brake, shim)!
5. When connecting hydraulic cylinders and motor pay attention to correct connection of hydraulic flexible hoses.
6. In case of exchanging the ports, the functions are vice versa (f. ex. lift-up/lower) - danger of accidents!
7. Check hydraulic flexible hoses regularly and replace them in case of dammage or wear! The new hose pipes must comply with the technical requirements of the machine manufacturer!

⚠ Orderly disposal or recycling of oil, fuel and filters!

Brueninghaus Hydromatik GmbH, Werk Elchingen, Glockeraustraße 2, D-89275 Elchingen, Tel. (07308) 820, Fax (07308) 7274, E-Mail: service.elchingen@bru-hyd.com
Brueninghaus Hydromatik GmbH, Werk Horb, An den Kelterwiesen 14, D-72160 Horb, Tel. (07451) 920, Fax (07451) 8221, E-Mail: service.horb@bru-hyd.com

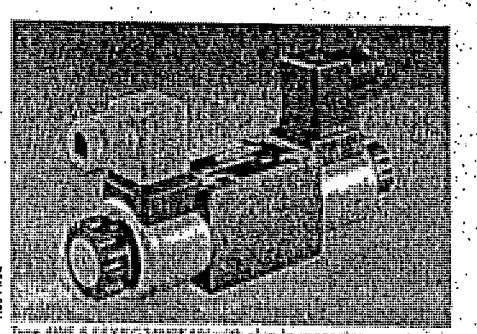
RE 23 163/09.99
Replaces: 02.99

engineering
Mannesmann Rexroth

4/3, 4/2 and 3/2 directional valves with wet pin DC solenoids, Type WE 6 ../.S

Nominal size 6
Series 6X
Maximum operating pressure 315 bar
Maximum flow 60 l/min

Standard industrial valve



Type 4WE 6 E6X/EG24N9K4/V with plug-in connector

Overview of contents

Contents	Page
Features	1
Ordering details	1
Symbols	2
Function, section	2
Technical data	3
Characteristic curves	4
Preferred types	4
Unit dimensions	5
Spare parts and seals, plug-in connectors	6

Features

The standard industrial valve type .WE 6 .6X/.S... is available parallel to the high performance type .WE 6 .6X/E... (catalogue sheet RE 23 178) in selected basic types with reduced performance data!

- Direct solenoid actuated directional spool valve
- Porting pattern to DIN 24 340 form A ISO 4401 and CETOP-RP 121 H, for subplates see catalogue sheet RE 45 052
- Wet pin DC solenoids
- Individual electrical connections
- Hand override, optional

Ordering details

2	3	4	6	7	9	10	11	12	15	22
	WE	6		6X/		S	G24		K4/	V

3 service ports = 3
4 service ports = 4

Nominal size 6 = 6

Symbol e.g. D, E, etc.
for possible versions see page 2

Series 60 to 69 = 6X
(60 to 69: unchanged installation and connection dimensions)

Spring return = No code
Without spring return with detent = OF
only available with symbol „D")

Standard valve = S

24 V DC = G24
(for the ordering details of other voltages see page 3)

V = FKM seals
⚠ Attention!
The compatibility of the seals and pressure fluid has to be taken into account!

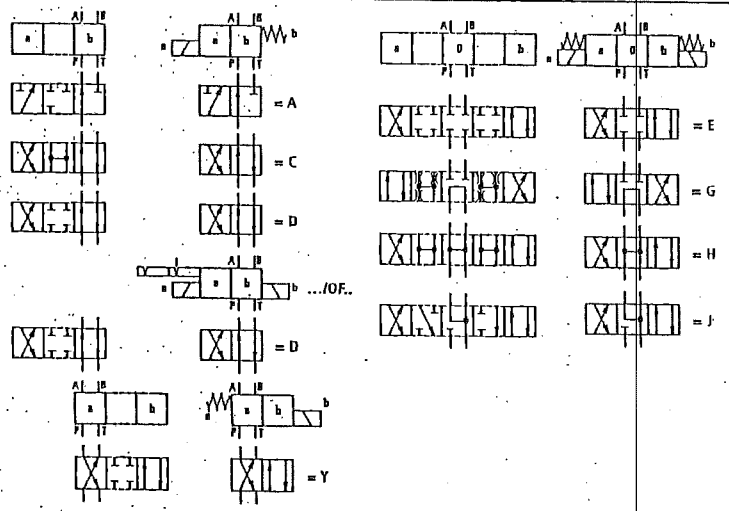
Electrical connections
K4 [1] = Single connection; with component plug DIN 43 650-AM2, without plug-in connector

N9 = With protected hand override (standard)
N = With hand override
No code = Without hand override

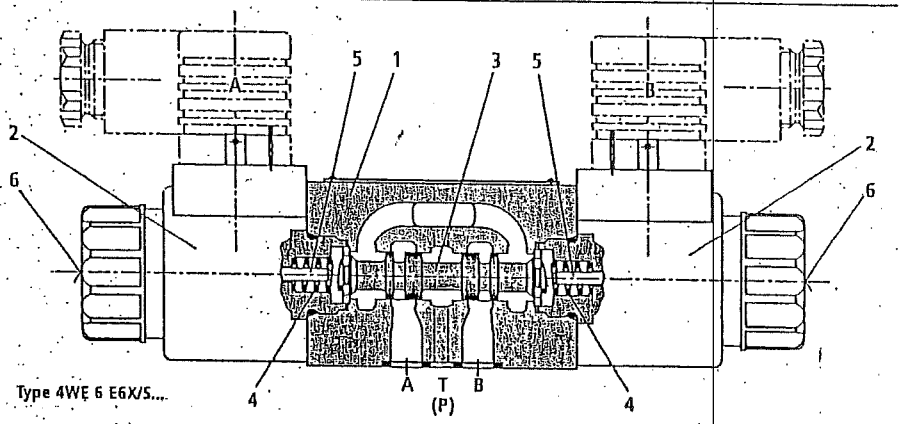
[1] Plug-in connectors must be ordered separately (see page 6)

Preferred types, see page 4, are readily available!

Symbols



Function, section



Type 4WE 6 E6X/S...

Type WE directional control valves are solenoid actuated directional spool valves. They control the start, stop and direction of flow.

The directional valves basically comprise of the housing (1), one or two solenoids (2), the control spool (3), as well as one or two return springs (4).

In the de-energised condition the control spool (3) is held in the neutral or initial position by means of the return springs (4) (with the exception of impulse spools). The control spool (3) is actuated by wet pin solenoids (2). To guarantee satisfactory operation, care should be taken to ensure that the solenoid pressure chamber is filled with oil.

The force of the solenoid (2) acts via the plunger (5) on the control spool (3) and pushes this from its neutral position into the required end position. Thus the required flow direction of P to A and B to T or P to B and A to T is achieved.

When solenoid (2) is de-energised, control spool (3) is returned to its neutral position by means of return springs (4).

A hand override (6), optional, allows movement of the control spool (3) without energising the solenoid.

Type 4WE 6 ..6X/OFS... (impulse spool, only possible with symbol D). This version is a directional valve with 2 switched positions, 2 solenoids and a detent. Thus the relevant switched positions are alternativly fixed and continuous energisation of the solenoid is unnecessary.

Note:
Pressure peaks in the tank line to two or more valves can, particularly with valves with detents, lead to unintended spool movements! It is therefore, recommended that a separate tank line is used.

Techn. ...a (for applications outside these parameters, please consult us!)

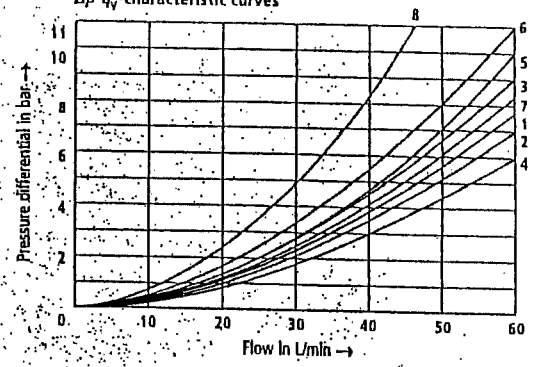
General			
Installation			optional
Max. ambient temperature		°C	50
Weight	Valve with 1 solenoid	kg	1.2
	Valve with 2 solenoids	kg	1.4
Hydraulic			
Max. operating pressure	Ports A, B, P	bar	315
	Port T	bar	210 with symbol A, connection T must be used as a drain connection when the operating pressure lies above the permissible tank pressure.
Max. flow		l/min	60
Pressure fluid			mineral oil (HL, HLP) to DIN 51 524; fast bio-degradable pressure fluids to VDMA 24 568 (also see RE 90 221); HETG (rape seed oil)
Pressure fluid temperature range		°C	– 20 to + 80 (FKM seals)
Viscosity range		mm²/s	2.8 to 500
Degree of contamination			maximum permissible degree of contamination of the pressure fluid is to NAS 1638, class 9. We, therefore, recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$.
Electrical			
Voltage type			DC
Available voltages		V	12, 24
Voltage tolerance (nominal voltage)		%	±10
Power consumption		W	26
Holding power		VA	–
Switch-on power		VA	–
Duty			continuous
Switching time ISO 6403	ON	ms	20 to 45
	OFF	ms	10 to 25
Max. switching frequency		cycles/h	15000
Protection to DIN 40 050			IP 65
Insulation class VDE 0580			F
Max. coil temperature [1]		°C	150

[1] Due to the occuring surface temperatures of the solenoid coils, the European standards EN563 and EN982 must be taken into account!

With electrical connections the protective conductor (PE ⏚) must be connected according to the relevant regulations.

Characteristic curves (measured at $\nu = 41$ mm²/s and $\vartheta = 50$ °C)

Δp-q_V-characteristic curves



Symbol	Flow direction			
	P – A	P – B	A – T	B – T
A	1	1	–	–
D, Y	5	5	3	3
C	1	1	3	1
E	3	3	1	1
H	2	4	2	2
J	1	1	2	1
G	6	6	7	7

[8] Symbol "G" in mid position P - T

Switching power limits (measured at $\nu = 41$ mm²/s and $\vartheta = 50$ °C)

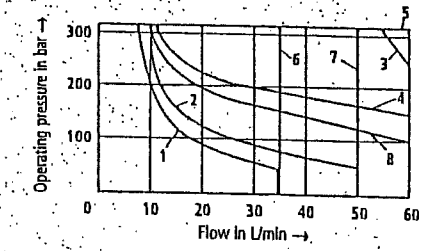
⚠ Attention!

The given switching power limits are valid for applications with two directions of flow (e. g. from P to A and simultaneously return flow from B to T).

Due to the flow forces active within the valves the permissible switching power limit may be significantly lower if there is only one direction of flow (e. g. from P to A and port B blocked)!

(For such applications, please consult us.)

The switching powr limits were measured with the solenoids at operating temperature, 10% under voltage and without tank back pressure.



DC solenoids 12 V, 24 V			
Char. curve	Symbol	Char. curve	Symbol
1	A [1]	5	D/OF
2	A	6	G
3	C, D, Y	7	H
4	E	8	J

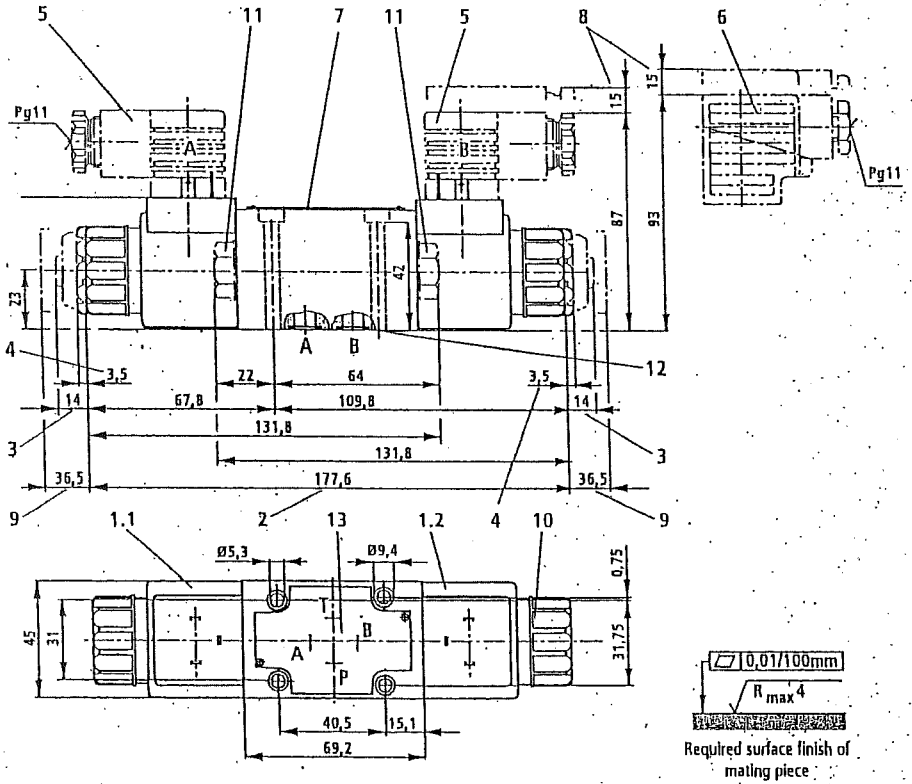
[1] With hand override

Preferred types (readily available!)

Type	Material number
3WE 6 A6X/SG24N9K4/V	00953560
4WE 6 C6X/SG24N9K4/V	00953563
4WE 6 D6X/SG24N9K4/V	00953564
4WE 6 E6X/SG24N9K4/V	00953566
4WE 6 G6X/SG24N9K4/V	00953567
4WE 6 J6X/SG24N9K4/V	00953568
4WE 6 Y6X/SG24N9K4/V	00953569
4WE 6 H6X/SG24N9K4/V	00953572
4WE 6 D6X/OFSG24N9K4/V	00953570

Preferred types and standard components are shown in the EPS price list (RDE 00 165).

Unit dimensions (Dimensions in mm)



Required surface finish of mating piece

1.1 Solenoid "a"

1.2 Solenoid "b"

2 Dim. for solenoid with protected hand override "N9"
– The hand override can only be actuated up to a tank pressure of approx. 50 bar
Avoid damage to the hand override pin bore!

3 Dim. for solenoid with hand override „N"

4 Dim. for solenoid without hand override

5 Plug-in connector without circuitry to DIN 43 650 [1]

6 Plug-in connector with circuitry to DIN 43 650 [1]

7 Name plate

8 Space required to remove plug-in connector

9 Space required to remove coil

10 Securing nut, M_A = 4 Nm

11 Plug for valves with one solenoid

12 R-ring 9.81 x 1.5 x 1.78

13 Porting pattern to DIN 24 340 form A, ISO 4401 and CETOP–RP 121 H.

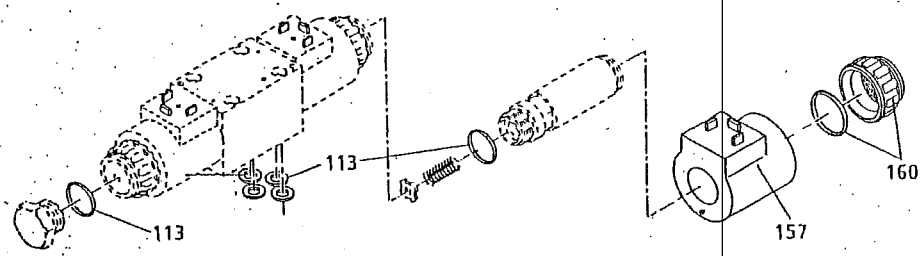
Subplates G 341/01 (G 1/4)
G 342/01 (G 3/8)
G 502/01 (G 1/2)

to catalogue sheet RE 45 052 and

Valve fixing screws
M5 x 50 DIN 912-10.9, M_A = 8.9 Nm, must be ordered separately.

[1] Must be separately ordered, see page 6.

Ordering details: spare parts and seals



Spare parts – solenoid

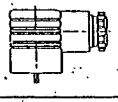
tem	Description	Vo tage	Materia no.
157	Coil for individual connections	12 V	00222314
		24 V	00221329
160	Nut; with protected hand override „N9"		00068604
	Nut; with hand override „N"		00227435
	Nut; without hand override		00227433

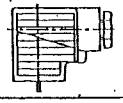
Seal kit – valve

Item	Seal material	Material number
113	FKM seals	00313163

Ordering details: plug-in connectors to DIN 43 650 A and ISO 4400 for component plug "K4"

For further plug-in connectors see RE 08 006





Valve side	Colour	Material no. Without circuitry	With indicator light 12 ... 240 V	With rectifier 24 ... 240 V	With indicator light and Z-diode protective circuit 24 V
a	grey	00074683	–	–	–
b	black	00074684	–	–	–
a/b	black	–	00057292	–	00310995

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E-mail: info@rexroth.co.uk

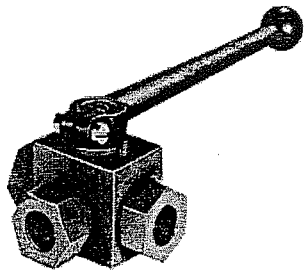
The specified data is for product description purposes only and may not be deemed to be guaranteed unless expressly confirmed in the contract.

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RAU09 02/07.03	3 Way Ball Valves Type KHB3K			Rexroth Bosch Group
	Size 3/8" - 1"		to 315 bar	

1. Description

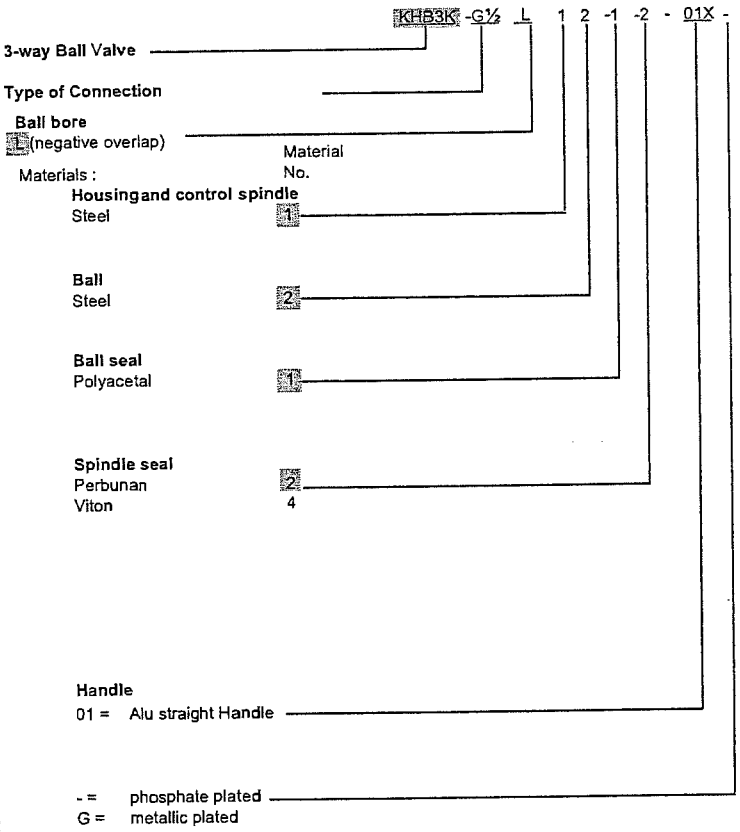
- 3-way ball valves are of a compact construction.
- Setting is by means of a milled slot.
- Valve positioning by means of a stop pin and stop disc.
- Valves are only sealed on ports 2 & 3. Therefore pressure inlet by port 1 only. Pressure can be diverted to either port 2 or 3. When pressure is diverted, no pressure should be locked in opposite port line, as this will cause leakages.
- Individual pressure testing ensures safety.
- The valves are supplied with straight handles, cranked handles are available on request.
- Working temperature : depending on sealing material -20°C to + 250°C.
- If the ball valves are to be used for gas, oxygen or other special applications, please give full details when ordering.
- Ball valves are not designed to be used as flow control valves; therefore they should always be either fully open or fully closed.



Type KHB3K female ports

2. Technical Details

2.1 Model Code
(also order code)



2.2 Type Of Connection

G= Withworth pipe thread ISO 228/1
NPT= NPT thread ASA B 2.1-1960
LR= For pipe compression fitting (light range) DIN 2353
SR= For pipe compression fitting (heavy range) DIN 2353

2.2.1 Nominal size

Housing (Block type)	DN 4-25
Housing (Sleeve type only stainless steel)	DN 4-25
G-thread	DN 4-25
LR pipe compression fitting	DN 4-25
SR pipe compression fitting	DN 4-25

2.3 Materials

Selection from compatibility table.

2.3.1 Housing

Block housing in steel (standard model phosphate plated, other metallic platings on request) or stainless steel (sleeve type housing) with test certificate to DIN 50049.

= units stocked in Australia

Technical Details *(cont.)*

2.3.2 Ball

Steel - chromed = standard Brass and stainless steel for improved corrosion protection and aggressive media.

2.3.3 Spindle

Steel = standard

Brass and stainless steel for improved corrosion protection and aggressive media.

2.3.4 Ball Seal

Polyacetal = standard for high pressures (max. 500 bar) Temperature range - 20°C to 100°C.

Nitrile for gaseous and max. pressures up to 100 bar. Temperature range - 20°C to 100°C.

PTFE for pressures up to 100 bar, aggressive media . Temperature range - 20°C to 100°C.

2.3.5 Control Spindle Seal

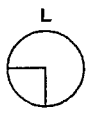
Nitrile = standard up to 500 bar Temperature range : - 20°C to 100°C.

PTFE for pressures up to 100 bar and aggressive media. Temperature range : - 20°C to 250°C.

Viton for many aggressive media. Temperature range : - 20°C to 200°C.

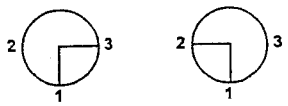
EPDM O-rings for hot water, brake and HFC fluids, not suitable for mineral oil.
Temperature range : - 20°C to 180°C..

2.3.6 Ball Bores



2.3.7 Switching Diagram

The valves are only sealed on ports 2 and 3.
Pressure inlet by port 1 only.
Pressure can be diverted to either port 2 or 3. When ressure is diverted no pressure should be locked in opposite port line as this will cause leakages.

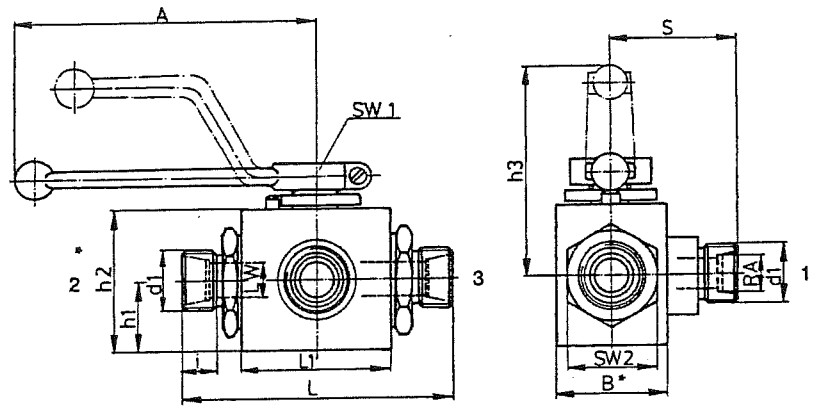


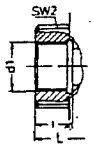
2.3.8 Handle

Handles in aluminium, anodised and stained red.

Cranked steel handles (zinc-plated) are also available on request.

Dimensions 3 way ball valve type G





Thread details Type G BSPP

= units stocked in Australia

Type of connection	DN	LW	PN	RA	d1	i	L	L1	B*	h1	h2	h3	SW1	SW2	A	S	Weight (kg)	Type Code
Internal thread DM 259 (ISO 228/1)	4	4	500	-	G 1/8	10	69	35	25	13	35	73	9	24	150	35	0.40	KHB3K-G1/8
	6	6	500	-	G 1/4	14	69	35	25	13	35	73	9	24	150	35	0.40	KHB3K-G1/4
	10	10	400	-	G 3/8	14	72	42	32	17	40	73	9	27	150	36	0.60	KHB3K-G3/8
Type G	12	12	400	-	G 1/2	16	83	47	35	17	40	73	9	32	150	40	0.70	KHB3K-G1/2 - SW9
	16	16	315	-	G 1/2	16	83	47	38	19	45	85	12	32	175	42	0.8	KHB3K-G1 1/2
	20	20	315	-	G 3/4	18	95	60	48	25	57	95	14	41	200	48	1.50	KHB3K-G3/4
	25	25	250	-	G1	20	113	65	58	29	64	98	14	50	200	57	2.20	KHB3K-G 1

Note:
All details in this brochure are subject to technical modifications

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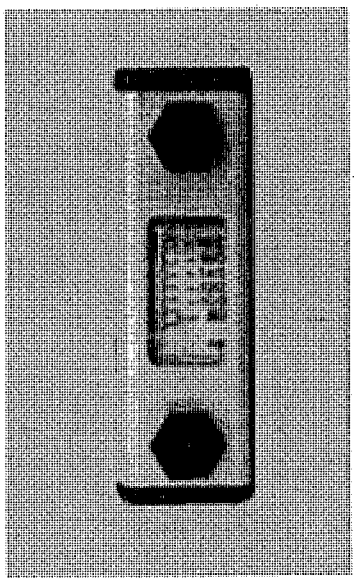
HYDAC Products

RAU30 13/02.96

Fluid Level Gauge Type FSA and FSK

Rexroth Bosch Group Pacific

1.Description



1.1 **Fluid Level Gauge FSA**

Fluid level gauges are available in five sizes with the option of built-in thermometer or temperature gauge for use on hydraulic tanks, lubrication, cooling, cutting oil tanks and gear boxes.

Suitable for use with mineral oil, water-oil emulsions and synthetic fluids such as phosphate-ester based hydraulic fluids. For other fluids contact our sales/technical department.

On fluid level gauges with thermometer the oil temperature is shown in degrees Centigrade and degrees Fahrenheit.

1.2 **Fluid Level Control FSK**

This device automatically monitors the level of fluid.

When the level drops below a certain point a contact is actuated, either a normally closed contact (type O) or a normally open contact (type C).

Available in four sizes, with temperature gauge if required. Upper viscosity limit is 2000 mm²/sec.

Same tank mounting and applications as for FSA.

1.3 **Thermo Switch TS**

Monitoring of the oil temperature in hydraulic tanks. The switch opens when the nominal temperature is reached.

The switch-on temperature is approx. 20 K below the nominal temperature. Application temperature: - 20°C to + 80°C.

1.4 Not suitable for water glycol.

Ordering Code: Fluid Level Gauge FSA

FSA 76 1 . 1 / T 12

Fluid level control

Size

76

127

176

254

381

Size = centre distance of bolts

Material : Seals

1 = Perbunan

2 = Viton

Modification Number

Thermometer

T = in the sight glass

FT 200 = temperature guage 200mm long

FT 300 = temperature guage 300 mm long

Banjo bolt thread

M12 (standard)

= units stocked in Australia

Ordering Code: Fluid Level Gauge FSK

Specifications

2.1 General

2.1.1 **Designation**

Fluid level control FSK
Fluid level gauge FSA
Thermo-switch TS

2.1.2 **Model Code**
(also order example)

FSK 127 2 . 2 / C / FT 200 / 12

Fluid level control
Size
127
176
254
381
Size = centre distance of bolts
Material : Seals
2 = Viton
Modification Number
Electrical Function
C closes at min. level
O opens at min. level
Thermometer
Temperature gauge
FT 200 = 200mm long
FT 300 = 300 mm long
Banjo bolt thread
M12 (standard)

= units stocked in Australia

Ordering Code: Thermo Switch TS

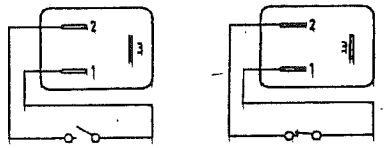
TS 70 / M 12

Thermo-switch
Nominal Temperature
50°C
60°C
70°C
80°C
Banjo Bolt Thread
M12 (standard)

Electrical Specification

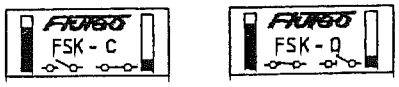
2.1.3. Electrical connection FSK
Electrical function

Type C Type O

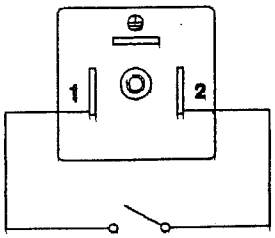


Switching Power: max 8 W
Switching Voltage : 50 V AC/DC
Switching Current : 0.2 A
Terminal 3 not connected

Type C Type O



2.14 Electrical connections TS
Electrical function



Terminal 3 not connected
Switching power : 10 A / 50V - 10 switching operations 2.5A / 50V - 10,000 switching operations 0.5A / 50V - 100,000 switching operations minimum current : 50 mA

2.1.5 Mounting

FSK/FSA

Two banjo bolts M12 (standard) or M10. The mounting holes can either be tapped M12 or M10 or clearance holes drilled to 13 or 11 mm diameter. Tightening torque of the screws max. 10Nm (1 mkp)/

2.1.6 Mounting TS

The thermo switch is fitted to the FSA or FSK instead of the lower banjo bolt

2.2 HYDRAULIC DATA

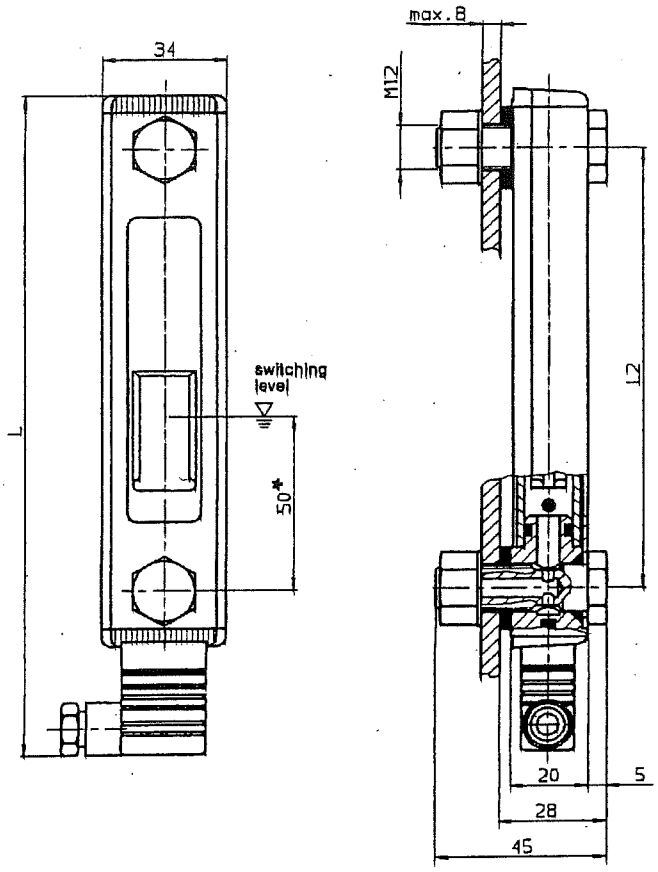
2.2.1 Temperature rang
FSK/FSA - 20°C .... + 80°C

2.2.2 Permissible tank pressure FSK/FSA
max. 1 bar

2.2.3 Temperature gauge range FSK/FSA

Thermometer model T
+ 20°C .... + 80°C (FSA only)
Thermometer model FT
0°C ..... + 100°C.

3. Dimensions
FSK

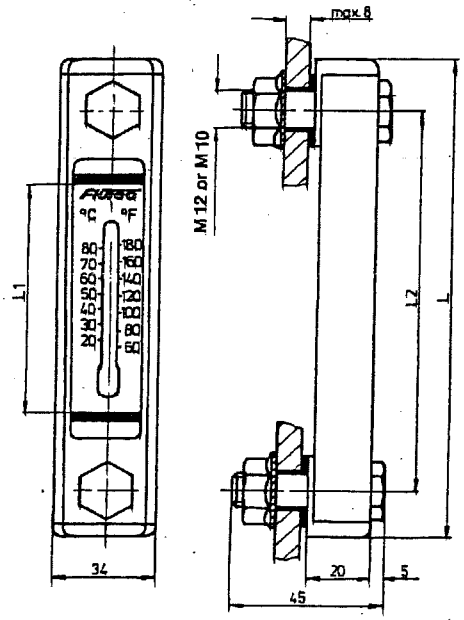


Size	L	L2
127	205	127
176	254	176
254	332	254
381	464	381

* depending on medium and temperature

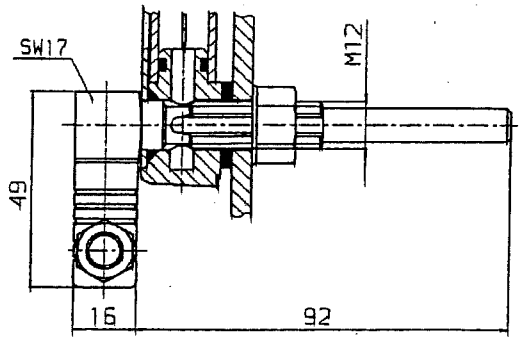
Dimensions and Spare Parts

FSA



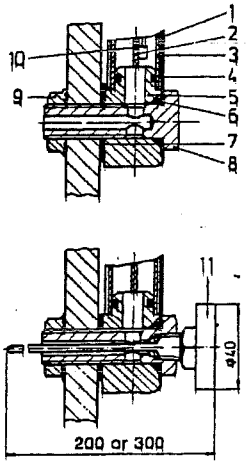
Size		L1	L2
76	108	37	76
127	159	76	127
176	208	125	176
254	286	203	254
381	413	330	381

TS

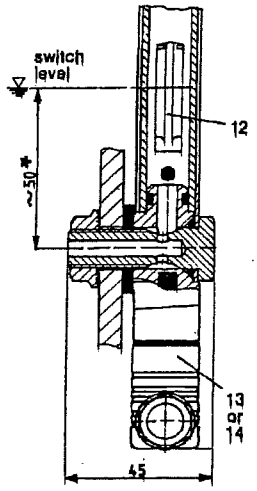


Note:
All details in this brochure are subject to technical modifications

FSA



FSK



Item	Description
1	Housing
2	Name plate
3	Tube
4	O-ring 13 X 2.45
5	End cap
6	O-ring 12.3 X 2.4
7	Washer
8	Banjo bolt
9	Hexagonal nut
10	Thermometer in the sight glass
11	Temperature gauge
12	Magnetic float
13	Base assembly with type C switch
14	Base assembly with type O switch

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MANNESMANN REXROTH

Check valve type S

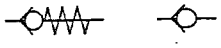
Sizes 6 to 30 | up to 315 bar | up to 450 L/min

RE 20 375/06.97

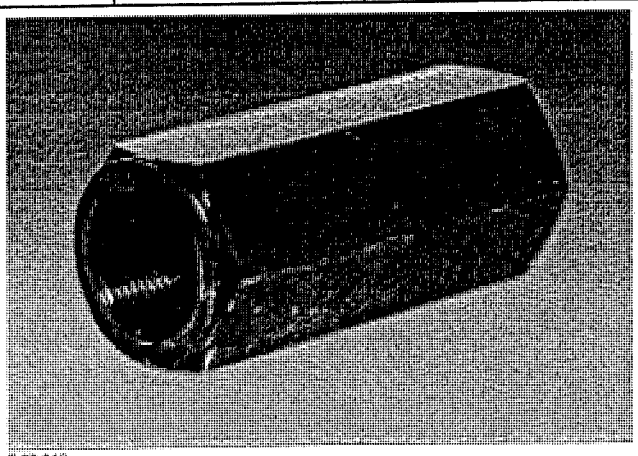
Replaces: 10.95

Features:
- For threaded connection (screw-in connection)
- Leakage-free closure in one direction
- Various cracking pressures, optional (see ordering details)

Symbols



(without spring)



F 87 018

Ordering details

S		A	•	/ *

Further details in clear text

0 = Revision index (defined by the factory)

Nominal size 6	= 6	
Nominal size 8	= 8	
Nominal size 10	= 10	
Nominal size 15	= 15	
Nominal size 20	= 20	
Nominal size 25	= 25	
Nominal size 30	= 30	
For threaded connection	= A	

0 =	without spring	Cracking pressure see characteristic curves, page 2
1 =	standard	
2 =		
3 =		
5 =		

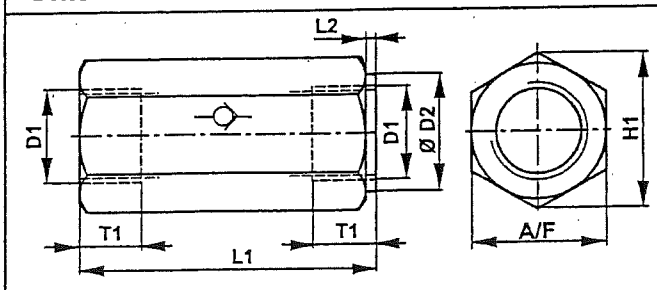
Technical data (for applications outside these parameters, please consult us!)

Max. operating pressure	bar	315
Cracking pressure		see characteristic curve, page 2
Maximum flow		see characteristic curve, page 2
Pressure fluid		Mineral oil (HL, HLP) to DIN 51 524; Fast bio-degradable pressure fluids to VDMA 24 568 (also see RE 90 221); HTEG (rape seed oil); HEPG (polyglycol); HEES (synthetic ester); other fluids on request
Pressure fluid - temperature range	°C	– 30 to + 80
Viscosity range	mm^2/s	2.8 to 500
Degree of contamination		Maximum permissible degree of contamination of the fluid is to NAS 1638 class 9. We, therefore, recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$.

		Size 6	Size 8	Size 10	Size 15	Size 20	Size 25	Size 30
Weight	kg	0.1	0.2	0.3	0.5	1.0	2.0	2.5

Unit dimensions

(Dimensions in mm)



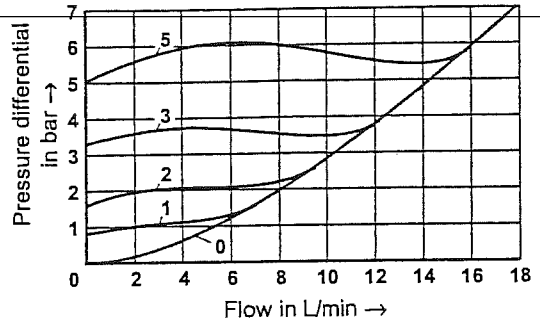
Pipe thread "G" to ISO 228/1

	Size 6	Size 8	Size 10	Size 15	Size 20	Size 25	Size 30
D1	G 1/4	G 3/8	G 1/2	G 3/4	G 1	G 1 1/4	G 1 1/2
ØD2	19	24	30	36	46	60	65
H1	22	28	34.5	41.5	53	69	75
L1	58	58	72	85	98	120	132
L2	2	2	2	2	2	2	2
T1	12	12	14	16	18	20	22
A/F	19	24	30	36	46	60	65

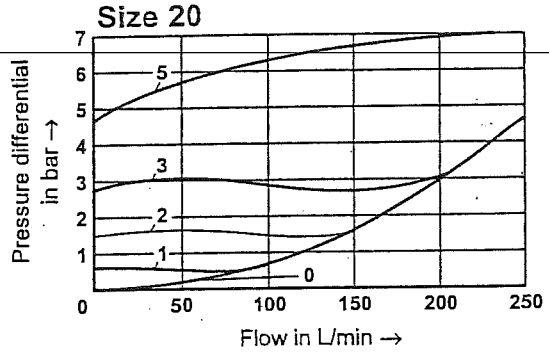
RE 20 375/07.86

Characteristic curves (measured at ν = 41 mm²/s and ϑ = 50 °C)

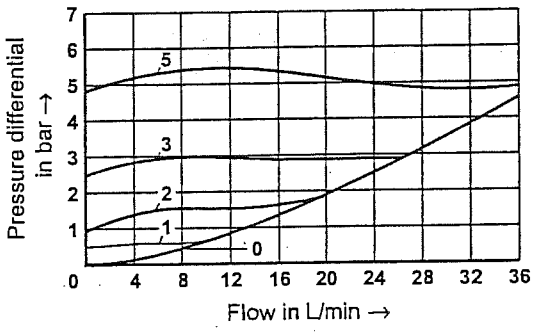
Size 6



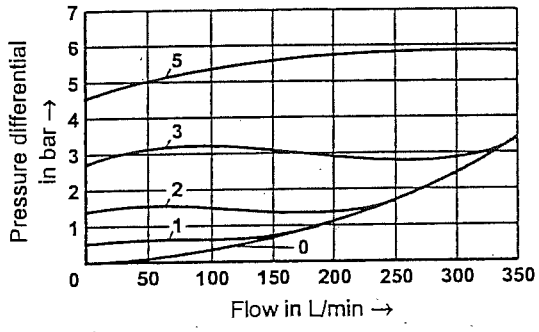
Size 20



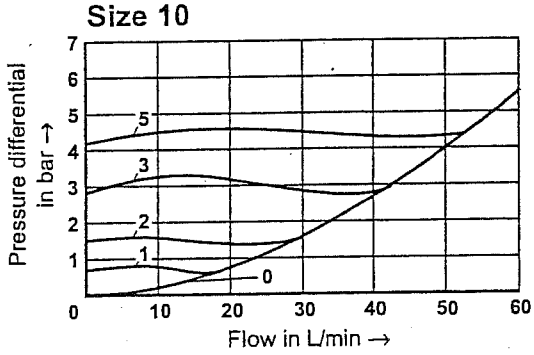
Size 8



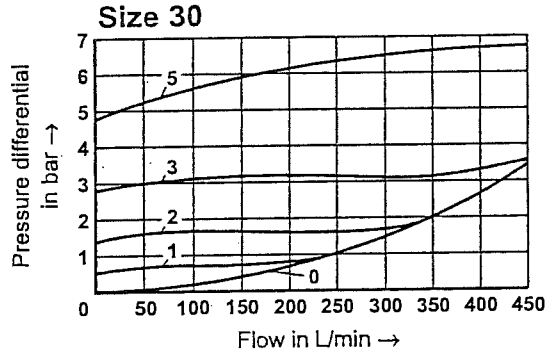
Size 25



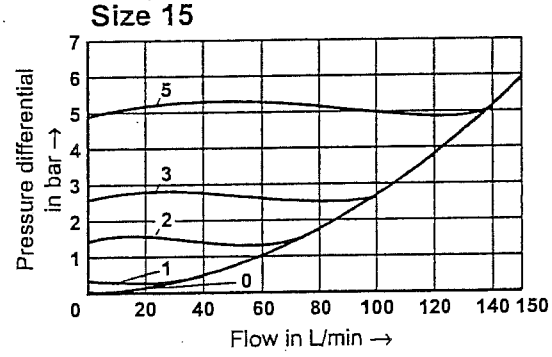
Size 10



Size 30



Size 15



Pressure differential Δp related to flow q_V at cracking pressure

Mannesmann Rexroth GmbH
D-97813 Lohr am Main
Jahnstraße 3-5 • D-97816 Lohr am Main
Telefon 0 93 52 / 18-0 • Telefax 0 93 52 / 18-10 40
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Mannesmann Rexroth Limited
Cromwell Road, St. Neots,
Huntingdon, Cambs. PE19 2ES
Tel: (01480) 476041
Fax: (01480) 219052

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MANNESMANN REXROTH

Pressure Line Filters Types LF and DF

RE 50 075/10.95

Sizes 30 to 660 | up to 420 bar

Replaces: 31 278

Pressure filters, types DF and LF are used in hydraulic systems for separating solids from the fluid being used.

They are suitable for pipe mounting.

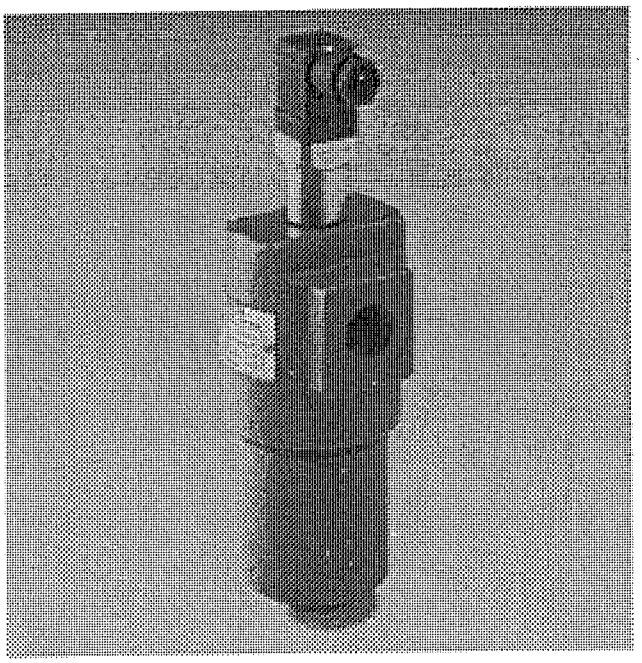
Filter elements:

Betamicron® disposable element (BH/HC, BN/HC) based on inorganic fibres

- Outstanding absorption of the finest particles over a wide differential pressure range
- Large specific absorption area leads to high contamination retention capacity
- Good chemical resistance due to use of epoxy resins for impregnation and bonding
- High burst resistance gives protection against element damage (e.g. during cold starts and high switching pressure peaks)
- Water and water traces in the hydraulic fluid does not impair the filtration capability
- Filtration 3 µm, 5 µm, 10 µm, and 20 µm absolute

Wire mesh element (W)

- Corrosion protection due to use of stainless steel filter material and galvanized steel parts
- High reliable pressure differential
- Cleanable (surface filter)
- High permissible temperature range
- Filtration 25 µm, nominal (further filtration ratings on request)



H/S/101
Pressure filter, type DF...G..
with electrical clogging indicator

Functional description, section

Filter types **LF** and **DF** are pressure filters, suitable for direct mounting in pressure lines. They are generally fitted upstream of sensitive closed and open loop control devices.

They basically comprise filter head (1), screw-in filter housing (2), filter element (3) clogging indicator (4) and optional bypass valve (5).

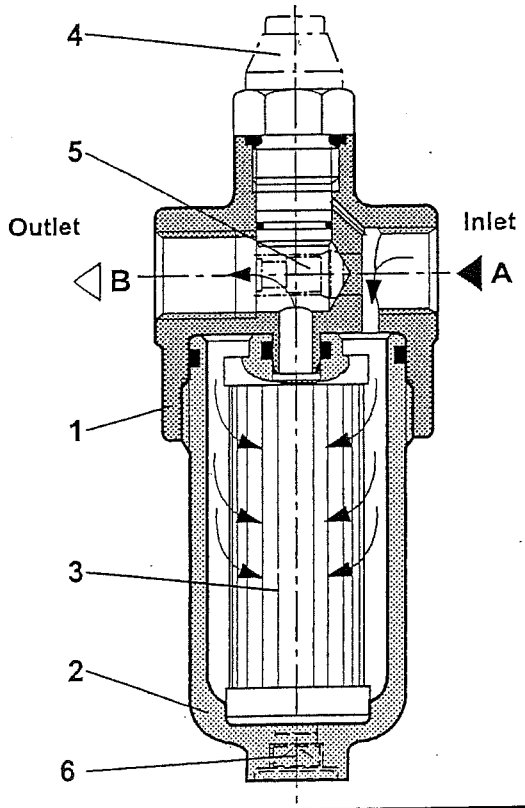
Sizes 330, 500 and 660 are supplied as standard with pressure release and oil drain screws (6).

Flow flows through port A to filter element (3) and is filtered according to the filtration rating. The contaminant particles which have been filtered out of the fluid remain in filter housing (2) and filter element (3). The filtered fluid then flows into the hydraulic circuit again via port B.

The filter housing and associated elements are designed to safely absorb pressure peaks. These peaks may occur, for example, due to the accelerated oil flow resulting from a large control valve being opened suddenly.

The pressure filters may be fitted with an optional bypass valve (check valve). The bypass valve opens when a pressure differential of 6 bar is reached.

The basic pressure filter has no clogging indicator (4). However, an optional optical and/or electrical clogging indicator may be fitted.



E 50 075/10.95

Ordering code for pressure filter

FILTER | | | | | | | | 1 • X | | | | | | | | *

Line filter = LF
High pressure filter = DF

Betamicron®-H-element = BH/HC
Betamicron®-N-element = BN/HC
Wire mesh element = W

Size	30	= 030
Size	60	= 060
Size	110	= 110
Size	140 (only type DF)	= 140
Size	160	= 160
Size	240	= 240
Size	280 (only type DF)	= 280
Size	330	= 330
Size	500 (only type DF)	= 500 [1]
Size	660	= 660

Threaded connection = G
Flanged connection = F
(only type DF 330, DF 500 and DF 660)

Filter rating

3 µm =	for Betamicron®-H-element and Betamicron®-N-element absolute filter rating	= 03
5 µm =		= 05
10 µm =		= 10
20 µm =		= 20
25 µm =	for wire mesh (W) nominal filter rating	= 25

No code = NBR seals, filter suitable for mineral oil (HL, HLP) to DIN 51 524
V = FPM seals, filter suitable for phosphate ester (HFD-R)
W = NBR seals, filter suitable for oil-in-water emulsion(HFA), water glycol (HFC) (only type DF)

L 24 = Lamp for 24 Volt
L 48 = Lamp for 48 Volt
L 110 = Lamp for 110 Volt
L 220 = Lamp for 220 Volt
LED = 2 off 24 Volt LEDs
(only for clogging indicator "D")

X = Series 0 to 9

1 = Standard connections

Clogging indicator (models A, B, C and D)
For ordering codes see symbols on page 6

No code = **without** bypass valve
B6 = **with** bypass valve

No code = Threaded connections to ISO 228

Further details in clear text

[1]) Fitted as standard with a pressure release screw and oil drain screw (see page 1, item 6)

Ordering code for filter element

FILTERELEMENT | | D | | | |

Size	30	= 0030
Size	60	= 0060
Size	110	= 0110
Size	140 (only type DF)	= 0140
Size	160	= 0160
Size	240	= 0240
Size	280 (only type DF)	= 0280
Size	330	= 0330
Size	500 (only type DF)	= 0500
Size	660	= 0660

Filter rating

3 µm	For Betamicron®-H-element and Betamicron®-N-element absolute filtration	= 03
5 µm		= 05
10 µm		= 10
20 µm		= 20
25 µm	For wire mesh (W) nominal filtration	= 25

No code = NBR seals, filter suitable for mineral oil (HL, HLP) to DIN 51 524
V = FPM seals, filter suitable for phosphate ester (HFD-R)
W = NBR seals, filter suitable for oil-in-water emulsion(HFA), water glycol (HFC)

BH/HC = Betamicron®–H–element
BN/HC = Betamicron®–N–element
W = Wire mesh element (not available from stock)

Preferred filter types (line filter, type LF)

Filter element (Filter material)	Filter size	Filter rating in µm	Type code	Order No.
Betamicron® -N-element (BN/HC)	30	10	FILTER LFBN/HC 030 G 10 A 1.X	543 550
			FILTER LFBN/HC 030 G 10 A 1.X/–B6	432 488
			FILTER LFBN/HC 030 G 10 B 1.X	543 551
			FILTER LFBN/HC 030 G 10 B 1.X/–B6	432 495
			FILTER LFBN/HC 030 G 10 C 1.X	543 552
			FILTER LFBN/HC 030 G 10 C 1.X/–B6	432 496
			FILTER LFBN/HC 030 G 10 D 1.X/LED	543 555
			FILTER LFBN/HC 030 G 10 D 1.X/LED–B6	543 586
			FILTER LFBN/HC 030 G 10 D 1.X/L 220	543 553
			FILTER LFBN/HC 030 G 10 D 1.X/L 220–B6	432 498
			FILTER LFBN/HC 030 G 10 D 1.X/L24	543 554
			FILTER LFBN/HC 030 G 10 D 1.X/L 24–B6	432 502
	60	10	FILTER LFBN/HC 060 G 10 A 1.X	543 556
			FILTER LFBN/HC 060 G 10 A 1.X/–B6	432 503
			FILTER LFBN/HC 060 G 10 B 1.X	543 557
			FILTER LFBN/HC 060 G 10 B 1.X/–B6	432 504
			FILTER LFBN/HC 060 G 10 C 1.X	543 558
			FILTER LFBN/HC 060 G 10 C 1.X/–B6	432 505
			FILTER LFBN/HC 060 G 10 D 1.X/LED	543 561
			FILTER LFBN/HC 060 G 10 D 1.X/LED–B6	543 587
			FILTER LFBN/HC 060 G 10 D 1.X/L220	543 559
			FILTER LFBN/HC 060 G 10 D 1.X/L220–B6	432 508
			FILTER LFBN/HC 060 G 10 D 1.X/L24	543 560
			FILTER LFBN/HC 060 G 10 D 1.X/L24–B6	432 509
	110	10	FILTER LFBN/HC 110 G 10 A 1.X	543 562
			FILTER LFBN/HC 110 G 10 A 1.X/–B6	432 511
			FILTER LFBN/HC 110 G 10 B 1.X	543 563
			FILTER LFBN/HC 110 G 10 B 1.X/–B6	432 513
			FILTER LFBN/HC 110 G 10 C 1.X	543 564
			FILTER LFBN/HC 110 G 10 C 1.X/–B6	432 515
			FILTER LFBN/HC 110 G 10 D 1.X/LED	543 567
			FILTER LFBN/HC 110 G 10 D 1.X/LED–B6	543 588
			FILTER LFBN/HC 110 G 10 D 1.X/L220	543 565
			FILTER LFBN/HC 110 G 10 D 1.X/L 220–B6	432 516
			FILTER LFBN/HC 110 G 10 D 1.X/L24	543 566
			FILTER LFBN/HC 110 G 10 D 1.X/L 24–B6	432 517
	160	10	FILTER LFBN/HC 160 G 10 A 1.X	543 568
			FILTER LFBN/HC 160 G 10 A 1.X/–B6	432 521
			FILTER LFBN/HC 160 G 10 B 1.X	543 569
			FILTER LFBN/HC 160 G 10 B 1.X/–B6	432 523
			FILTER LFBN/HC 160 G 10 C 1.X	543 570
			FILTER LFBN/HC 160 G 10 C 1.X/–B6	432 524
			FILTER LFBN/HC 160 G 10 D 1.X/LED	543 573
			FILTER LFBN/HC 160 G 10 D 1.X/LED–B6	543 589
			FILTER LFBN/HC 160 G 10 D 1.X/L 220	543 571
			FILTER LFBN/HC 160 G 10 D 1.X/L 220–B6	432 529
			FILTER LFBN/HC 160 G 10 D 1.X/L 24	543 572
			FILTER LFBN/HC 160 G 10 D 1.X/L 24–B6	432 536
	240	10	FILTER LFBN/HC 240 G 10 A 1.X	543 574
			FILTER LFBN/HC 240 G 10 A 1.X/–B6	432 538
			FILTER LFBN/HC 240 G 10 B 1.X	543 575
			FILTER LFBN/HC 240 G 10 B 1.X/–B6	432 539
			FILTER LFBN/HC 240 G 10 C 1.X	543 576
			FILTER LFBN/HC 240 G 10 C 1.X/–B6	432 540
			FILTER LFBN/HC 240 G 10 D 1.X/LED	543 579
			FILTER LFBN/HC 240 G 10 D 1.X/LED–B6	543 590
			FILTER LFBN/HC 240 G 10 D 1.X/L 220	543 577
			FILTER LFBN/HC 240 G 10 D 1.X/L 220–B6	432 544
			FILTER LFBN/HC 240 G 10 D 1.X/L 24	543 578
			FILTER LFBN/HC 240 G 10 D 1.X/L 24–B6	432 545
	330	10	FILTER LFBN/HC 330 G 10 A 1.X	543 580
			FILTER LFBN/HC 330 G 10 A 1.X/–B6	432 547
			FILTER LFBN/HC 330 G 10 B 1.X	543 581
			FILTER LFBN/HC 330 G 10 B 1.X/–B6	432 548
			FILTER LFBN/HC 330 G 10 C 1.X	543 582
			FILTER LFBN/HC 330 G 10 C 1.X/–B6	432 552
			FILTER LFBN/HC 330 G 10 D 1.X/LED	543 585
			FILTER LFBN/HC 330 G 10 D 1.X/LED–B6	543 591
			FILTER LFBN/HC 330 G 10 D 1.X/L 220	543 583
			FILTER LFBN/HC 330 G 10 D 1.X/L 220–B6	432 553
			FILTER LFBN/HC 330 G 10 D 1.X/L 24	543 584
			FILTER LFBN/HC 330 G 10 D 1.X/L 24–B6	432 554

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Preferred filter types (line filter type LF)

Filter element (Filter material)	Filter size	Filter rating in µm	Type code	Order No.
Betamicron ® -H-element (BH/HC)	30	10	FILTER LFBH/HC 030 G 10 A 1.X	432 564
			FILTER LFBH/HC 030 G 10 B 1.X	432 566
			FILTER LFBH/HC 030 G 10 C 1.X	432 569
			FILTER LFBH/HC 030 G 10 D 1.X/LED	543 592
			FILTER LFBH/HC 030 G 10 D 1.X/L 220	432 570
			FILTER LFBH/HC 030 G 10 D 1.X/L 24	432 573
	60	10	FILTER LFBH/HC 060 G 10 A 1.X	432 575
			FILTER LFBH/HC 060 G 10 B 1.X	432 576
			FILTER LFBH/HC 060 G 10 C 1.X	432 578
			FILTER LFBH/HC 060 G 10 D 1.X/LED	543 593
			FILTER LFBH/HC 060 G 10 D 1.X/L 220	432 579
			FILTER LFBH/HC 060 G 10 D 1.X/L 24	432 581
	110	10	FILTER LFBH/HC 110 G 10 A 1.X	432 584
			FILTER LFBH/HC 110 G 10 B 1.X	432 586
			FILTER LFBH/HC 110 G 10 C 1.X	432 590
			FILTER LFBH/HC 110 G 10 D 1.X/LED	543 594
			FILTER LFBH/HC 110 G 10 D 1.X/L 220	432 591
			FILTER LFBH/HC 110 G 10 D 1.X/L 24	432 594
	160	10	FILTER LFBH/HC 160 G 10 A 1.X	432 595
			FILTER LFBH/HC 160 G 10 B 1.X	432 597
			FILTER LFBH/HC 160 G 10 C 1.X	432 598
			FILTER LFBH/HC 160 G 10 D 1.X/LED	543 595
			FILTER LFBH/HC 160 G 10 D 1.X/L 220	432 599
			FILTER LFBH/HC 160 G 10 D 1.X/L 24	432 602
	240	10	FILTER LFBH/HC 240 G 10 A 1.X	432 603
			FILTER LFBH/HC 240 G 10 B 1.X	432 609
			FILTER LFBH/HC 240 G 10 C 1.X	432 610
			FILTER LFBH/HC 240 G 10 D 1.X/LED	543 596
			FILTER LFBH/HC 240 G 10 D 1.X/L 220	432 612
			FILTER LFBH/HC 240 G 10 D 1.X/L 24	432 613
	330	10	FILTER LFBH/HC 330 G 10 A 1.X	432 621
			FILTER LFBH/HC 330 G 10 B 1.X	432 622
			FILTER LFBH/HC 330 G 10 C 1.X	432 624
			FILTER LFBH/HC 330 G 10 D 1.X/LED	543 597
			FILTER LFBH/HC 330 G 10 D 1.X/L 220	432 626
			FILTER LFBH/HC 330 G 10 D 1.X/L 24	432 627

Preferred filter types (high pressure filter type DF)

Filter element (Filter material)	Filter size	Filter rating in µm	Type code	Order No.
Betamicron ® -H-element (BH/HC)	30	5	FILTER DFBH/HC 030 G 05 A 1.X	432 628
			FILTER DFBH/HC 030 G 05 B 1.X	432 629
			FILTER DFBH/HC 030 G 05 C 1.X	432 631
			FILTER DFBH/HC 030 G 05 D 1.X/LED	543 538
			FILTER DFBH/HC 030 G 05 D 1.X/L 220	432 634
			FILTER DFBH/HC 030 G 05 D 1.X/L 24	432 636
	60	5	FILTER DFBH/HC 060 G 05 A 1.X	432 637
			FILTER DFBH/HC 060 G 05 B 1.X	432 638
			FILTER DFBH/HC 060 G 05 C 1.X	432 639
			FILTER DFBH/HC 060 G 05 D 1.X/LED	543 540
			FILTER DFBH/HC 060 G 05 D 1.X/L 220	432 640
			FILTER DFBH/HC 060 G 05 D 1.X/L 24	432 643
	110	5	FILTER DFBH/HC 110 G 05 A 1.X	432 646
			FILTER DFBH/HC 110 G 05 B 1.X	432 649
			FILTER DFBH/HC 110 G 05 C 1.X	432 650
			FILTER DFBH/HC 110 G 05 D 1.X/LED	543 542
			FILTER DFBH/HC 110 G 05 D 1.X/L 220	432 651
			FILTER DFBH/HC 110 G 05 D 1.X/L 24	432 653

Preferred filter types (high pressure filter type DF)

Filter element (Filter material)	Filter size	Filter rating in µm	Type code	Order No.
Betamicron® -H-element (BH/HC)	160	5	FILTER DFBH/HC 160 G 05 A 1.X	432 655
			FILTER DFBH/HC 160 G 05 B 1.X	432 657
			FILTER DFBH/HC 160 G 05 C 1.X	432 658
			FILTER DFBH/HC 160 G 05 D 1.X/LED	543 544
			FILTER DFBH/HC 160 G 05 D 1.X/L 220	432 660
			FILTER DFBH/HC 160 G 05 D 1.X/L 24	432 662
	240	5	FILTER DFBH/HC 240 G 05 A 1.X	432 665
			FILTER DFBH/HC 240 G 05 B 1.X	432 667
			FILTER DFBH/HC 240 G 05 C 1.X	432 672
			FILTER DFBH/HC 240 G 05 D 1.X/LED	543 546
			FILTER DFBH/HC 240 G 05 D 1.X/L 220	432 673
			FILTER DFBH/HC 240 G 05 D 1.X/L 24	432 674
	330	5	FILTER DFBH/HC 330 G 05 A 1.X	432 675
			FILTER DFBH/HC 330 G 05 B 1.X	432 676
			FILTER DFBH/HC 330 G 05 C 1.X	432 678
			FILTER DFBH/HC 330 G 05 D 1.X/LED	543 548
			FILTER DFBH/HC 330 G 05 D 1.X/L 220	432 679
			FILTER DFBH/HC 330 G 05 D 1.X/L 24	432 682
Betamicron® -H-element (BH/HC)	30	10	FILTER DFBH/HC 030 G 10 A 1.X	359 918
			FILTER DFBH/HC 030 G 10 B 1.X	457 147
			FILTER DFBH/HC 030 G 10 C 1.X	457 148
			FILTER DFBH/HC 030 G 10 D 1.X/LED	543 539
			FILTER DFBH/HC 030 G 10 D 1.X/L 220	457 149
			FILTER DFBH/HC 030 G 10 D 1.X/L 24	457 150
	60	10	FILTER DFBH/HC 060 G 10 A 1.X	443 680
			FILTER DFBH/HC 060 G 10 B 1.X	464 099
			FILTER DFBH/HC 060 G 10 C 1.X	367 365
			FILTER DFBH/HC 060 G 10 D 1.X/LED	543 541
			FILTER DFBH/HC 060 G 10 D 1.X/L 220	457 151
			FILTER DFBH/HC 060 G 10 D 1.X/L 24	477 095
	110	10	FILTER DFBH/HC 110 G 10 A 1.X	457 152
			FILTER DFBH/HC 110 G 10 B 1.X	457 153
			FILTER DFBH/HC 110 G 10 C 1.X	367 309
			FILTER DFBH/HC 110 G 10 D 1.X/LED	543 543
			FILTER DFBH/HC 110 G 10 D 1.X/L 220	457 155
			FILTER DFBH/HC 110 G 10 D 1.X/L 24	457 159
	160	10	FILTER DFBH/HC 160 G 10 A 1.X	457 160
			FILTER DFBH/HC 160 G 10 B 1.X	359 908
			FILTER DFBH/HC 160 G 10 C 1.X	457 164
			FILTER DFBH/HC 160 G 10 D 1.X/LED	543 545
			FILTER DFBH/HC 160 G 10 D 1.X/L 220	457 195
			FILTER DFBH/HC 160 G 10 D 1.X/L 24	457 196
	240	10	FILTER DFBH/HC 240 G 10 A 1.X	457 197
			FILTER DFBH/HC 240 G 10 B 1.X	369 230
			FILTER DFBH/HC 240 G 10 C 1.X	457 198
			FILTER DFBH/HC 240 G 10 D 1.X/LED	543 547
			FILTER DFBH/HC 240 G 10 D 1.X/L 220	457 202
			FILTER DFBH/HC 240 G 10 D 1.X/L 24	457 203
	330	10	FILTER DFBH/HC 330 G 10 A 1.X	335 656
			FILTER DFBH/HC 330 G 10 B 1.X	457 231
			FILTER DFBH/HC 330 G 10 C 1.X	377 468
			FILTER DFBH/HC 330 G 10 D 1.X/LED	543 549
			FILTER DFBH/HC 330 G 10 D 1.X/L 220	457 232
			FILTER DFBH/HC 330 G 10 D 1.X/L 24	446 273

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Preferred filter types

For a max. permissible pressure differential at the filter element of 30 bar

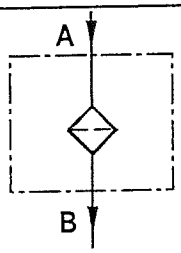
Filter material	Filter size	Filter rating in µm	Type code	Order No.
Betamicron® -N-element (BN/HC)	30	10	FILTER ELEMENT 0030 D 10 BN/HC	017 589
	60		FILTER ELEMENT 0060 D 10 BN/HC	017 590
	110		FILTER ELEMENT 0110 D 10 BN/HC	017 591
	160		FILTER ELEMENT 0160 D 10 BN/HC	017 592
	240		FILTER ELEMENT 0240 D 10 BN/HC	017 593
	330		FILTER ELEMENT 0330 D 10 BN/HC	017 594

For a max. permissible pressure differential at the filter element of 210 bar

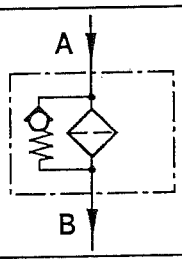
Filter material	Filter size	Filter rating in µm	Type code	Order No.
Betamicron® -H-element (BH/HC)	30	5	FILTER ELEMENT 0030 D 05 BH/HC	013 896
		10	FILTER ELEMENT 0030 D 10 BH/HC	017 600
	60	5	FILTER ELEMENT 0060 D 05 BH/HC	017 595
		10	FILTER ELEMENT 0060 D 10 BH/HC	017 601
	110	5	FILTER ELEMENT 0110 D 05 BH/HC	017 596
		10	FILTER ELEMENT 0110 D 10 BH/HC	017 602
	160	5	FILTER ELEMENT 0160 D 05 BH/HC	017 597
		10	FILTER ELEMENT 0160 D 10 BH/HC	017 603
	240	5	FILTER ELEMENT 0240 D 05 BH/HC	017 598
		10	FILTER ELEMENT 0240 D 10 BH/HC	017 604
	330	5	FILTER ELEMENT 0330 D 05 BH/HC	017 599
		10	FILTER ELEMENT 0330 D 05 BH/HC	017 605

Symbols

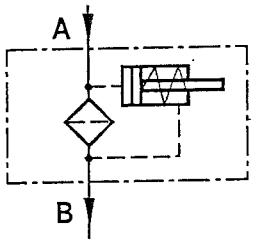
Without bypass valve
Without clogging indicator
ordering code **A**



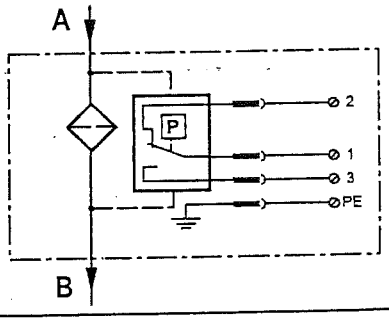
with bypass valve
Without clogging indicator
ordering code **A../..B6**



With **optical** clogging indicator
ordering code **B**

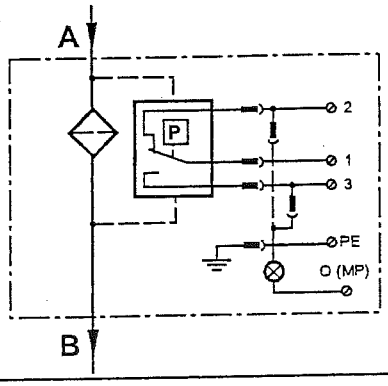


with **electrical** clogging indicator
ordering code **C**
(connector
to DIN 43 650)

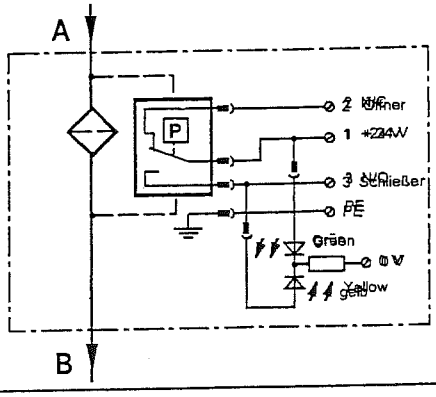


With **optical/electrical** clogging indicator
ordering code **D**
(large connector to
DIN 43 650 with
lamp "L")

The lamp
may be
connected
via a N/O
switch (3) or
a N/C switch
(2).



Ordering code **D...LED**
(large connector
with LEDs)



Technical Data (For operation outside these parameters, please consult us!)

General											
Installation position			Vertical								
Direction of flow			Inlet and outlet on opposite sides at the same height								
Weight	Size		30	60	110	140	160	240	280	330	500	660
	– LF	with element kg	0,8	1,5	1,8	–	3,7	4,3	–	8,2	–	17,8
		without element kg	0,7	1,3	1,5	–	3,2	3,6	–	7,0	–	15,6
	– DF	with element kg	1,9	4,1	6,0	6,6	9,6	11,3	15,9	22,6	26,9	30,5
		without element kg	1,8	3,9	5,7	6,2	9,1	10,6	14,5	21,4	25,2	28,3

Hydraulic				
Filter element		Betamicron® BH/HC	Betamicron® BN/HC	Wire mesh W
Operating pressure	– LF bar	100		
pressure p max.	– DF bar	420		30
Max. pressure differential at filter element bar		210	30	
Total pressure differential of complete filter		see filter selection on page 11		
Pressure differential at bypass valve		see Δp-q_v charateristic curves on page 11		
Bypass valve cracking pressure bar		6 + 10%		
Clogging indicator response pressure bar		5 – 10%		
Pressure fluid		Mineral oil (HL, HLP) to DIN 51 524 Phosphate ester (HFD-R) Oil-in-water emulsion (HFA), Water glycol (HFC)		
Pressure fluid temperature range °C		– 10 to + 100		

Electrical and optical/electrical clogging indicators		
Electrical connections to DIN 43 650		3 pin + PE connection
Cross sectional area of connection mm²		max.1,5
Insulation to DIN 40 050		IP 65
Contact load	AC	5A at 220V ohmic load
	DC	3A at 24V ohmic load
		For DC inductive loads, a spark extinguisher is to be provided in order to lengthen the service life.
Max. switching power with ohmic load		100VA; 60W

Aprrox. filter area in cm² for ...D ...W

Size	W
30	320
60	410
110	760
140	980
160	1000
240	1500
280	3000
330	2000
500	3100
660	4000

True contaminant retainment capacity to ISO 4572 for Betamicron ® -elements

ACFTD retention capacity in g with a Δp = 5 bar

Size	BH/HC			
	3 µm	5 µm	10 µm	20 µm
30	2,5	3,0	3,8	5,0
60	3,5	4,3	5,3	7,1
110	7,7	9,2	11,5	15,4
140	10,2	12,2	15,3	20,0
160	11,6	13,9	17,4	23,0
240	19,1	23,0	29,0	38,0
280	42,0	51,0	64,0	85,0
330	29,0	35,0	43,0	56,0
500	48,0	57,0	72,0	95,0
660	64,0	76,0	95,0	127,0

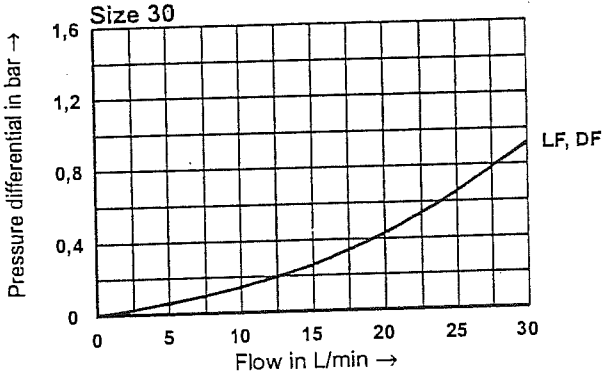
Size	BN/HC			
	3 µm	5 µm	10 µm	20 µm
30	2,9	3,4	4,3	5,7
60	4,3	5,2	6,5	8,6
110	9,4	11,2	14,0	18,7
140	12,4	14,9	18,6	25,0
160	11,9	14,3	17,9	24,0
240	19,6	24,0	29,0	39,0
280	44,0	52,0	66,0	87,0
330	32,0	39,0	48,0	64,0
500	53,0	64,0	80,0	106,0
660	71,0	85,0	106,0	142,0

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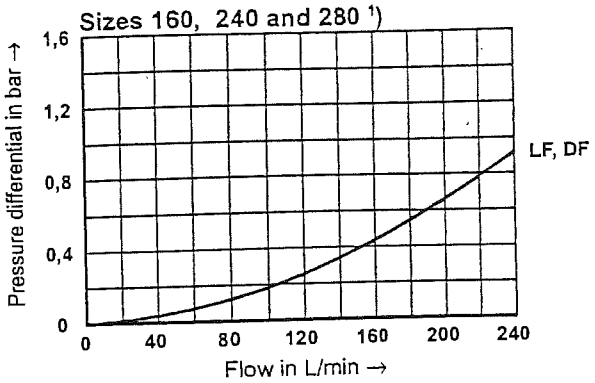
Δp-q_V Filter housing characteristic curves: pressure filter types LF and DF

The filter housing characteristic curves are valid for mineral oil with a density of 0,86 kg/dm³ and kinematic viscosity of 30 mm²/s.
With turbulent flow the pressure differential changes in proportion to the density.
With laminal flow it changes in proportion to the density and viscosity.

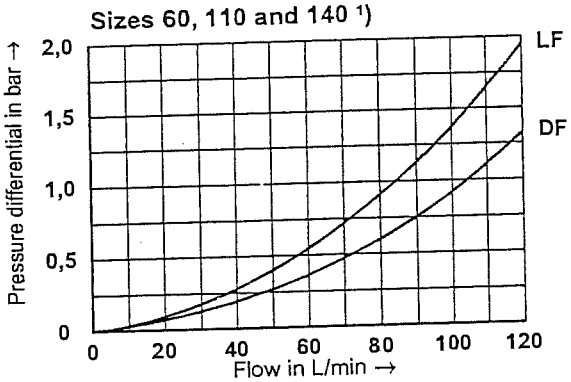
Size 30



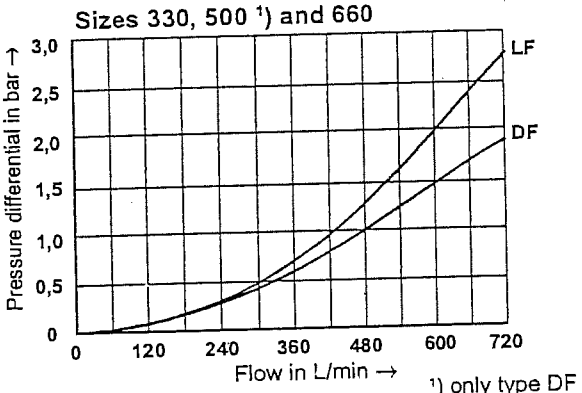
Sizes 160, 240 and 280 [1])



Sizes 60, 110 and 140 [1])



Sizes 330, 500 [1]) and 660

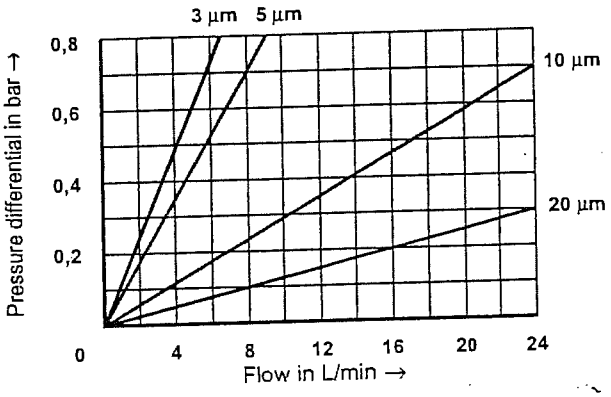


[1]) only type DF

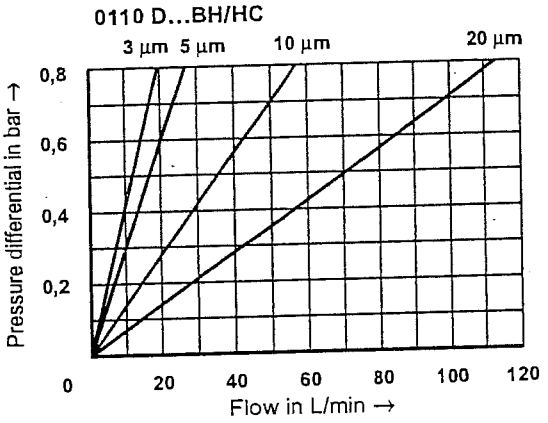
Δp-q_V Filter element characteristic curves

The element curves are valid for mineral oils with a kinematic viscosity of 30 mm²/s.

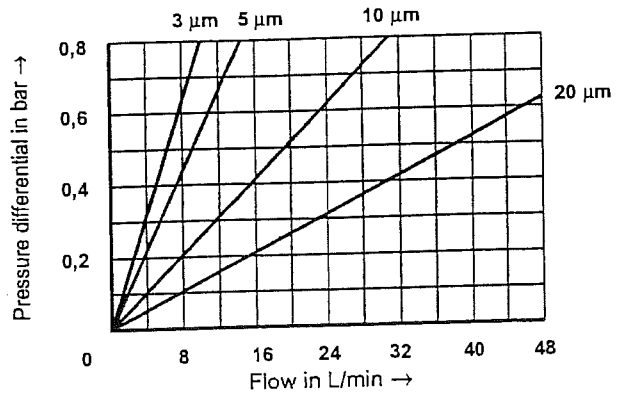
0030 D...BH/HC



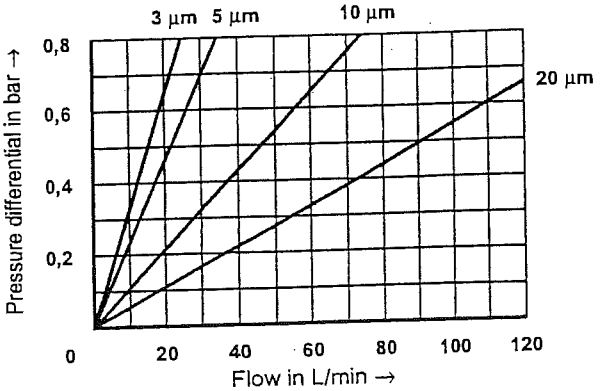
0110 D...BH/HC



0060 D...BH/HC

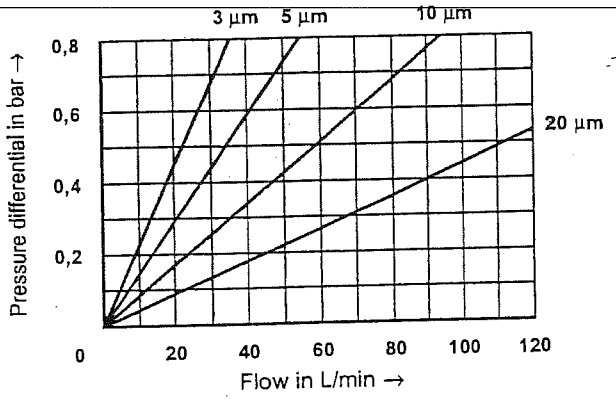


0140 D...BH/HC

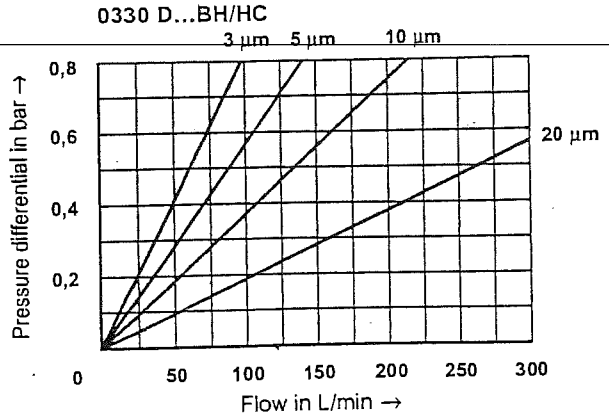


Δp-q_v Filter element characteristic curves

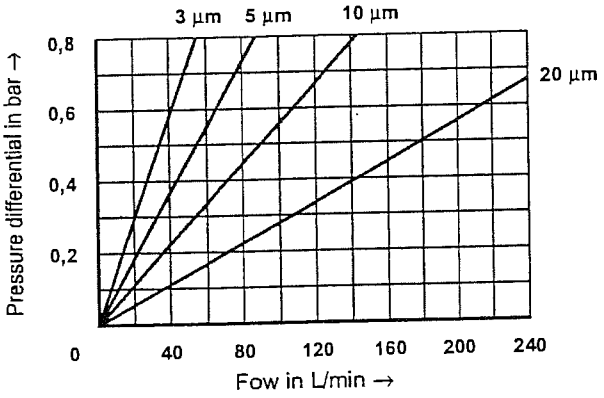
0160 D...BH/HC



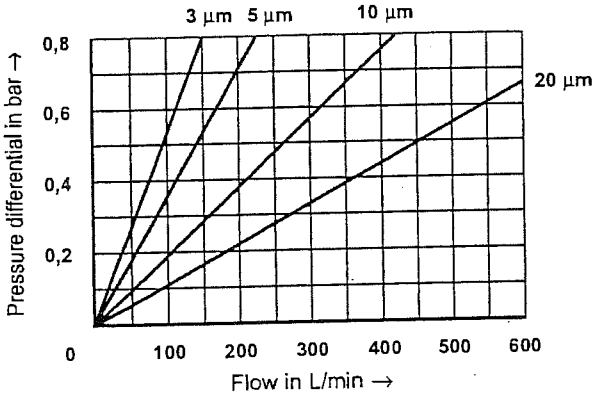
0330 D...BH/HC



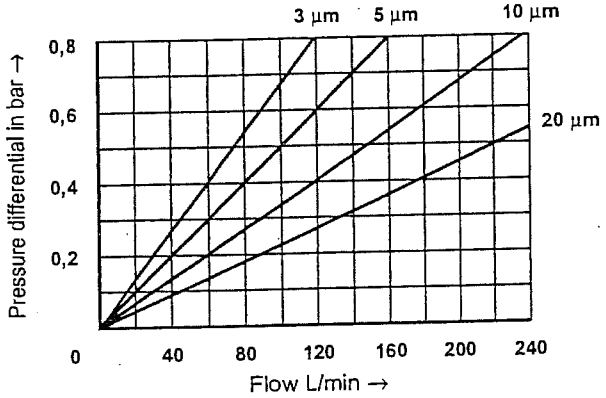
0240 D...BH/HC



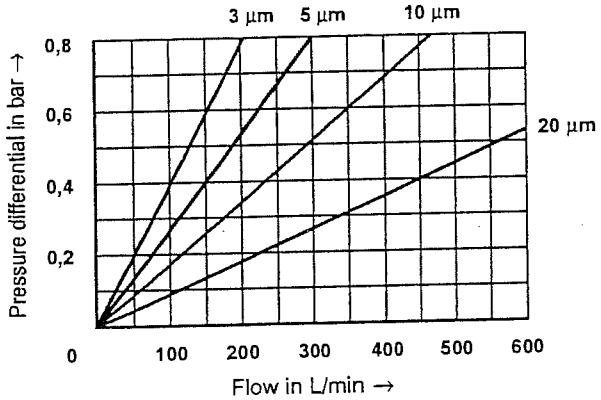
0500 D...BH/HC



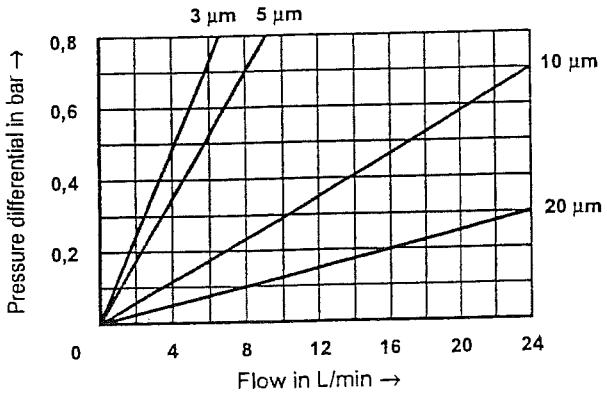
0280 D...BH/HC



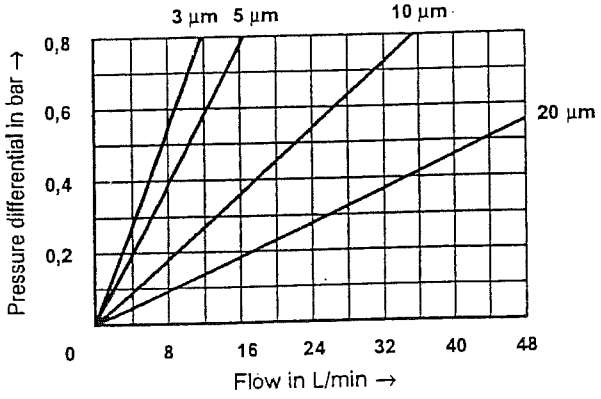
0660 D...BH/HC



0030 D...BN/HC

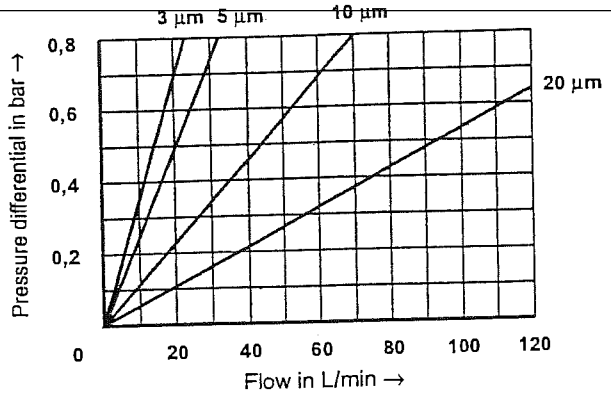


0060 D...BN/HC

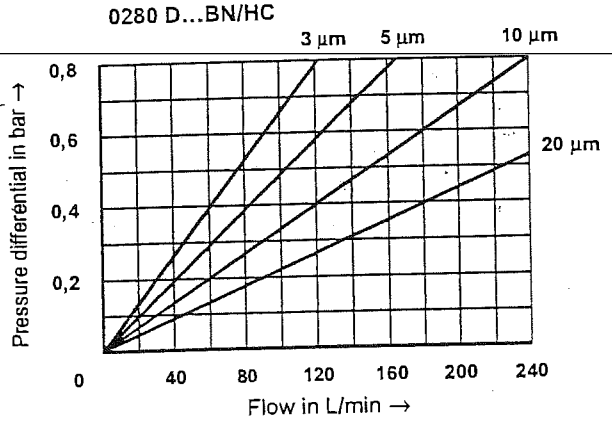


Δp-q_V Filter element characteristic curves

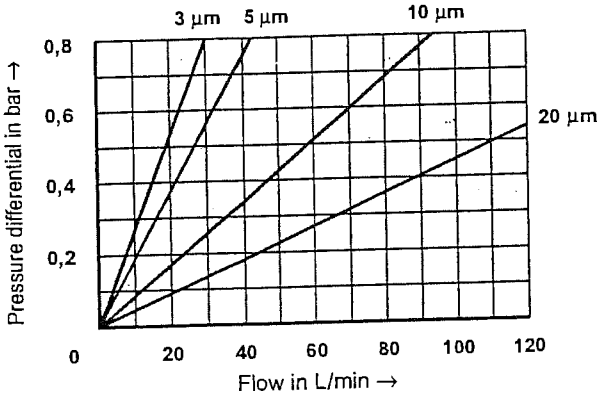
0110 D...BN/HC



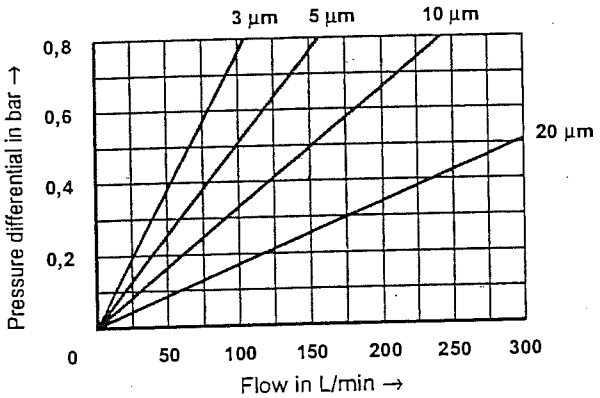
0280 D...BN/HC



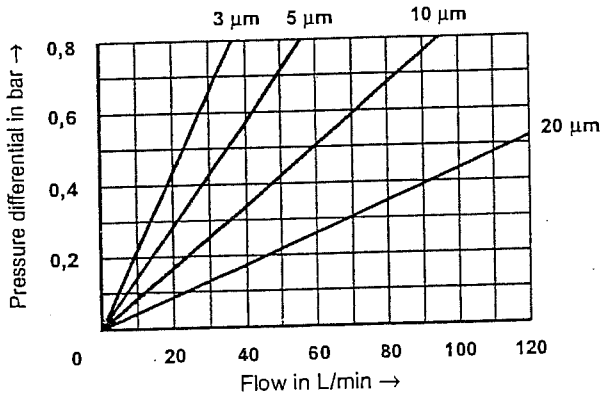
0140 D...BN/HC



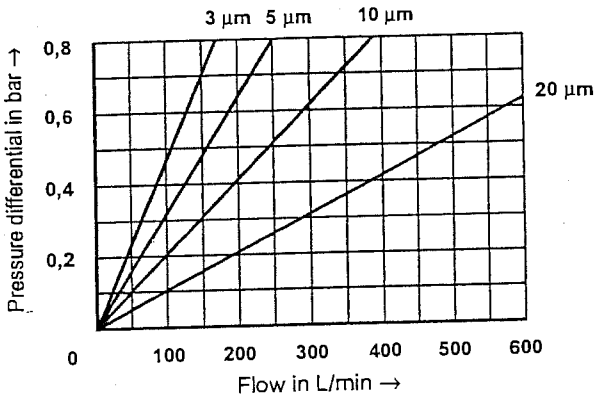
0330 D...BN/HC



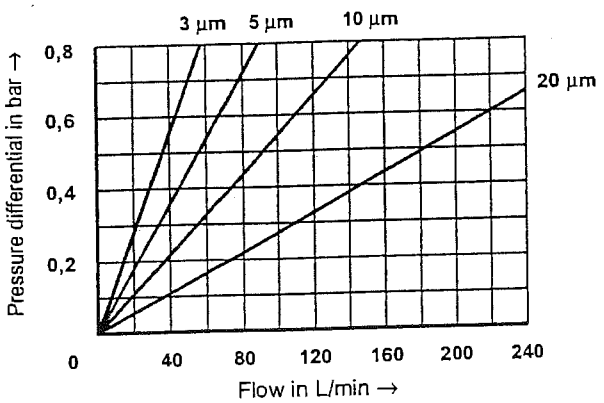
0160 D...BN/HC



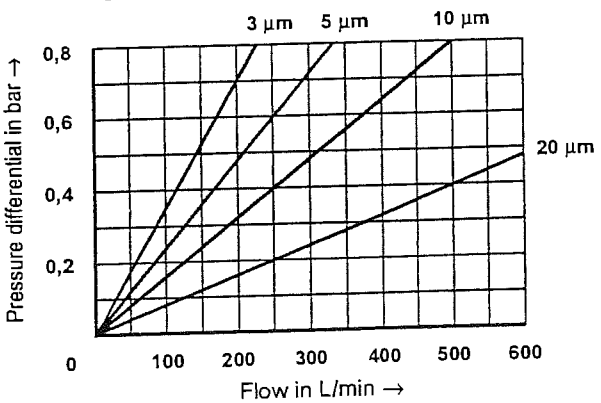
0500 D...BN/HC



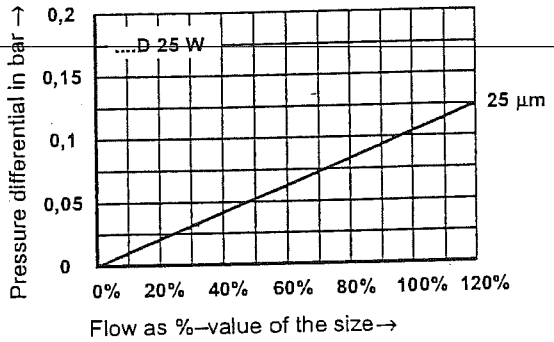
0240 D...BN/HC



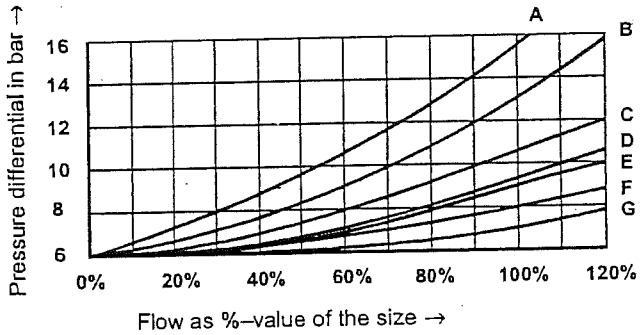
0660 D...BN/HC



Δp-q_V Filter element characteristic curves



Δp-q_V Bypass valve characteristic curve



The bypass valve characteristic curves are valid for mineral oils with a density of 0,86 kg/dm³.

The pressure differential varies in proportion to the density.

A: Sizes 0660 D...
B: Sizes 0500 D...
C: Sizes 0280 D...
D: Sizes 0330 D... and 0140 D...
E: Sizes 0110 D... and 0030 D...
F: Sizes 0240 D...
G: Sizes 0160 D... and 0060 D...

Filter selection

Total pressure differential for complete filter
The total pressure differential under clean conditions is obtained by adding the housing pressure differential to the element pressure differential at operating viscosity.

$$\Delta p_{total} = \Delta p_{housing\ at\ qv} + f \times \Delta p_{element\ at\ qv}$$

Δp_{total} = Total pressure differential for complete filter

$\Delta p_{housing\ at\ qv}$ = Housing pressure differential:
Determined by means of housing characteristic curves, see page 8.

$\Delta p_{element\ at\ qv}$ = Element pressure differential at 30 mm²/s:
Determined by means of element operating element characteristic curves, see pages 8 to 10.

f = Viscosity conversion factor (see diagram)

q_V = Maximum flow in L/min through the filter

Design guidelines

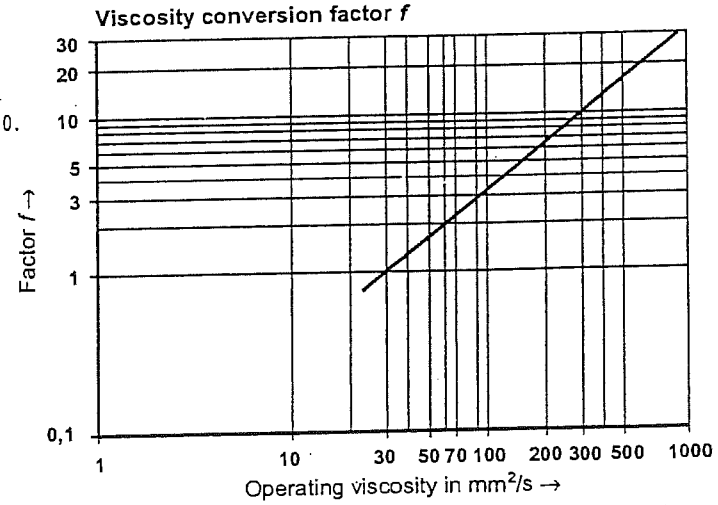
Due to the high contamination retention capacity of Betamicron®-elements, we recommend that the filter (element is clean and at operating viscosity) is selected using the following initial pressure loss:

Δp_{total} = 0,2 x response pressure of clogging indicator

For the response pressure of the clogging indicator see page 7. Other selections are possible depending on the system.

As the filter selection using the given formula takes considerable time, we recommend that the filter size may be initially estimated by using the filter pre-selection nomogram on page 12.

Viscosity conversion factor *f*



Pre-selection nomogram, example

The filter pre-selection nomogram is valid for a viscosity of 30 mm²/s and for normal hydraulic loads and under optimum installation conditions for the following filters:

Filter types: DF, LF
Element types: ...D ...BN/HC and ...D ...BH/HC

The following explains the procedure for the filter pre-selection nomogram.

Example:

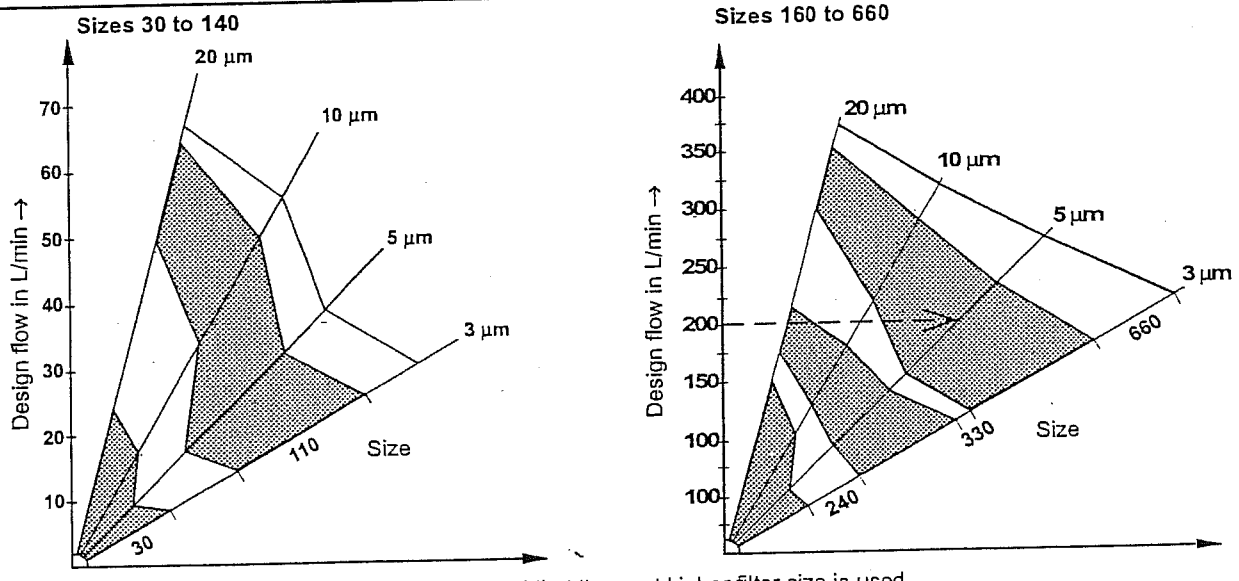
- **System dependant data**
  Variable displacement pump flow — $q_{V\,p}$ = 180 to 250 L/min
  Max. operating pressure: — p_B = 280 bar
  Required filtration: — 5 µm absolute
  Filter material: — BH/HC

- **Procedure:**
  Determination of filter type
  Max. operating pressure: — p_B = 280 bar
  Hence for $p_B \leq p_{max}$ → Filter type: DF filter (see page 7)

- **Determination of required flow $q_{V\,A}$**
  $q_{V\,A}$ = max. flow through the filter
  $q_{V\,A} = q_{V\,p\,max}$ = 250 L/min

- **Determination of filter size:**
  For a design flow of $q_{V\,A}$ = 250 L/min and and a filter rating of 5 µm absolute, this results in a size of 500 which is obtained from the filter pre-selection nomogram
  → Filter type: DF BH/HC 500..05 ...

Filter pre-selection nomogram (for DF- and LF-filters with Betamicron®–elements)



If the selection results in a border value, we recommend that the next higher filter size is used.

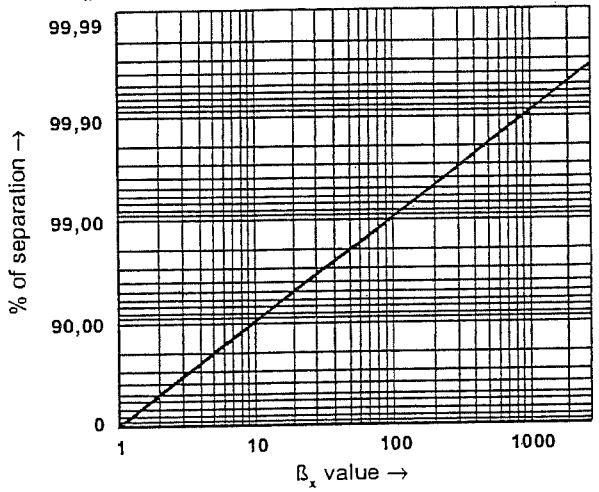
Filter rating oil cleanliness classes

Hyraulic systems	Recommended absolute filter rating x in µm ($\beta_x \geq 100$)	Obtainable cleanliness class [1] to NAS 1638 particles of 5 to 15 µm	Obtainable cleanliness class [1] ISO DIS 4406
Systems with servo valves	3	4 to 5	13/10
Systems with control valves	5	7 to 8	17/13
Systems with proportional valves	10	9	18/14
General hydraulic systems	10 bis 20	9 to 10	18/14

[1] for optimum filter design

Filtration performance

Relationship
Beta value $ß_x$ to degree of separation in %



Contaminate retention capacity for Betamicron®–elements

Absolute contaminate retention capacity

The given data sheet values were determined on the basis of the multi-pass test to ISO 4572 carried out (multi-pass test process for determination and verification of the filter performance, extended to finest filtration) on a test rig.

In this test, the test filter must retain at least 99% of the particles for a given filtration rating and achieve this up to the specified pressure differential. A degree of separation rate of 99% corresponds to a $ß_x$ value of 100 ($ß_x = 100$), which is known as absolute filtration.

Betamicron® elements ensure an absolute filtration over a wide range of pressure differentials.
(See multi-pass filter performance data to ISO 4572)

Multi-pass filter performance data to ISO 4572 for Betamicron®–H–elements (BH/HC)
The relationship of $ß_x$ values to filter element pressure differentials depends on the response pressure of the pressure differential indicator.

Betamicron® element type ...BH/HC Filter rating	Beta values in relation to the filter element pressure differential						
	Filter element Δp in bar	$ß_x = \frac{\text{Number of particles with dimensions > x µm before the filter}}{\text{Number of particles with dimensions > x µm after the filter}}$					
		$ß_2$	$ß_3$	$ß_5$	$ß_{10}$	$ß_{15}$	$ß_{20}$
3 µm	5	40	250	> 2000	> 3000	–	–
	8	36	200	> 2000	> 3000	–	–
	24	34	150	> 500	> 1000	–	–
5 µm	5	12	45	500	> 3000	–	–
	8	12	40	300	> 3000	–	–
	24	10	30	150	> 3000	–	–
10 µm	5	–	–	4	400	> 3000	–
	8	–	–	4	300	> 3000	–
	24	–	–	6	200	> 3000	–
20 µm	5	–	–	–	5	> 50	400
	8	–	–	–	5	> 50	400
	24	–	–	–	7	> 40	200

Multi-pass filter performance data to ISO 4572 for Betamicron®–N–elements (BN/HC)
The relationship of $ß_x$ values to filter element pressure differentials depends on the response pressure of the pressure differential indicator and response pressure of the bypass valve.

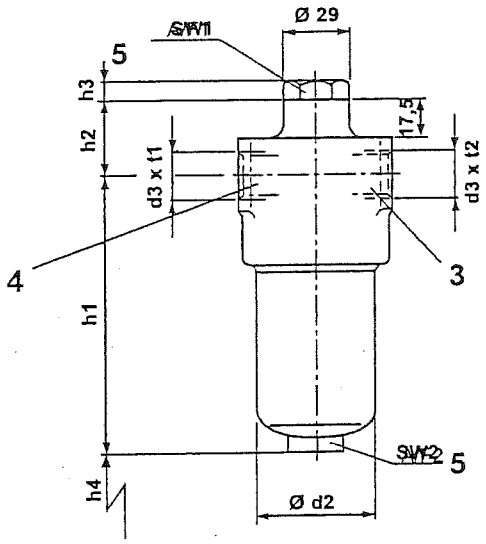
Betamicron® element type ...BN/HC Filter rating	Beta values in relation on the filter element pressure differential						
	Filter element Δp in bar	$ß_x = \frac{\text{Number of particles with dimensions > x µm before the filter}}{\text{Number of particles with dimensions > x µm after the filter}}$					
		$ß_2$	$ß_3$	$ß_5$	$ß_{10}$	$ß_{15}$	$ß_{20}$
3 µm	2	40	250	> 1000	> 2000	–	–
	5	35	200	> 1000	> 2000	–	–
	15	30	150	> 500	> 1000	–	–
5 µm	2	12	40	300	> 2000	–	–
	5	11	35	200	> 2000	–	–
	15	10	30	120	> 1000	–	–
10 µm	2	–	–	6	300	> 2000	–
	5	–	–	6	200	> 2000	–
	15	–	–	7	150	> 500	–
20 µm	2	–	–	–	4	30	250
	5	–	–	–	4	20	150
	15	–	–	–	6	20	100

RE 50 075/10.95

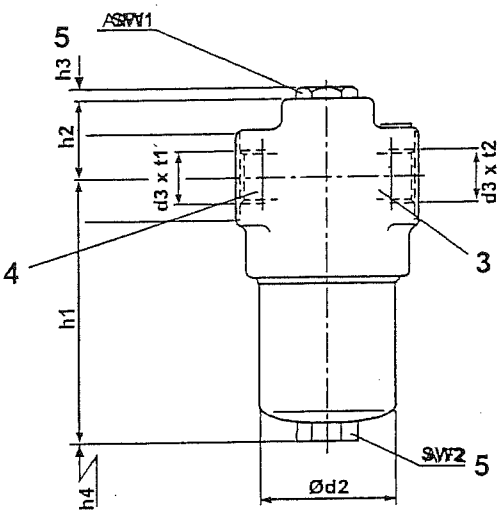
Unit dimensions: Line filter type LF

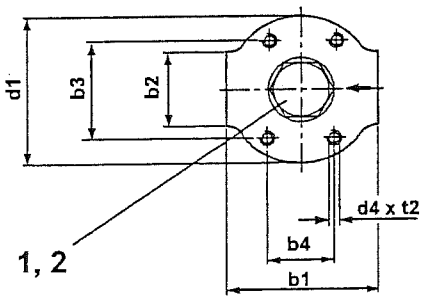
(Dimensions in mm)

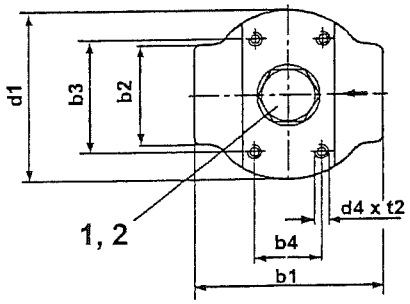
Size 30



Sizes 60 to 660







1 Without clogging indicator
2 Mounting face for clogging indicator
3 Inlet "A"
4 Outlet "B"
5 Width across flats (A/F1, A/F2), see table

Type	b1	b2	b3	b4	Ød1	Ød2	d3 [1])	d4
LF 030 G	69	33	45	30	67	52	G 1/2	M5
LF 060 G	92	50	56	32	84	68	G 3/4	M6
LF 110 G	92	50	56	32	84	68	G 3/4	M6
LF 160 G	128	65	85	35	116	95	G 1 1/4	M10
LF 240 G	128	65	85	35	116	95	G 1 1/4	M10
LF 330 G	162	85	115	60	159	130	G 1 1/2	M12
LF 660 G	162	85	115	60	159	127	G 1 1/2	M12

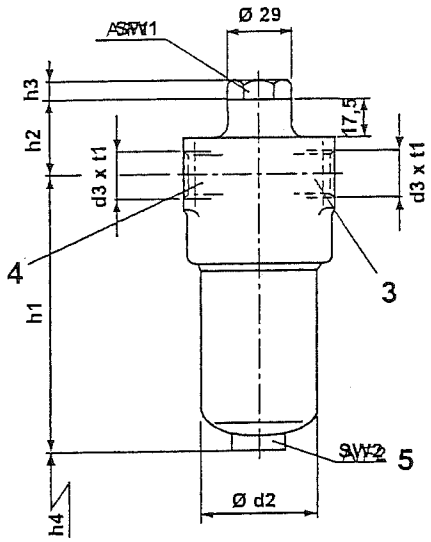
Type	h1	h2	h3	h4	A/F1	A/F2	t1	t2
LF 030 G	125,5	35	7	75	27	24	15	6
LF 060 G	137,5	40	6	75	27	27	17	9
LF 110 G	205	40	6	75	27	27	17	9
LF 160 G	190,5	47	6	95	27	32	21	14
LF 240 G	250,5	47	6	95	27	32	21	14
LF 330 G	252,5	50	6	105	27	36	23	17
LF 660 G	417,5	50	6	105	27	36	23	17

[1]) "G" threads to ISO 228

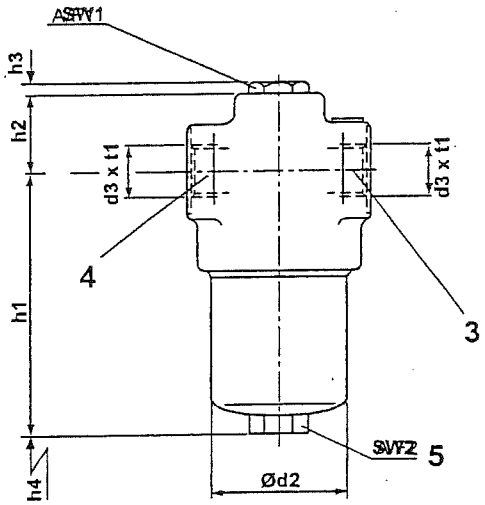
Unit dimensions: High pressure filter type DF

(Dimensions in mm)

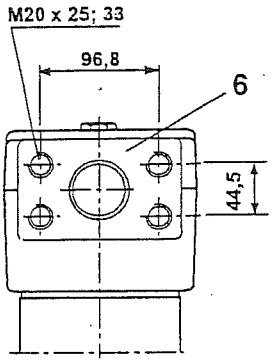
Size 30

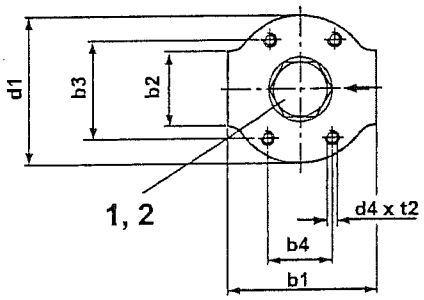


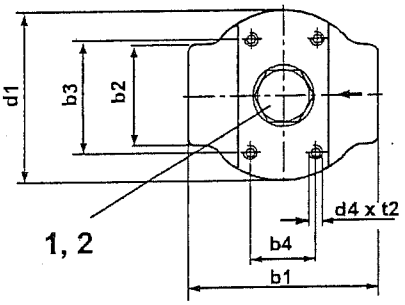
Sizes 60 to 660



Sizes 330, 500 and 660
(only model DF...F)







1 Without clogging indicator
2 Mounting face for clogging indicator
3 Inlet "A"
4 Outlet "B"
5 Width across flats (A/F1, A/F2), see table
6 Flange mounting pattern to ISO/DIS 6261/SAE J 518 C High pressure series 6000 psi (420 bar)

Type	b1	b2	b3	b4	Ød1	Ød2	d3[1]	d4	h1	h2	h3	h4	A/F1	A/F2	t1	t2
DF 030 G	69	33	45	30	67	52	G 1/2	M5	127	34	7	75	27	24	15	6
DF 060 G	93	50	56	32	84	68	G 3/4	M6	134	40	6	85	27	27	17	9
DF 110 G	93	50	56	32	84	68	G 3/4	M6	202	40	6	85	27	27	17	9
DF 140 G	93	50	56	32	84	68	G 3/4	M6	245	40	6	85	27	27	17	9
DF 160 G	128	65	85	35	116	95	G 1 1/4	M10	193	47	6	105	27	32	21	14
DF 240 G	128	65	85	35	116	95	G 1 1/4	M10	253	47	6	105	27	32	21	14
DF 280 G	128	65	85	35	116	95	G 1 1/4	M10	435	47	6	105	27	32	21	14
DF 330 G	167	138	115	60	159	130	G 1 1/2	M12	255	52	6	115	27	36	23	17
DF 330 F	160	138	115	60	159	130	SAE DN 50	M12	255	52	6	115	27	36	23	17
DF 500 G	167	138	115	60	159	130	G 1 1/2	M12	348	52	6	115	27	36	23	17
DF 500 F	160	138	115	60	159	130	SAE DN 50	M12	348	52	6	115	27	36	23	17
DF 660 G	167	138	115	60	159	130	G 1 1/2	M12	426	52	6	115	27	36	23	17
DF 660 F	160	138	115	60	159	130	SAE DN 50	M12	426	52	6	115	27	36	23	17

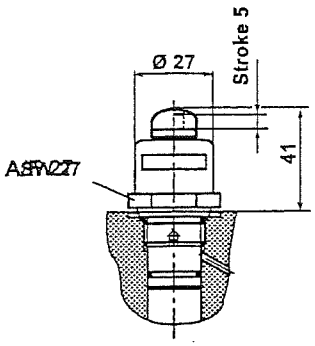
[1]) "G" threads to ISO 228
Flange connections to SAE (high pressure series)

RE 50 075/10.95

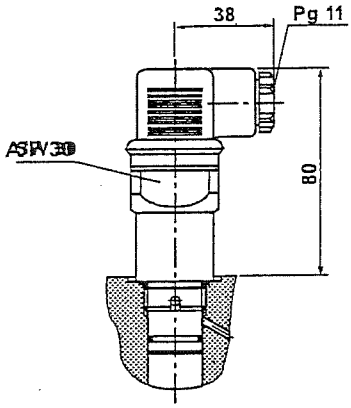
Clogging indicators

(Dimensions in mm)

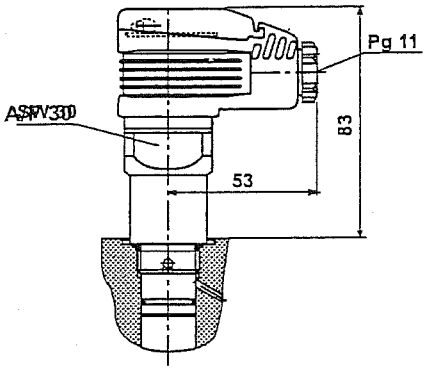
with **optical** clogging indicator
Model **B**



with **electrical** clogging indicator
Model **C** (Z 14)
Connection to DIN 43 650



with **optical and electrical** clogging indicator
Models **D** (Z 15) and **D...LED** (L6)
large connector with lamp or LED



Maximum tightening torque for clogging indicator: M_A = 30 Nm – for model "LF"

M_A = 50 Nm – for model "DF...C1.X/..(Z14)
– for model "DF...D1.X/L...(Z15)
– for model "DF...D1.X/LED..(Z6)

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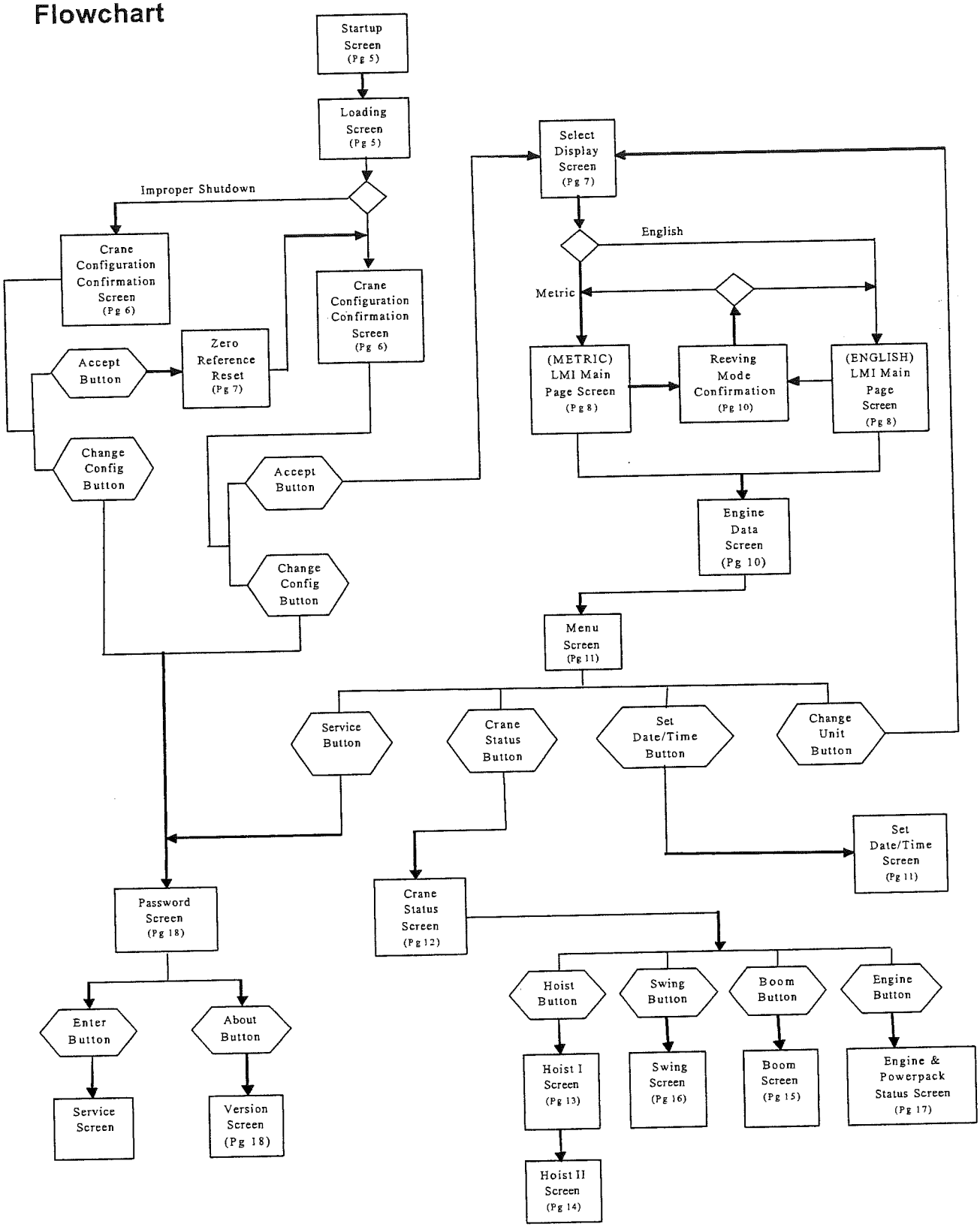
Crane Status 12

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Flowchart


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Hoist II Screen (Pg 14)

Startup Screen



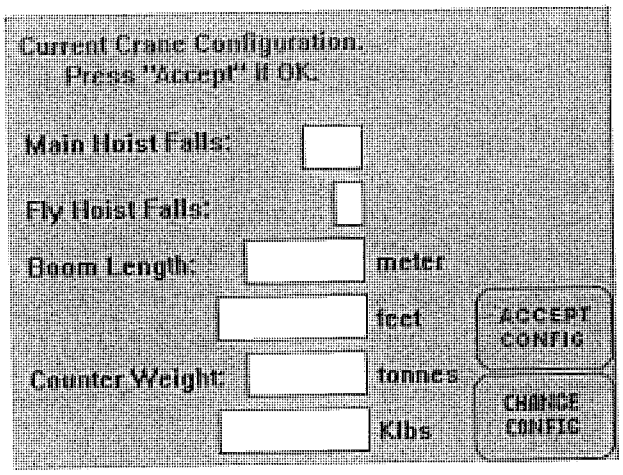
When ignition key is switched on, this startup screen will appear showing the display is trying to establish communication with the controller.

Loading Screen



After approximately 2 seconds this screen will appear. During this period all required data is being loaded.

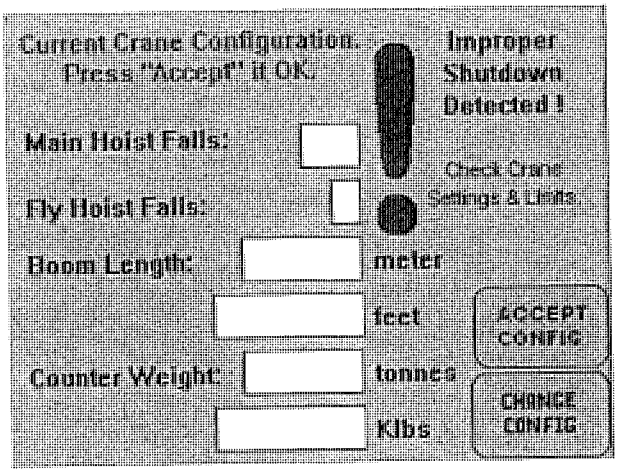
Crane Configuration Confirmation Screen



Normal Operation

After all the required data has been loaded, this screen will appear. Here, the crane operator is required to confirm the current crane configuration by pressing the **ACCEPT CONFIG** button. If there is a need to change the current crane configuration, press the **CHANGE CONFIG** button.

NOTE: Password is required to change the crane settings.

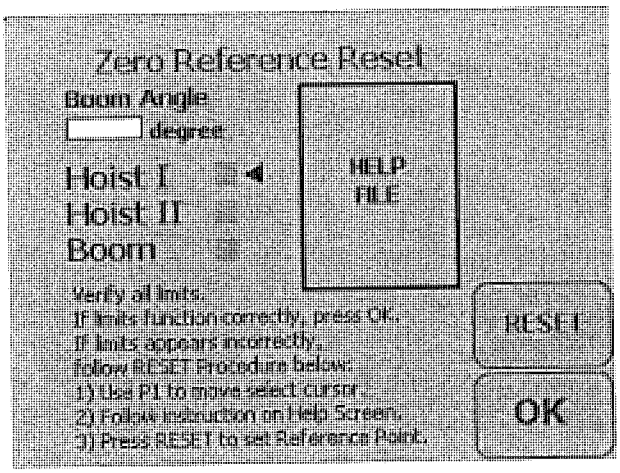


Improper Shutdown

If an improper shutdown is detected, confirmation page screen will look like the above. When the ACCEPT CONFIG button is pressed, the ZERO REFERENCE RESET screen will appear.

Improper Shutdown:
An incident where there is a sudden loss of power to the controller and sensors.

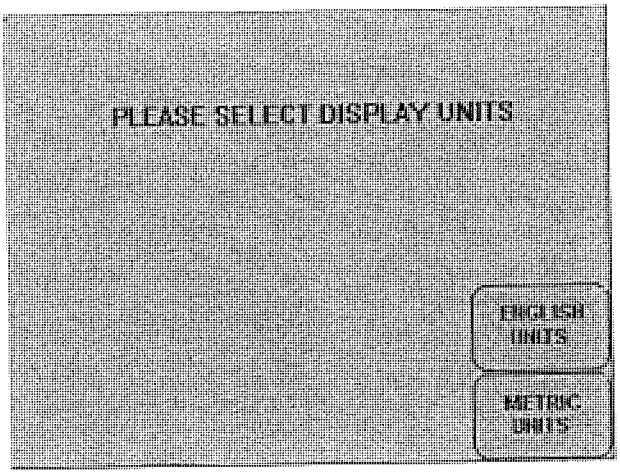
Zero Reference Screen



Zero Reference Reset Page

If there is an improper shutdown, such as power failure, and the operator select the ACCEPT CONFIG Button, this screen would be displayed. Here, the operator needs to Reset the Limits to its Zero Reference Point. After every limits has been resetted to its Zero Reference Point, the operator needs to press the OK button, and this will bring the operator back to the Confirmation Page.

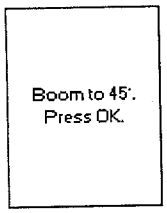
Select Display Screen



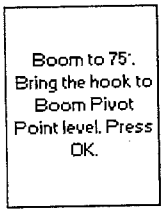
Once the crane configuration has been verified by the operator, the display will be showing this screen. Here, the operator can choose to have the LMI Main Screen in the "English Units" or in the "Metric Units".

Reference Points Definition and Settings

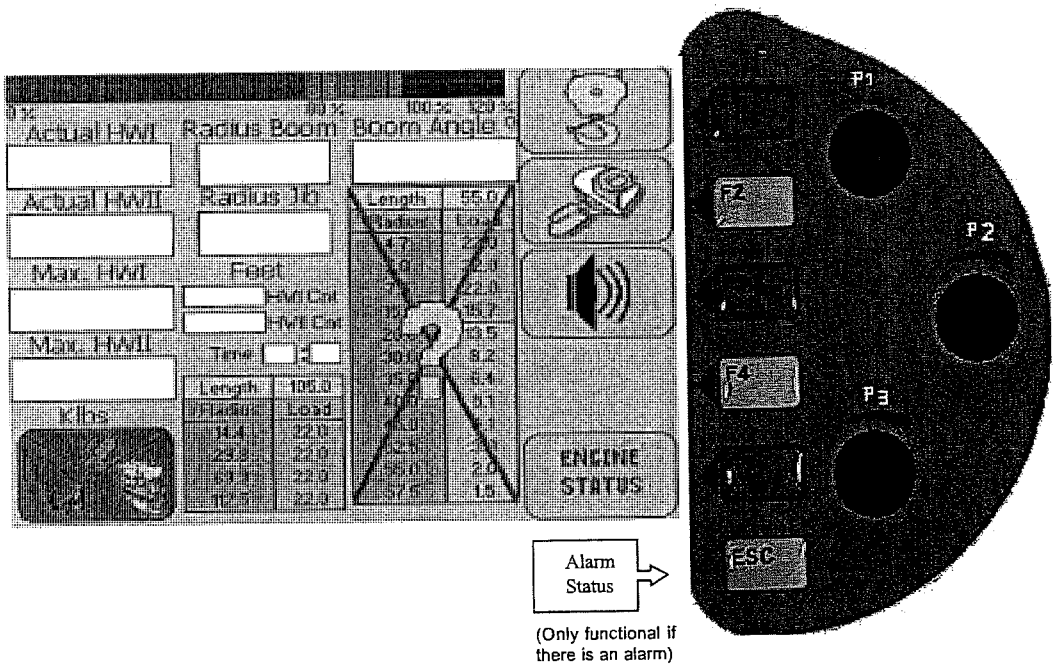
Boom



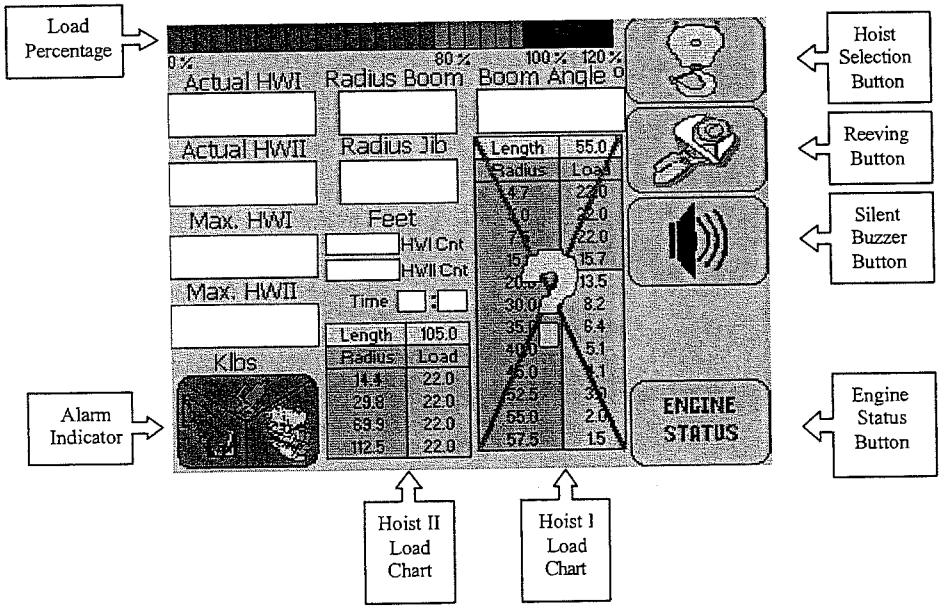
Hoist I & Hoist II



LMI Main Page Screen



If "English Units" is selected, the LMI Main Screen will look like the above. "Metric Units" screen is shown below. For the purpose of this manual, the "Metric Units" wil be used to describe all the functions.

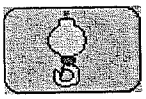


Hoist Selection Button [F1]

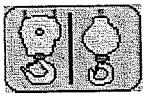
By default, main only indicator will be shown. Other selection is only possible i the crane is configured to have an auxiliary attached.



Main Only
Only the main hoist will be functioning. During this mode, the main hoist will be able to reach its maximum speed.



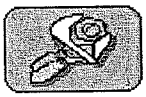
Fly Only
Only the fly hoist will be functioning. During this mode, the fly hoist will be able to reach it's maximum speed.



Main & Fly
The main hoist and fly hoist will be able to work simultaneously. However, the maximum speed of both the main hoist and fly hoist will be reduced.

Reeving Button [F2]

If this button is pressed, the display will show another screen where the crane operator/authorized personnel need to confirm the Reeving Mode selection.

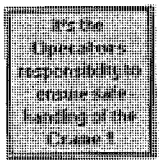


Reeving Mode OFF
During this mode, all crane limits will be in effect.



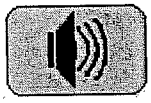
Reeving Mode ON
During this mode, all the crane limit, Hydraulic Alarm and Engine Alarm will be by-passed. It's the operator's responisbility to ensure the safe handling of the crane.

If the Reeving mode is ON, the indicator below will be displayed at the Hoist II load chart. Under this mode, the crane can only lift up to a max load of 2 tonne. Note that the LMI is not bypassed and there is no loadchart shown.



CAUTION: All limits and alarms will be disabled. This mode should only be used during erection.

Buzzer Indicator [F3]



Buzzer On
Used when the operator wishes to cancel the audible alarms.



Buzzer Off
Pressing this button will mute the audible alarm for a period of 5 minutes.

Alarm Indicator



Indicates that there is a HYDRAULIC ALARM. Press ESC button for more detailed information.

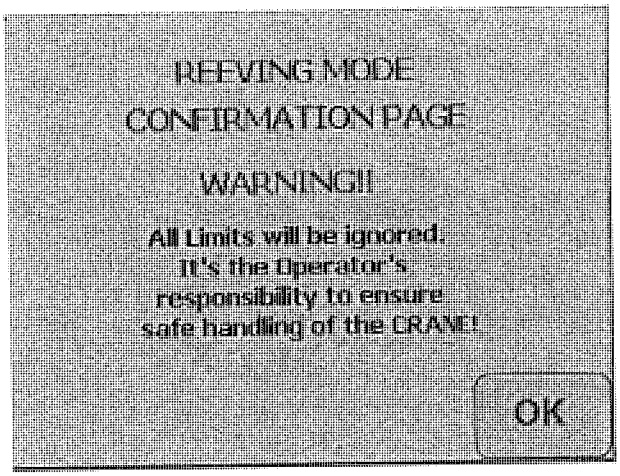


Indicates that there is a CRANE LIMIT ALARM. Press ESC button for more detailed information



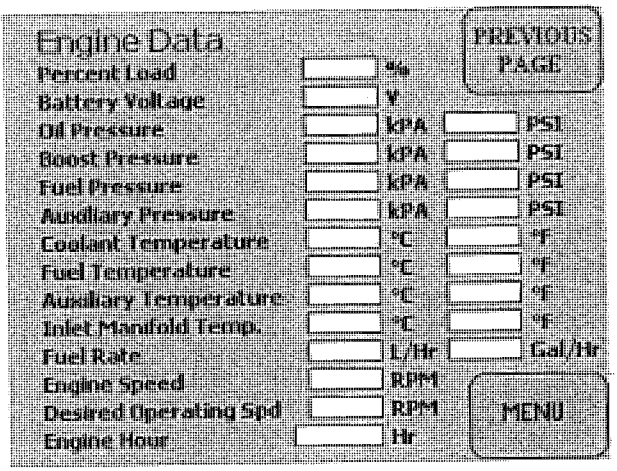
Indicates that there is an ENGINE ALARM. Press ESC button for more detailed information.

Reeving Mode Confirmation Screen



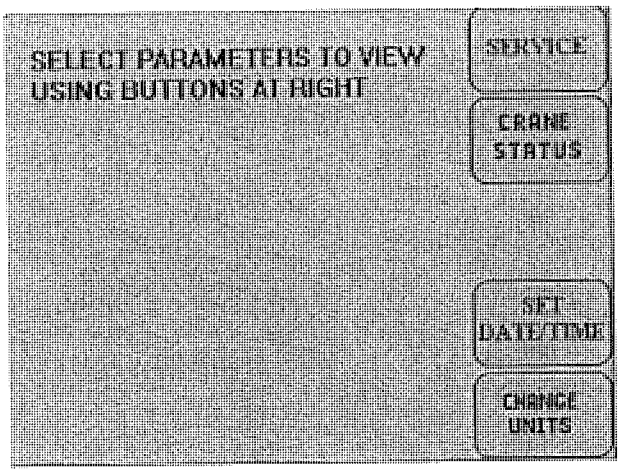
When the Reeving button is pressed, this screen will be displayed. Here the operator is required to confirm the Reeving Mode request by pressing the OK button. If the operator does not want the crane to be in Reeving Mode, ESC button can be pressed to cancel the selection.

Engine Data Screen



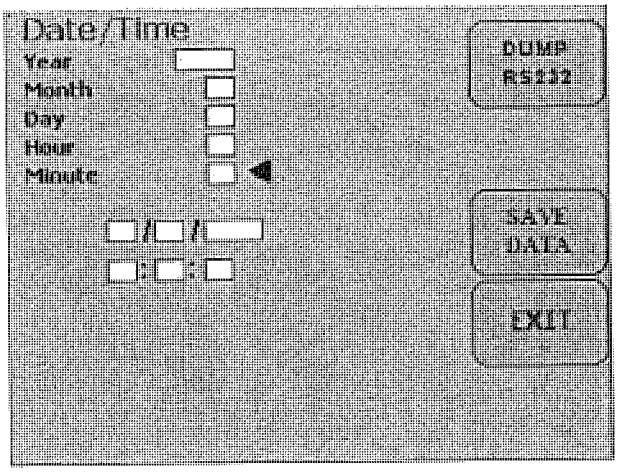
When the Engine Status button is pressed, this screen will appear. Here, the various Engine Data is displayed.

Menu Screen



When the MENU button is pressed, this screen will be shown. Here, the operator can choose to either go to the service menu by pressing the Service button, or view the crane status by pressing the Crane Status button. On this screen, the operator can also change or set the date and time, or change the LMI Main Screen's units, from the Metric Units to English Units, and vice versa.

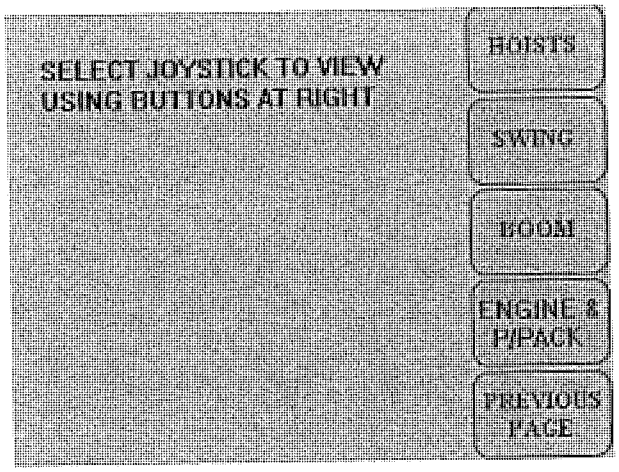
Set Date/Time Screen



When the SET DATE/TIME Button is pressed, this screen will appear on the display.
Here, the operator can change the Date and Time data on the controller. To scroll down the selection, use P1. To change the value of selected data, use P3.

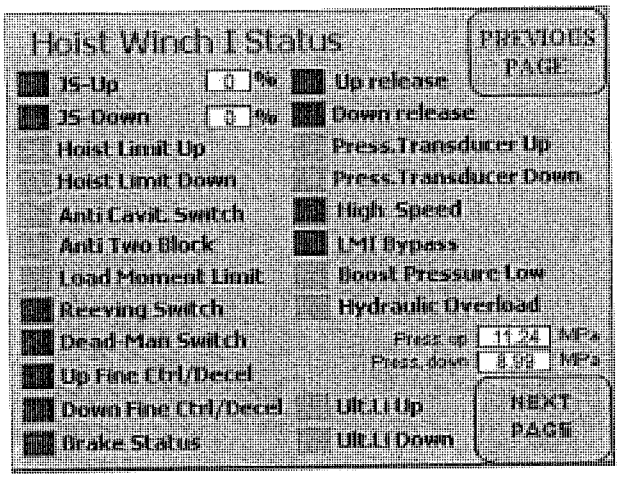
NOTE: All data must be set to current settings even though only one data is to be changed. Time format is military ie. 24:00 = 12 AM.

Crane Status



When the CRANE STATUS button is pressed, this screen will appear on the display. Here the operator can choose which category of crane status to be viewed; the Hoist Status, Swing Status, Boom Status and the Engine Status.

Hoist Winch I Status



Note: This screen shows the status of the Main Hoist Operation. It has 22 indicators.

JS-Up & JS- Down
This indicator will remain RED when there is no movement on the Joystick. It will turn GREEN when the operator presses the Deadman Switch and moves the Joystick. Movement of the Joystick is shown as percentage scale.

Hoist Limit Up, Hoist Limit Down, Ult.Li Up, Ult.Li Down
This indicator will remain GREEN if the crane is operating within the Limits. Once the crane is operating out of specified limits, the appropriate indicator will turn into RED.

Up Fine Ctrl/Decel, Down Fine Ctrl/Decel
This indicator will remain RED. It will change to GREEN once the Fine Control is activated or the crane deceleration limit is reached. It will also turn GREEN if the LMI limit is reached.

Up Release, Down Release
This indicator will remain RED if there is no hoisting or under normal operation, it will change to GREEN if the operator is trying to operate the hoist.

Press Transducer Up, Press. Transducer Down
This indicator shows the "health" of the pressure transducer. GREEN indicates that the pressure transducer is working.

Brake Status
This indicator will change from RED to GREEN if the Brake has been released.

Anti Cavit. Switch
This indicator will only change from GREEN to RED if there is cavitation in the pump.

Anti Two Block (if applicable)
This indicator will remain GREEN until there is a Two Block incident. Then it will turn to RED.

Load Moment Limit
If the load is within the max load at that particular radius, this indicator should remain GREEN. Once the load reaches 100% of the Rated Load on that radius, this indicator will turn RED.

Reeving Switch
This indicator will turn GREEN from RED if the crane is in Reeving mode.

Dead Man Switch
This indicator will turn GREEN once the Deadman switch on the Joystick is pressed

LMI Bypass
This indicator will remain RED under normal operation. It will turn to GREEN when the LMI-Bypass switch is turned ON.

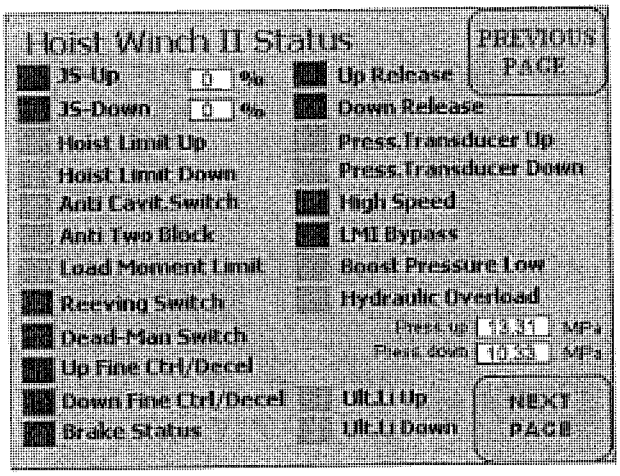
Boost Pressure Low & Hydraulic Overload
These indicators will remain GREEN until there's a problem with the hydraulic system, i.e. a low Boost Pressure is detected.

High Speed
This function is not available on this version.

Press Up - This shows the pressure in the Up line in MPa

Press Down- This shows the presure in the Down line in MPa.

Hoist Winch II Status



Note: This screen shows the status of the Auxiliary Hoist Operation. It has 22 indicators.

JS-Up & JS- Down

This indicator will remain RED when there is no movement on the Joystick. It will tum GREEN when the operator presses the Deadman Switch and moves the Joystick. Movement of the Joystick is shown as percentage scale.

Hoist Limit Up, Hoist Limit Down, Ult.Li Up, Ult.Li Down

This indicator will remain GREEN if the crane is operating within the Limits. Once the crane is operating out of specified limits, the appropriate indicator will turn into RED.

Up Fine Ctrl/Decel, Down Fine Ctrl/Decel

This indicator will remain RED. It will change to GREEN once the Fine Control is activated or the crane deceleration limit is reached. It will also turn GREEN if the LMI limit is reached.

Up Release, Down Release

This indicator will remain RED if there is no hoisting or under normal operation, it will change to GREEN if the operator is trying to operate the hoist.

Press Transducer Up, Press. Transducer Down

This indicator shows the "health" of the pressure transducer. GREEN indicates that the pressure transducer is working.

Brake Status

This indicator will change from RED to GREEN if the Brake has been released.

Anti Cavit. Switch

This indicator will only change from GREEN to RED if there is cavitation in the pump.

Anti Two Block (if applicable)

This indicator will remain GREEN until there is a Two Block incident. Then it will turn to RED.

Load Moment Limit

If the load is within the max load at that particular radius, this indicator should remain GREEN. Once the load reaches 100% of the Rated Load on that radius, this indicator will turn RED.

Reeving Switch

This indicator will turn GREEN from RED if the crane is in Reeving mode.

Dead Man Switch

This indicator will turn GREEN once the Deadman switch on the Joystick is pressed

LMI Bypass

This indicator will remain RED under normal operation. It will turn to GREEN when the LMI-Bypass switch is turned ON.

Boost Pressure Low & Hydraulic Overload

These indicators will remain GREEN until there's a problem with the hydraulic system, i.e. a low Boost Pressure is detected.

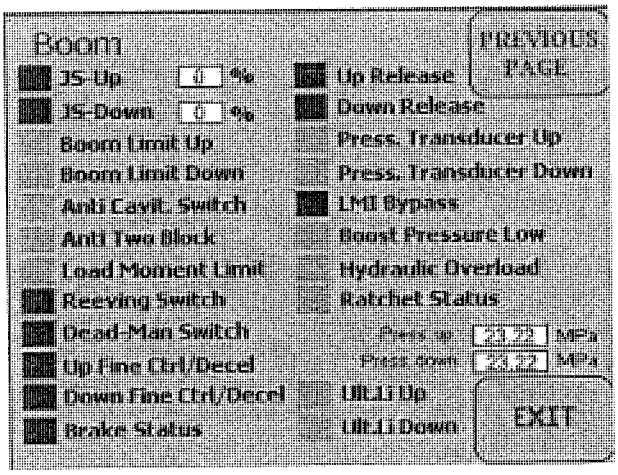
High Speed

This function is not available on this version.

Press Up - This shows the pressure in the Up line in MPa

Press Down- This shows the presure in the Down line in MPa.

Boom Status



Note: This screen shows the status of the Boom Operation. It has 22 indicators.

JS-Up & JS- Down
This indicator will remain RED when there is no movement on the Joystick. It will turn GREEN when the operator presses the Deadman Switch and moves the Joystick. Movement of the Joystick is shown as percentage scale.

Boom Limit Up, Boom Limit Down, Ult.Li Up, Ult.Li Down
This indicator will remain GREEN if the crane is operating within the Limits. Once the crane is operating out of specified limits, the appropriate indicator will turn into RED.

Up Fine Ctrl/Decel, Down Fine Ctrl/Decel
This indicator will remain RED. It will change to GREEN once the Fine Control is activated or the crane deceleration limit is reached. It will also turn GREEN if the LMI limit is reached.

Up Release, Down Release
This indicator will remain RED if there is no boom hoisting or under normal operation, it will change to GREEN if the operator is trying to operate the boom.

Press Transducer Up, Press. Transducer Down
This indicator shows the "health" of the pressure transducer. GREEN indicates that the pressure transducer is working.

Brake Status
This indicator will change from RED to GREEN if the Brake has been released.

Anti Cavit. Switch
This indicator will only change from GREEN to RED if there is cavitation in the pump.

Anti Two Block (if applicable)
This indicator will remain GREEN until there is a Two Block incident.

Load Moment Limit
If the load is within the max load at that particular radius, this indicator should remain GREEN. Once the load reaches 100% of the Rated Load on that radius, this indicator will turn RED.

Reeving Switch
This indicator will turn GREEN from RED if the crane is in Reeving mode.

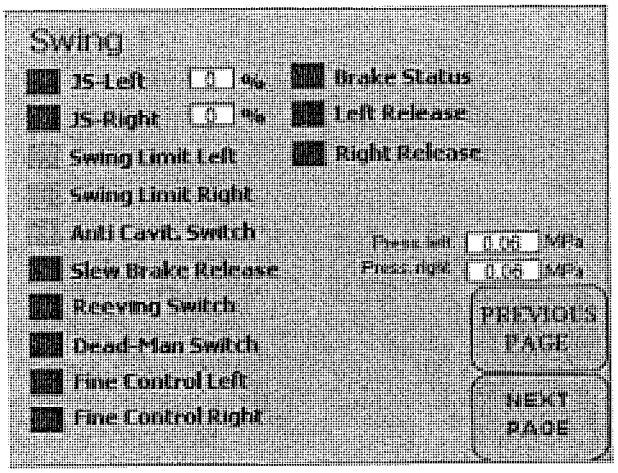
Dead Man Switch
This indicator will turn GREEN once the Deadman switch on the Joystick is pressed

LMI Bypass
This indicator will remain RED under normal operation. It will turn to GREEN when the LMI-Bypass switch is turned ON.

Boost Pressure Low & Hydraulic Overload
These indicators will remain GREEN until there's a problem with the hydraulic system, i.e. a low Boost Pressure is detected.

Ratchet Status
It will turn GREEN when the Luff Ratchet is in 'Open' position. When it is in 'Lock' position it will be RED.

Swing Status



Note: This screen shows the status of the Swing Operation. It has 13 indicators. Press. left and Press right are not applicable for this version.

JS-Left & JS- Right

This indicator will remain RED when there is no movement on the Joystick. It will turn GREEN when the operator presses the Deadman Switch and moves the Joystick. Movement of the Joystick is shown as percentage scale.

Swing Limit Left, Swing Limit Right (If Applicable)

This indicator will remain GREEN if the crane is operating within the Limits. Once the crane is operating out of specified limits, the appropriate indicator will turn into RED.

Fine Ctrl Left /Fine Ctrl Right

This indicator will remain RED. It will change to GREEN once the Fine Control is activated or the crane deceleration limit is reached. It will also turn GREEN if the LMI limit is reached.

Left Release, Right Release

This indicator will remain RED if there is no swinging or under normal operation, it will change to GREEN if the operator us trying to operate the swing.

Brake Status

This indicator will change from RED to GREEN if the Brake has been released.

Anti Cavit. Switch

This indicator will only change from GREEN to RED if there is cavitation in the pump.

Reeving Switch

This indicator will turn GREEN from RED if the crane is in Reeving mode.

Dead Man Switch

This indicator will turn GREEN once the Deadman switch on the Joystick is pressed.

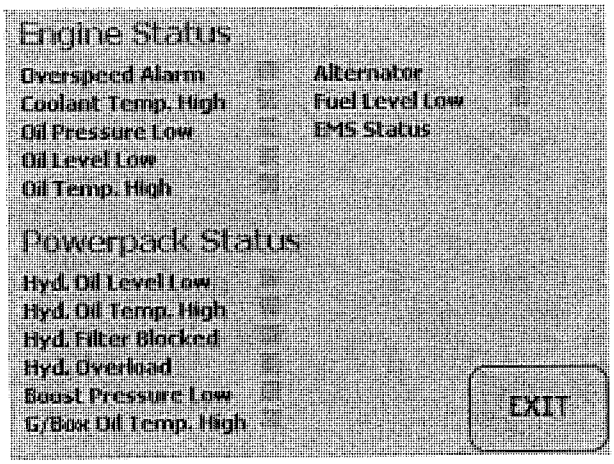
Slew Brake Release

This indicator will turn GREEN if the Slew Brake is released.

Press Left- This shows the pressure in the left line in MPa

Press Right- This shows the presure in the Right line in MPa.

Engine & Powerpack Status Screen



Engine Status

Overspeed Alarm (if applicable)
The indicator turns RED when there is an Engine overspeed Alarm. Under normal condition, it should remain GREEN.

Coolant Temp. High
This indicator turns RED when the Engine Coolant Temperature is high. Under normal condition, it should remain GREEN.

Oil Pressure Low
This indicator turns RED when the Engine Lube Oil Pressure is low. Under normal condition, it should remain GREEN.

Oil Level Low (if applicable)
This indicator turns RED when the Engine Lube Oil Level is low. Under normal condition, it should remain GREEN.

Oil Temp. High (If Applicable)
This indicator turns RED when the Engine Lube Oil Temperature is high. Under normal condition, it should remain GREEN.

Alternator
This indicator turns RED when a faulty alternator is detected.

Fuel Level Low (if applicable)
This indicator turn RED when the Fuel Level is low. Under normal condition, it should remain GREEN.

EMS Status (if applicable)
This indicator turn RED when there is a Warning Alarm on the Engine's EMS. Under normal condition, it should remain GREEN.

Powerpack Status

Hyd. Oil Level Low
This indicator turns RED when the Hydraulic Oil Level in hydraulic tank is low. Under normal condition, it should remain GREEN.

Hyd. Oil Temp. High (if applicable)
This indicator turns RED when the Hydraulic Oil Temperature is high. Under normal condition, it should remain GREEN.

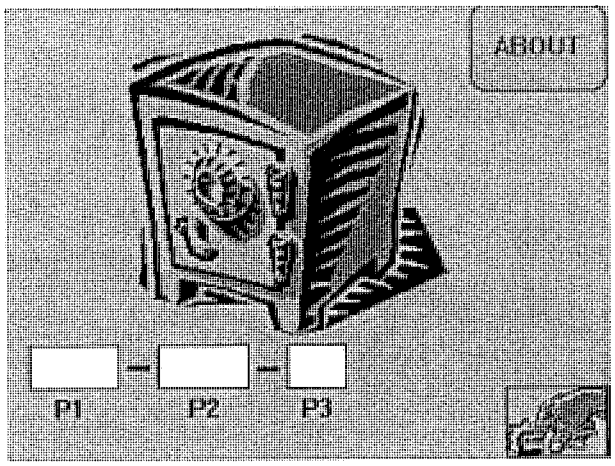
Hyd. Filter Blocked
This indicator turns RED when the Hydraulic Oil Filters are blocked. Under normal condition, it should remain GREEN.

Hyd. Overload
This indicator turns RED when there is a Hydraulic Overload in the system. Under normal condition, it should remain GREEN.

Boost Pressure Low
This indicator turns RED when the Boost Pressure is low. Under normal condition, it should remain GREEN.

G/Box Oil Temp. High
This indicator turns RED when the Pump Drive Gear-box Lube Oil Temperature is high. Under normal condition, it should remain GREEN.

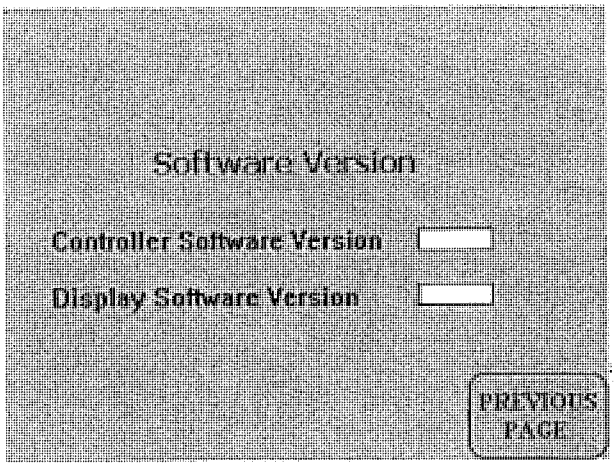
Password Screen



When the operator pressed the Service Button, this screen will be displayed. Here, the operator is required to key in the password to access the crane settings section.

Note: The crane settings should only be changed by Authorized Personnel.

Version Screen



Version Screen

By pressing the About button on the Password page, this screen will be displayed. Here, the current software version of both the display and the controller will be displayed.

9 AIR CONDITIONER

RV Products
A Division of AIRXCEL, Inc.

OPERATION AND MAINTENANCE INSTRUCTIONS FOR 7000 & 8000 SERIES ROOF TOP AIR CONDITIONERS AND CEILING PLENUMS

MODE D'EMPLOI ET UTILISATION DES CLIMATISEURS DE TOIT DES SÉRIES 7000 ET 8000 ET PLÉNUM DE PLAFOND

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Wichita, KS 67204

1971Y982 (3-00) PP

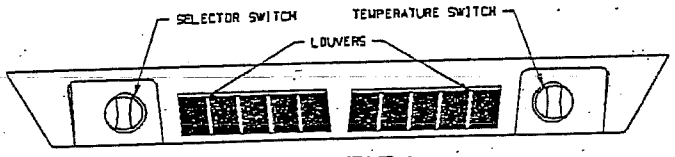
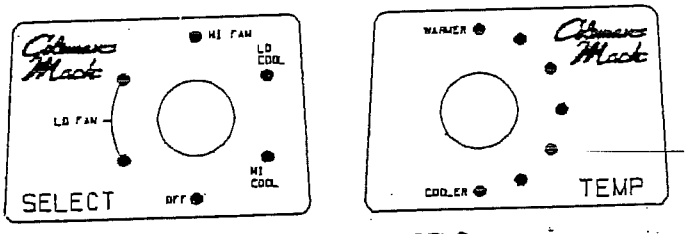
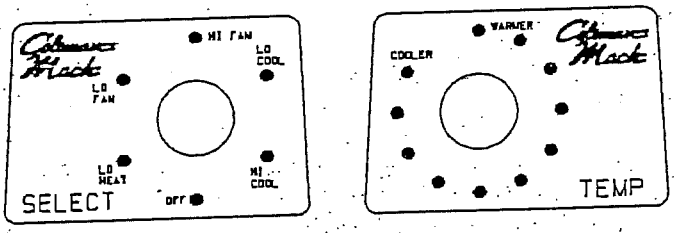


FIGURE 1



COOLING ONLY MODELS



COOLING / HEATING MODELS

FIGURE 2

SECTION III - OPERATION

I. **For Cooling (Refer to Figure 1 and 2, page 3).**

A. Turn the selector switch to the "LOW COOL" or "HIGH COOL" position.

B. Rotate the thermostat (temperature control) to the position that is the most comfortable to you. The thermostat will turn the compressor on when the temperature of the air entering the air conditioner rises a few degrees above the setting you have selected. Then the temperature of the air entering continues to cycle the compressor on and off in the above mentioned fashion until the selector switch is turned to another mode of operation.

C. Position the louvers to the desired direction the discharge air is to flow.

Note: The fan operation is constant, only the compressor cycles on the thermostat.

II. **Operation During Cooler Nights (Cooling Operation).**

It is important, when the outdoor temperature drops in the evening or during the night to below 75 degrees F, that the thermostat (temperature control) be set at a midpoint between "Warmer" and "Cooler". If the setting is at "Cooler", the evaporator coil may become iced-up and stop cooling. During the day when the temperatures have risen above 75 degrees F, reset the thermostat switch to the desired setting.

NOTE

Should icing-up occur, it is necessary to let the cooling (evaporator) coil defrost before normal cooling operation is resumed. During this time, operate the unit in the "HIGH FAN" position with the system at maximum air flow. When increased or full air flow is observed, the cooling coil should be clear of ice.

Cleaning and/or changing the filters:

1. Remove the selector switch and thermostat knobs from the ceiling assembly.

2. Remove the two screws that secure the ceiling assembly shroud to the ceiling assembly. See Figure 3.

3. Lower the shroud and gently slide it off the control knob shafts.

4. Take filters out and either clean or exchange with other filters (See Figure 3).

5. If the vehicle is equipped with a flush mount ceiling assembly, remove the four return air grill screws. Remove filter from grill and either clean or exchange with new filters.

NOTE

If replacement filters are necessary, the filters can be purchased from most RV Products Authorized Service Centers. It is recommended that spare filters be carried with the RV at all times to replace worn, torn or deteriorated filters.

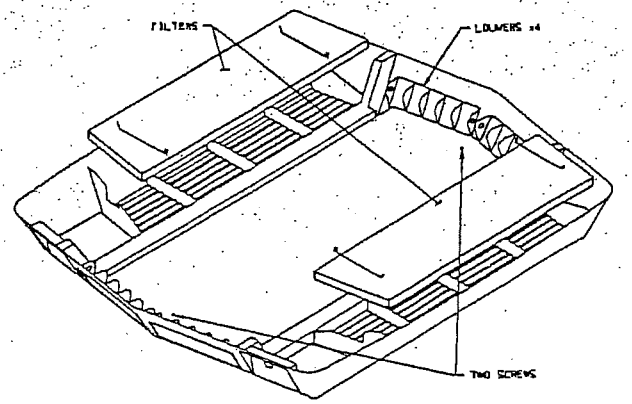


FIGURE 3

II. Service Person

A. Electrical - All electrical work and/or inspection should be performed only by qualified service personnel. Contact your nearest RV Products Service Center if electrical problems should arise.

B. Check Points - Failure to start or to cool the air are sometimes problems with air conditioning units. The RV Products RV air conditioner is designed to operate on 115 volt electrical power. If the compressor on the air conditioner fails to start, check with your RV Products Service Center to determine that the proper wire size is connected to the unit, the proper circuit breakers are installed as protection devices on the electrical circuit and the proper sized extension cord is being used for the distance covered from the utility outlet to the RV. The required minimum wire size is #12 AWG for lengths up to 25 feet (larger wire size for greater distances). Each air conditioning unit must be protected with a 20 amp time delay fuse or circuit breaker.

If the air conditioner continues to trip off the circuit breakers, have an electrician check the starting amperage and running amperage on the unit. If the circuit breaker continues to trip off and the electrical consumption is found to be normal, it will require the replacement of the faulty circuit breaker.

If all electrical power to the air conditioner is normal but neither the fan or the compressor will operate, the connector plug located behind the ceiling assembly control box should be checked to determine whether it is faulty.

On the heating-cooling air conditioner models, if all electrical power to the unit is normal and the fan runs but you never get any heated air, then the electrical plug to the heating unit should be checked for a secure connection. If this does not correct the malfunction, the heating thermostat or limit switch may be faulty.

C. Mechanical Integrity - The air conditioner should be inspected periodically to be sure that the bolts which secure the unit to the roof are tight and in good shape. Also, an examination of the plastic shroud covering the air conditioner on the top of the roof should be made periodically. Be sure the four mounting screws and washers are snug and holding the shroud to the air conditioner. Also examine the shroud to be sure it is not developing cracks or has suffered damage from impact.

D. Lubrication

DANGER

DISCONNECT THE POWER SUPPLY TO THE UNIT BEFORE SERVICING TO PREVENT A SHOCK HAZARD OR POSSIBLE INJURY FROM MOVING PARTS.

The blower drive motor on some units may include oiling cups at the top of the motor. There is no requirement to oil the journals under normal operating conditions. However, if lubrication to the unit is desired, use only SAE 20 non-detergent type oil. DO NOT OVER OIL - three to four drops in each oil hole once a year is sufficient.

OPERATION

The chart below shows the system functions with the "Heat/Cool" thermostat. After the entire air conditioning system (and furnace system) is installed, check each position function. Disregard references to heat functions when using the "Cool Only" thermostat.

■ SHOWS POSITION OF SWITCH								OPERATION
SYSTEM				FAN				
				AUTO		ON		
HEAT	COOL	OFF	FAN	HI	LO	LO	HI	
☐	☐	■	☐	☐	☐	☐	☐	No functions occur.
☐	☐	☐	■	☐	☐	☐	☐	Air conditioner fan runs at high speed continuously regardless of fan switch setting or setpoint. No other functions occur.
☐	■	☐	☐	■	☐	☐	☐	Air conditioner compressor and high speed fan cycle to satisfy setpoint.
☐	■	☐	☐	☐	■	☐	☐	Air conditioner compressor and low speed fan cycle to satisfy setpoint.
☐	■	☐	☐	☐	☐	■	☐	Air conditioner compressor cycles to satisfy setpoint. Air conditioner low speed fan runs continuously.
☐	■	☐	☐	☐	☐	☐	■	Air conditioner compressor cycles to satisfy setpoint. Air conditioner high speed fan runs continuously.
■ *	☐	☐	☐	■	☐	☐	☐	Furnace and furnace blower cycles to satisfy setpoint. Furnace blower operates from sequencer or time delay in furnace. Air conditioner blower does not run.
■ *	☐	☐	☐	☐	■	☐	☐	
■ *	☐	☐	☐	☐	☐	■	☐	
■ *	☐	☐	☐	☐	☐	☐	■	

All cooling functions controlling to setpoint have a short cycle protection time delay of 3 minutes. There will be no delay if the cycle OFF time exceeds 3 minutes.

* There is no heat switch or furnace function available with the "Cool Only" thermostat.

SECTION VI - WARRANTY SERVICE

Let's face it. Sometimes even the best products may need service. To obtain warranty service on your RV Products air conditioner, contact your selling dealer or dial toll free 1-877-430-8084 to locate the Authorized Service Center closest to you. You may also access our web site on the Internet at www.rvcomfort.com for answers to the most frequently asked questions and service center locations.

RV Products support help may be accessed by E-mail at RVPSupport@Airxcel.com.

All written correspondence should be directed to:

RV Products
A Division of Airxcel, Inc.
P.O. Box 4020
Wichita, KS 67204

IMPORTANT

1. Carefully read your limited two year product warranty which is packed with the product.

2. An optional three year extended parts only contract is available at an additional cost of $89.95. To obtain this optional three years parts contract, fill out the application card stapled to the front of this envelope. Please mail the card and a check or money order to the address above. Applications must be made within ninety (90) days of the original purchase.

3. Inquiries about your RV Products air conditioner must include the model and serial numbers and the date of purchase. The model and serial numbers can be found on the I.D. label located on the air conditioner basepan return air opening at the bottom of the roof unit. This information may also be found on the air conditioner rating plate.

RV Products
A Division of AIRXCEL, Inc.

INSTALLATION INSTRUCTIONS
FOR
8000 SERIES
AIR CONDITIONERS

CLIMATISEURS
SÉRIE 8000
INSTRUCTIONS D'INSTALLATION

II. AIR CONDITIONING SIZING

The ability of an air conditioner to provide a comfortable environment for the consumer is dependent upon the following conditions.

Air conditioners are rated primarily by their ability to remove heat. The thermal measurement used for detecting a gain or loss of heat is the British Thermal Unit (BTU). One (1) BTU is the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit. An air conditioner rated at 13,500 BTUH can remove 13,500 BTU's of heat in one hour.

The ability of an air conditioner to cool down a vehicle or maintain a consumer desired temperature is dependent upon the heat gain of the vehicle. The physical size, the amount of window area, the quality and amount of insulation, the position exposure to sunlight, the number of people using the vehicle and the outside temperature may increase the heat gain to such an extent that the capacity of the air conditioner is exceeded.

As a general rule, air supplied (discharge air) from the air conditioner will be 15 to 20 degrees cooler than the air entering (return air) the ceiling assemblies bottom air grilles.

For example, if the air entering the air conditioner is 80 Degree F (return air), the supply air (discharge air) into the vehicle will be 60 to 65 Degree F. As long as this temperature difference (15 to 20 Degrees) is being maintained at the air conditioner, the air conditioner is operating properly.

Again, give careful consideration to the vehicle heat gain variables. During extreme outdoor temperatures, the heat gain of the vehicle may be reduced by:

- parking the vehicle in a shaded area
- keeping windows and doors closed
- avoiding the use of heat producing appliances
- using window shades (blinds and/or curtains)

For a more permanent solution to high heat gain situations, additional vehicle insulation, window awnings and/or window glass tinting should be considered.

III. SELECTING AN INSTALLATION LOCATION

Your RV Products air conditioner has been designed for use primarily in recreational vehicles.

Is the roof of the vehicle capable of supporting both the roof top unit and ceiling assembly without additional support structures? Inspect the interior ceiling mounting area to avoid interference with existing structural members such as: bunks, curtains, tracks or room dividers. The depth of the ceiling assembly shroud is 3". Be sure to check clearance for doors which must be swung open (refrigerator, closets, cabinets).

Most of the time, roof mount air conditioners are installed at existing roof vent locations. If there are no roof vents (existing mounting hole), the following placement locations are recommended.

Motor Homes - a single unit or the forward of two units should be mounted within 9 feet of the drivers compartment.

Travel Trailers or Mini-Homes - a location should be selected that is near the door slightly forward of the vehicle center length.

Vans - location should be in the center of the roof (side to side - front to back).

Truck with Camper - location should be between 4 or 5 feet from the rear of the camper to achieve maximum cooling effect.

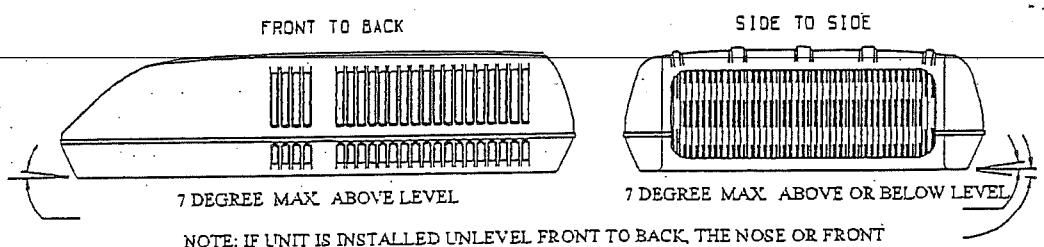
IV. INSTALLING THE ROOF TOP UNIT

DANGER
SHOCK HAZARD

DISCONNECT ALL POWER TO THE VEHICLE BEFORE PERFORMING ANY CUTTING TO THE VEHICLE. CONTACT WITH HIGH VOLTAGE CAN RESULT IN EQUIPMENT DAMAGE, PERSONAL INJURY OR DEATH.

IMPORTANT

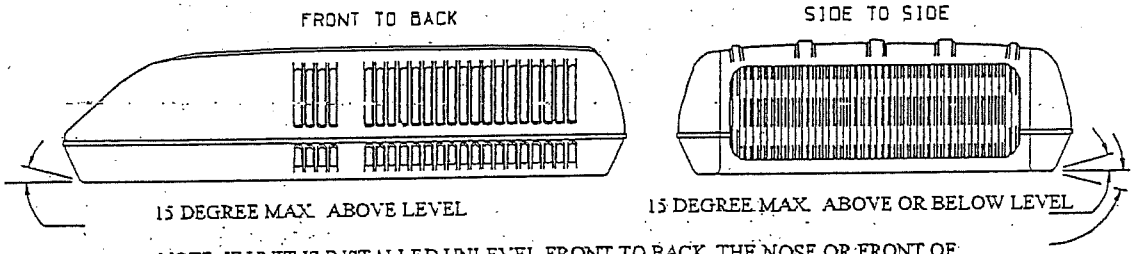
TO PREVENT DAMAGE TO THE WIRING AND BATTERY, DISCONNECT THE BATTERY CABLE FROM THE POSITIVE BATTERY TERMINAL BEFORE PERFORMING ANY CUTTING TO THE VEHICLE.



NOTE: IF UNIT IS INSTALLED UNLEVEL FRONT TO BACK, THE NOSE OR FRONT OF THE UNIT MUST BE UP. DO NOT INSTALL NOSE DOWN.

ALLOWABLE OFFSET FOR ALL AIR CONDITIONERS WITH RECIPROCATING COMPRESSORS.

FIGURE 2



NOTE: IF UNIT IS INSTALLED UNLEVEL FRONT TO BACK, THE NOSE OR FRONT OF THE UNIT MUST BE UP. DO NOT INSTALL NOSE DOWN.

ALLOWABLE OFFSET FOR ALL AIR CONDITIONERS WITH ROTARY COMPRESSORS.

FIGURE 3

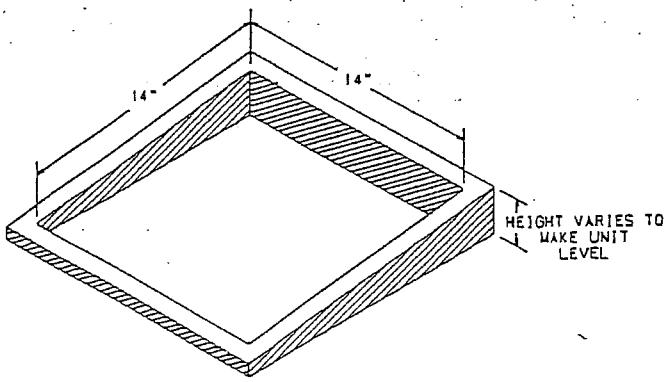


FIGURE 4

If the roof of the vehicle is sloped (not level) such that the roof top air conditioner cannot be mounted within the maximum allowable degree deviations, an exterior leveling shim will need to be added to make the roof top air conditioner level. A typical leveling shim is shown in Figure 4.

E. After the mounting hole area is properly prepared, remove the carton and shipping pads from the roof top air conditioner. Carefully lift the unit to the top of the vehicle. Do not use the outer plastic shroud for lifting. Place the roof top air conditioner over the prepared mounting hole. The pointed end (nose) of the shroud must face towards the front of the vehicle. Pull the electrical conduit down from the roof air conditioner through the mounting opening and let hang.

VI. ELECTRICAL WIRING

ROUTING 115 VAC WIRING

Following RV Products high voltage wiring specifications and all local and national electrical codes, route the roof top unit 115 VAC supply wiring from its power source to the wirebox.

High Voltage Wiring Specifications

1. U.L. requires copper conductors only with minimum #12 AWG.

2. To prevent voltage drops greater than 10% during starting loads, adhere to the following guideline:

   For lengths greater than 50', use #10 AWG.
   Circuit Protection - Refer to upper unit nameplate.

DANGER - SHOCK HAZARD

MAKE SURE THAT ALL POWER SUPPLY TO THE UNIT IS DISCONNECTED BEFORE PERFORMING ANY WORK ON THE UNIT TO AVOID THE POSSIBILITY OF SHOCK INJURY OR DAMAGE TO THE EQUIPMENT.

DANGER

WHEN USING NON-METALLIC SHEATH CABLES (ROMEX, ETC.), STRIP SHEATH BACK TO EXPOSE 4-6 INCHES OF THE SUPPLY LEADS. STRIP THE INDIVIDUAL WIRE LEAD ENDS FOR WIRE CONNECTION (ABOUT 3/4" BARE WIRE). INSERT THE SUPPLY WIRES INTO THE ELECTRICAL CONNECTOR CLAMP. SHEATH MUST PROTRUDE PAST THE CLAMP BUSHING INSIDE THE BOX AS ILLUSTRATED. MAKE SURE SHEATH CABLE IS CENTERED IN CLAMP BEFORE TIGHTENING UP ON IT. DO NOT OVERTIGHTEN!! THIS COULD RESULT IN PINCHING THROUGH THE PLASTIC WIRE INSULATION AND CAUSE SHORTING OR "HOT" WIRES TO GROUND (SHOCK HAZARD). THE CLAMP IS INTENDED FOR STRAIN RELIEF OF THE WIRES. SLIGHT PRESSURE IS USUALLY SUFFICIENT TO ACCOMPLISH THIS.

IF OTHER THAN NON-METALLIC CABLES ARE USED FOR SUPPLY CONDUCTORS, APPROPRIATE STRAIN RELIEF CONNECTORS OR CLAMPS SHOULD BE USED.

IN NO CASE SHOULD CLAMPING OR PINCHING ACTION BE APPLIED TO THE INDIVIDUAL SUPPLY LEADS (NEUTRAL AND "HOT" WIRES).

DANGER
SHOCK HAZARD

TO PREVENT THE POSSIBILITY OF SHOCK INJURY, THE WHITE WIRE MUST BE CONNECTED TO NEUTRAL IN THE SERVICE BOX ENTRANCE AND THE MECHANICAL GROUND MUST BE CONNECTED TO A GROUNDING LUG EITHER IN THE SERVICE BOX OR THE MOTOR GENERATOR COMPARTMENT.

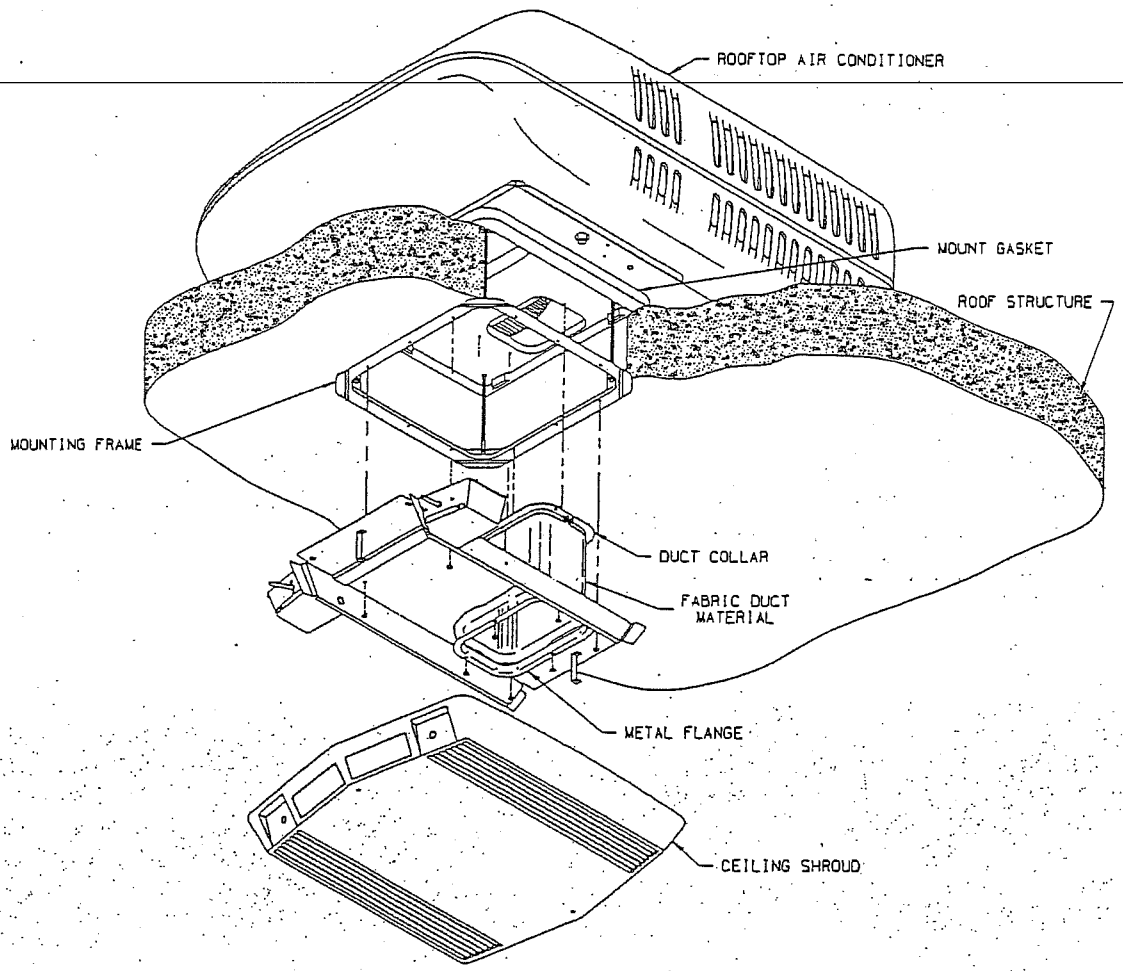


FIGURE 6

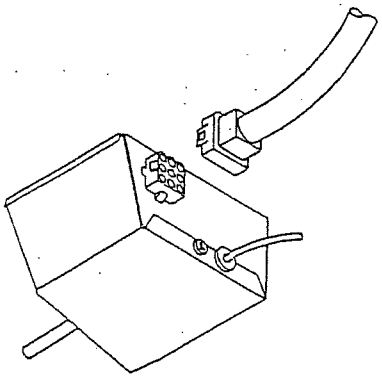


FIGURE 7

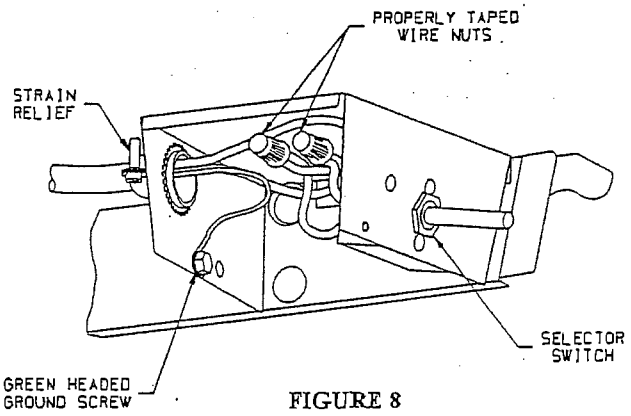


FIGURE 8

F. Install the provided cable clamp in the 7/8" dia. hole on the back of the metal field wiring box. Insert the supply wiring through the cable clamp and into the field wiring box so that 4 - 6" of supply conductor is inside the box. Secure the cable clamp over the supply wire sheath so that no movement is possible (See Figure 13).

G. Connect the supply power conductors to the black and white pigtail wires and the supply ground wire to the green pigtail wire found in the field wiring box using the 3 provided wire nuts. IMPORTANT - Connect the black supply to the black pigtail and the white supply to the white pigtail. Using a U.L. approved electrical tape, secure the wire nuts to wires in a workmanlike manner (See Figure 13).

H. Place the metal control box shield over the thermostat, switch and field wiring boxes. Make certain that all wires are pushed into the control boxes or laying in the wireway between the thermostat and switch boxes and will not be pinched by the control box shield. Control box shield is properly installed when the two holes in the shield are aligned with the two screw holes in the ceiling assembly chute (See Figure 12).

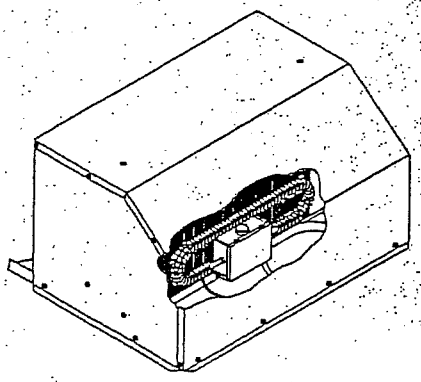


FIGURE 10

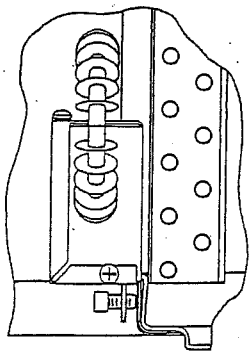


FIGURE 11

I. Raise the ceiling assembly and secure to the mounting frame with 4 provided shoulder screw/spring assemblies. The front two screws should pass through the clearance holes in the metal control box shield (See Figure 15).

J. The ceiling assembly shroud is curved to contour to a crowned ceiling. If installation is to a flat ceiling and gaps are present on the sides of the shroud, two metal clips and screws are provided to pull the sides of the shroud flush with ceiling. Position the clips through return air slots on the sides of the shroud and attach the clips to the mounting frame with provided screws (See Figure 14).

K. Pull the fabric duct material through ceiling assembly discharge opening. Peel the release liner from the adhesive strip around the discharge opening. Press the fabric duct material firmly in place around opening. Cut off excess fabric on inside of ceiling assembly chute with a box knife taking care not to tear the fabric beyond the adhesive strip.

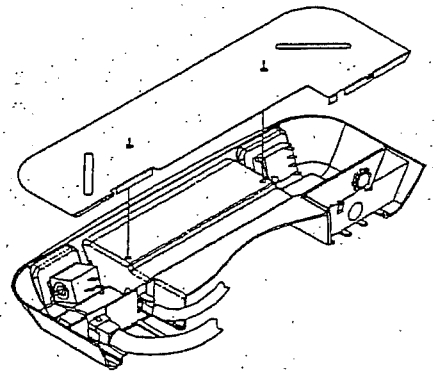


FIGURE 12

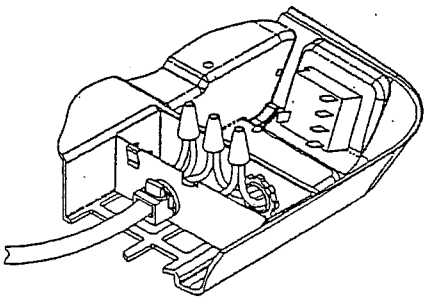


FIGURE 13

RV Products
A Division of AIRXCEL, Inc.

DATA INQUIRY SHEET
8373A896 MACH 3+
8473A896 ROUGHNECK
INTERNATIONAL SERIES
WITH R-407C

Capacity (Nominal BTUH)	Cooling - Output BTU Heating - Output BTU (1)	13,500 5,600
Electrical Rating	240 VAC, 50 HZ, 1 Phase	
Cooling Full Load AMP's At A.R.I. Standard Condition	Compressor Fan Motor Total	6.2 Low - .8 High - 1.2 7.0 7.4
Feature Equipment Amps	Heating (1)	9.0
Running Watts: (cooling) A.R.I. Standard Condition (80 F. DB/67 F. WB Indoor, 95F. DB Outdoor)	1687	
Running Watts: (cooling) A.R.I. Maximum Condition (95 F. DB/71 F. WB Indoor, 115 F. DB Outdoor)	2117	
Running Watts: (heating) (1)	1800	
Compressor Locked Rotor Amps	32.0	
Thermostat Temperature Range	Cooling - 61 F. (±5)	Heating (1) - 85F. (±5)
Metering Device	Capillary Tube	
Refrigerant Charge	8373A 12.75 oz. 8473A 15.00 oz.	
Evaporator Air Delivery (CFM)	300 CFM - High Speed	
Generator Size	See "Generators" Below	
Unit Weight (pounds) - Heat/Cool	95.0 (2)	
Use time delay fuse or circuit breaker (U.L. H.A.C.R. Type C.S.A.) Rated at 15 amps. Supply Wires 12 AWG Min. (Copper)		

(1) When equipped with Elect-A-Heat feature.
(2) Ceiling assemblies may add an additional 3.5 to 12.5 pounds depending on the model number.

CEILING ASSEMBLY: 8370-715

GENERATORS:
It is not the policy of RV Products to size generators for application in Recreation Vehicles or related structures. However, when sizing generators, the total electrical power consumption in Watts must be determined and taken into consideration, such as:

A. Maximum running watts of the air conditioner at A.R.I. maximum operating conditions (See Specifications).
B. Power consumption of electronic ovens, toasters, coffee makers, television sets, refrigerators, lights, etc.
C. Generators do lose capacity under the following conditions: (1) Altitude increases above sea level, (2) Temperature increases above certain outdoor design temperatures and (3) Lack of maintenance.

RV Products
A Division of Airxcel, Inc.
P.O. Box 4020
Wichita, KS 67204

RV Products
A Division of AIRXCEL, Inc.

SERVICE MANUAL

FOR

6700, 7000 & 8000 SERIES

AIR CONDITIONERS

(MECHANICAL CONTROLS ONLY)

FOR WALL MOUNT THERMOSTATS AND LOW VOLTAGE CONTROL CIRCUITS, REFER TO THEIR APPROPRIATE MANUALS

FOR ELECTRICAL CHECKOUTS ON DELTA T AND DELTA TX AIR CONDITIONERS, REFER TO MANUAL R-332 (2-86)

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Basic Components and Their Functions
Refrigeration System Diagram

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II. Air Handling Circuits 6

III. Electric Power Circuits 6

IV. Tools And Equipment 10

V. Service Problems And Their Solutions 13

VI. Typical Wiring Diagrams 20

QUICK DIAGNOSIS CHART

Problem	Possible Causes	Ref. Page Number
Fan And Compressor Will Not Run	No Power 115V	7
	Selector Switch	7
Fan Will Not Run	Selector Switch	7
	Fan Run Capacitor	8
	Motor	8
	Wiring (Mis-wired)	20-21
Compressor Will Not Run	Selector Switch	7
	Thermostat	7
	Run Capacitor	10
	Start Capacitor	10
	PTCR or Start Relay	10
	Overload	8
	Compressor	7-8
	Wiring (Mis-wired)	20-21

The purpose of this part of the Service Manual is to acquaint the Service Technician with the system components so that when he has a problem, he can intelligently analyze and isolate the problem and efficiently correct it.

BASIC COMPONENTS AND THEIR FUNCTIONS

1. REFRIGERANT CIRCUIT

1. Refrigerant Charge

The systems covered by this service manual all use a refrigerant called monochlorodifluoromethane (better known as R-22).

We know that R-22 is not a deadly gas because many of us have breathed it many times and we are still living. But, no one has said that R-22 is completely safe to breathe; so, a wise service technician will always keep a work space well ventilated if R-22 can escape into the air. IF R-22 IS RAISED TO A HIGH TEMPERATURE IN THE PRESENCE OF WATER (which always exists in the atmosphere), IT DEFINITELY DOES BECOME A TOXIC GAS by changing from virtually harmless R-22 to phosgene, hydrochloric and hydrofluoric acids. So, if R-22 in the air is exposed to a welding or soldering torch flame, burning water heater burner, burning furnace burner, etc., be sure to avoid breathing it.

The temperature at which R-22 changes to toxic gases and acids varies with the amount or concentration of water present i.e. the greater the concentration of water, the lower the temperature and vice versa. High temperatures normally exist inside a refrigeration circuit, so we must keep the circuit as absolutely dry as possible to prevent the formation of destructive acids.

Liquid R-22 in the atmosphere will always be at about -41°. Therefore, always wear safety glasses when working with R-22.

Again unburned R-22 is not a deadly gas, so by using reasonable safety precautions, the service technician will not be hurt by it.

In addition to being almost non-toxic, R-22 is non-flammable, non-explosive, non-corrosive and miscible (mixable) with oil. It also has a rather high latent heat value. This means that is must absorb a large amount of heat per lb. to vaporize or change from a liquid to a vapor; and it must give up a large amount of heat per lb. to condense or change from a vapor to a liquid.

2. High and Low Sides

It is customary for air conditioning technicians to use the terms high side and low side. In doing so, we refer to the parts of the refrigeration circuit which, when the system is running, contain high pressure refrigerant (high side) and low pressure refrigerant (low side). The high side of these systems exists from the discharge port of the compressor to the cap tube. The low side is from the cap tube to the compressor cylinders. The dividing points then are the cap tube and compressor cylinders.

The high side pressure is also referred to as head pressure or condensing pressure, and the low side pressure is also referred to as suction pressure or evaporator pressure.

It is impossible to state the exact pressures that will exist in the high side or low side because those pressures will both vary with different temperature and humidity conditions between inside and outside the recreational vehicle.

3. Capillary Tube (Cap Tube)

The refrigerant enters the cap tube from the condenser as a warm high pressure liquid. As the refrigerant flows through the small diameter cap tube, the pressure drops rather rapidly. As the pressure drops, a tiny amount of the liquid refrigerant will vaporize. This vaporization requires heat which must come from the liquid refrigerant itself - thus the liquid temperature is constantly lowered as it passes through the cap tube. As the refrigerant leaves the cap tube, it is still mostly liquid; however, a small portion has changed to a vapor called flash gas. When the liquid refrigerant passes from the cap tube to the evaporator, it is at low side pressure and will therefore, vaporize at low temperature as it picks up heat from the air being conditioned.

4. Evaporator Coil

The purpose of the finned evaporator coil is to transfer the heat from the warm and moist indoor air to the cold low pressure refrigerant.

As the heat leaves the air, the air temperature drops and some of the moisture in the air condenses from a vapor to a liquid. The liquid water (condensate) is drained onto the roof of the recreational vehicle. As the heat enters the refrigerant in the evaporator, it causes the refrigerant to evaporate (change from a liquid to a vapor). Thus the name – evaporator.

The refrigerant remains at nearly constant temperature (called evaporator temperature or low side saturation temperature) in the evaporator as long as there are both liquid and vapor together. However, near the outlet of the evaporator coil, all of the liquid has boiled (evaporated) away and from there on the temperature of the vapor rises (the vapor becomes superheated). It is necessary that the vapor

2. Power Supply - from Commercial Utility

1) Wire Size

The power supply to the air conditioner must come through a circuit breaker or time delay fuse. The power supply must be 20 amperes and 12 AWG wire minimum. Any size larger at any time may be used and should be used if the length of the wire is over 32 feet.

2) Color Code

The electric power from the electric service panel should be delivered through a 3 conductor cable and the Service Technician should check to be sure the color code is correct. The electrician probably installed the cable with the colors according to code, but don't bet your life on it.

a) The wire with black insulation is the hot wire and there should be 115 volts (domestic USA) between it and either of the other wires. All switches, fuses, circuit breakers, disconnects, etc. should be in this line.

b) The wire with the white insulation is the neutral. There should be 115 volts (domestic USA) between the neutral and the hot (black) wire, but there should be 0 volts between the neutral and the ground (the green wire or the frame of the air conditioner). **There must be no switches, fuses, disconnects, etc. of any kind in the neutral wire.**

c) The third wire may be covered with green insulation or it may be a bare metal wire. It is the ground wire. There must be 115 volts (domestic USA) between this wire and the hot (black) wire and 0 volts between it and the neutral (white) wire. The ground wire must be securely fastened to the air conditioner cabinet. A ground screw is provided for this purpose.

3) Voltage

The voltage (electrical pressure) at the unit should be 115 volts (domestic USA) and all electrical components will perform best at the correct voltage. However, the voltage will vary and the air conditioning system will perform satisfactorily within plus or minus 10% of the rated (115) voltage (domestic USA). Therefore, the voltage has to be between 103.5 volts and 126.5 volts.

3. Power Supply - Generated by on-board motor generator

If the power supply for the recreational vehicle is supplied by an on-board motor generator, its wiring may be identical to the commercial power described above.

There are, however, some motor generators on which both the current carrying leads are insulated from the ground. That is to say; there is no grounded neutral, so there will be 115 volts (domestic USA) between the black and white leads, but there will be 0 volts between either lead and ground.

WARNING: The service technician must keep in mind when checking to make sure that the power is turned off. Check only between the hot (black) lead and the neutral (white) lead.

4. Selector Switch - Free Delivery Ceiling Assemblies

The selector switch is mounted on the left side of the interior ceiling assembly. The selector switch allows the unit to be operated on high to low blower only, or high to low blower with compressor operation for cooling. On heating and cooling models, the selector switch can also switch in the electric heater at low blower operation only.

5. Thermostat (Mechanical Rotary)

The thermostat (temperature controller) is mounted on the right side of the interior ceiling assembly. The thermostat controls the on-off cycle of the compressor when the selector switch is in the cooling position and on heating and cooling models, the on-off cycle of the electric heater when the selector switch is in the heating position. The thermostat is actuated by sensing the temperature of the return air through the vent where the bulb is located.

6. Compressor Motor

The compressor motor is located inside the hermetic compressor housing and therefore not accessible for service or visual observation in the field. However, the motor winding condition can be analyzed by using an ohm meter. Be sure to remove all the leads from the compressor terminals before making this check.

1) If the resistance between any two terminals is 0 ohms, the motor windings are shorted.

2) If the resistance between any terminal and the compressor housing is anything but infinity, the winding is grounded.

3) If the resistance between any two terminals is infinity, the winding is open.

a) Disconnect all electrical power to the air conditioner.

b) Discharge the capacitor with a 20,000 ohm (approx. 3 watt) resistor or larger.

c) You may discharge capacitors with a standard volt meter if you use a scale over 500 volts and touch the leads (one lead to each side of the capacitor). The volt meter will discharge the capacitor.

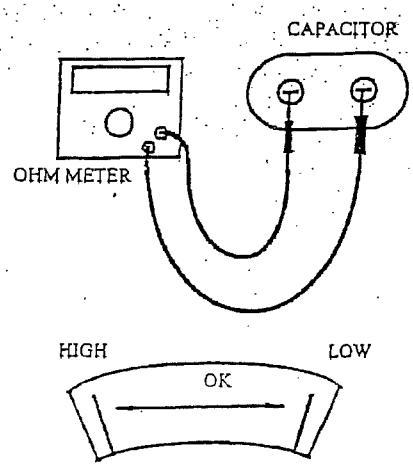
d) Identify and disconnect the wiring from the capacitor.

e) Set and zero the ohm meter on the "highest" scale.

When testing for a good, open or shorted capacitor, perform the following checks: Place the ohm meter leads across the capacitor terminals (one lead on each terminal) and perform a continuity test. Then observe the action of the meter needle or indicator. Reverse the leads and test again. The result should be the same. Note: If the capacitor had not been properly discharged, a false reading could be indicated on the first test. Always test several times (reversing the leads with each test). This will verify the capacitors condition.

Good Capacitor

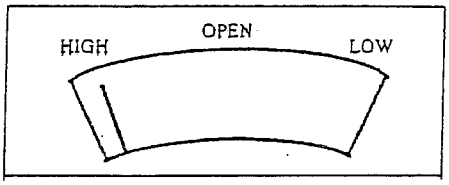
If the capacitor is good, the indicator will move from infinity (the left side), up towards zero ohms and slowly return back to infinity. Reverse the leads and test again. The result should be the same.



Indicator sweeps back and forth as shown above. Capacitor is good.

Open Capacitor

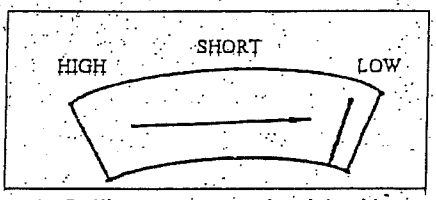
If the capacitor is open, the indicator will show no deflection or movement. Reverse the leads and test again. If there is no indicator movement on the second test, the capacitor is open. Open capacitors are defective and must be replaced.



Indicator shows no movement. Needle stays to the left side. If needle shows no movement after reversing the leads, the capacitor is open.

Shorted Capacitor

If the capacitor is shorted, the indicator will move towards and sometimes hit zero ohms, and will stay there. This indicates a completed circuit through the inside of the capacitor (shorted). Shorted capacitors are defective and must be replaced.



Indicator moves to the right side of the scale and stays there (indicating a completed circuit). The capacitor is shorted.

I. Ammeter And Its Use

An ammeter is an instrument for measuring electric current. Current electricity is actually electrons moving from one atom to another through a conductor. In order to intelligently use electricity, we must have a measurement of a quantity of electrons.

The instrument we use to measure the number of amperes is called an ammeter. The handiest ammeter to use in our business is an AMPROBE. These instruments have snap-around jaws that will allow you to read the current through a wire without detaching the wire from the system. Always buy an energizer with the instrument so that you can accurately read low current circuits. These meters also have volt meter and ohm meter attachments so they are an excellent multi-purpose meter. NO TECHNICIAN SHOULD EVER ATTEMPT A SERVICE CALL WITHOUT ONE.

1. Ohm Meter And Its Use

An ohm meter or resistance meter indicates the resistance of a circuit to current flow. Just as every water pipe or hose has a resistance to water flow or every air duct has resistance to air flow, so does every wire have resistance to the flow of electric current. There is no such thing as a conductor with zero resistance to electron flow although sometimes we will be measuring the resistance of a conductor and find it so low that we cannot detect any resistance; so we call the resistance zero. What we mean is that the resistance is so low that we can't find it. The amount of resistance or holding back force of the wire or conductor depends on:

a) The material the conductor is made of; silver, copper and aluminum are good conductors. This means that in any given size wire, these materials will have low resistance. Silver has the lowest resistance, but its price is too high, so we use copper.

b) The diameter of the wire. The longer the wire, the greater the resistance because there is more metal to carry the current.

c) The length of the wire. The longer the wire, the greater the resistance. In fact, the resistance of any wire varies in direct ratio with its length.

d) The temperature of the conductor. The resistance of most - but not all - conductors increases as the temperature of the conductor rises. Hence, the resistance of the filament of a light bulb is rather low when it is turned off and cooled down; but when the power is turned on, the filament temperature increases until it glows and the resistance increases.

Resistance to electron flow is measured in units called ohms. An ohm is actually the amount of resistance that will hold the current down to one ampere (one coulomb of electrons per second) if there is one volt of pressure.

An ohm meter is really a resistance meter that is calibrated in ohms. The ohm meter has its own power source, a small dry cell, which forces a small amount of current through a conductor via the meter probes. The meter must be calibrated to read 0 ohms when the probes are touched together each time it is used because as the dry cell loses its charge, the meter will get out of calibration.

If the probes of an ohm meter are attached to the terminals of a closed switch, the meter will read 0. This means that there is virtually no resistance to current flow through the switch. Now, if the switch is turned off, the contacts will be open and there will be very high resistance. In fact, the resistance is so high it is an infinite number of ohms so we call this reading infinity.

With the switch open, there is not a continuous conductor through it so we say there is no continuity. If the ohm meter reads anything other than infinity, we say we do have continuity. As can be seen from the above example, an ohm meter is a good instrument for checking to see if the contacts of a switch, thermostat, relay, overload, etc. are closing properly or creating continuity.

The previous examples show two conditions that can be detected by an ohm meter; (1) a closed, 0 resistance conductor and (2) an open circuit which reads infinity or no continuity. Now let's consider something in between – the windings of a compressor. If we attach the ohm meter probes to the common and run terminals of the compressor, we can read the resistance of the main or run winding. The winding is a solid and continuous copper wire so there will be continuity through it; but instead of 0 ohms, as there was through the closed switch, this winding is of such small wire and so long that there is resistance. Now let's attach the probes to the common and start terminals to get the resistance of the start of phase winding. Since this winding is made of even smaller and longer wire, its resistance will be greater than the main winding. Now let's attach the probes to the start and run terminals to read the resistance through both windings. This reading is the same number of ohms as the total of the two previous readings.

If the reading between any two terminals is infinity, we can determine that the winding is open – the wire is broken or burned in two. If the reading between any two terminals is 0 ohms, the insulation is burned off the winding and we can determine that the compressor motor is shorted. If the reading between any terminal and the compressor housing is anything except infinity, we can determine that the compressor motor is grounded. An open, shorted or grounded compressor must be replaced. The fan motor

8. Leak Detectors

It is strongly recommended that a Service Technician carry two types of leak detectors at all times.

1. Most all electronic leak detectors are very sensitive and are field reliable. A word of warning – do not "give it a whiff of refrigerant" as a test to see if it is working because its sensitivity and life expectancy diminishes as it is exposed to refrigerant.

   Always use this instrument as a final leak test. It will find the very small leaks that take several weeks to cause trouble but will cause a burn out if not repaired.

2. With an electronic leak detector, a leak is sometimes difficult to pinpoint – you can find the general area of the leak, but not its exact location. A soap bubble type leak detector will show its exact location.

9. Brazing Equipment

For all brazing work, a Prest-O-Lite type torch with a #4 tip will be most satisfactory. You need a torch type that burns with a soft flame that is easy to control and is hot enough for brazing refrigerant tubes. The easiest and most satisfactory brazing rod to use is Sil Fos or Stay Silv – 15% silver. This rod can be used to blend with any brazing rod that exists on today's units.

CAUTION

Always have a dry powder fire extinguisher with you (not in your truck) while you are brazing.

10. Gauge Manifold

Gauge manifold sets are used for checking pressures, evacuating and recharging the a/c.

Basically a gauge manifold consists of a compound gauge and a high pressure gauge mounted on a manifold with hand valves to isolate the common (center) connection or open it to either side as desired.

Connecting the gauge manifold to the system is necessary to read the suction pressure and head pressure, and to intelligently analyze a system for malfunction. Any service technician will naturally hesitate to connect his gauges because to do so involves opening a hermetic system.

The R-22 that is in the system will have to be released to a refrigerant recovery system (see equipment manufacturer's guide for system access information).

V. SERVICE PROBLEMS AND THEIR SOLUTIONS

When a recreational vehicle owner calls for service on his air conditioner, let him explain exactly what has happened; when the air conditioner first gave him trouble, what is sounded like, how hot was the weather, what time was it, etc. He is a rich source of information. Listen to everything he says. You will compliment him and he will help you to identify the problem.

Always be alert for a customer who has been working on his own equipment. Check all wiring and visually inspect all motors, fans, capacitors, dampers, tubing, etc.

When a Service Technician gets all the information he can from the customer, he then examines the equipment for more facts that might lead to the cause of the problem (always be on the alert for loose or burned wires, smoke stains, kinked or broken tubes, oil stains, etc. - those things which would obviously cause a malfunction or would indicate a malfunction).

After he gets all the available information together, he starts asking himself questions:

"What causes has the information eliminated and why?" (For instance, if the compressor is running, that eliminates a tripped circuit breaker as the cause of the problem.)

"What are the possible causes?"

"Which of the possible causes are the most probable ones?"

"How should I check them out?"

For each of his questions, he expects an answer. Since there is no one else around qualified to answer his questions, he must supply the answers himself.

As his questions and answers eliminate the possible causes one by one, he will soon identify the reason for the malfunction. Then he can repair it.

ISOLATE THE PROBLEM – THE SOLUTION IS SIMPLE.

Problem

1. Nothing runs.

The customer turns the selector switch to the "Cool" position and the thermostat to a low temperature (below room temperature) and nothing happens. This is surely a serious problem, but it is usually the easiest to correct.

Problem

3. No Cooling.

The customer turns the selector switch to "Cool" and the thermostat to a low temperature (below room temperature). The fan runs OK, but the unit does not cool. When the unit housing is removed, we observe that the compressor does not run and it does not hum (the compressor is completely dead).

Question: "What are the possible causes?"

Answer:

1. "The selector switch may be open to the compressor."

   Check around selector switch (LA to 4) with ohm meter.

2. "Thermostat may be open."

   Check around thermostat (2 to 3) with ohm meter.

3. "Overload switch may be open."

   Check around overload switch with ohm meter.

4. "Compressor winding may be open."

   Check out compressor windings with ohm meter. See the section on compressors.

   Notice that when we are using an ohm meter, the power must be turned off. It is also important to disconnect all wires from a conductor being checked with an ohm meter to prevent any chance of feedback.

Problem

4. No Cooling.

The customer turns the selector switch to "Cool" and the thermostat to a low temperature (below room temperature). The fan runs OK, but the unit does not cool. When the unit housing is removed, we observe that the compressor does not run; however, it periodically hums for 15 to 30 seconds.

Question: "Could the cause of the trouble be the circuit breaker or fuse, the selector switch or the thermostat?"

Answer: "No - because we know that power is getting to the common and run terminals of the compressor to make it hum and the Thermal-Current Overload switch is breaking the circuit to protect the compressor from burn out."

Question: "What are the possible causes of the problem."

Answer: The possible causes are –

2. "The voltage could be low – "

   a) Check the voltage between #1 on the overload switch and the "R" terminal of the compressor while it is not humming. This voltage must be 115 volts domestic USA models or 240 volts export/overseas models. No less than minus 10% is allowable.

   b) Check the voltage from "C" or "R" of the compressor while it is humming (trying to start). The latter reading will probably be lower, but it still must be 103.5 volts minimum domestic USA or 216 volts minimum export/overseas models.

   If the first reading is above 103.5V domestic USA and the second is under 103.5V domestic USA, there is too much voltage drop in the lines - a situation which must be corrected for the air conditioner to perform safely and satisfactorily.

2. "A capacitor could be shorted, weak or open."

   Turn the power off at the selector switch. Remove the capacitor and relay box and carefully (do not jar it any more than absolutely necessary) lay it down beside the unit with all wires still attached.

   Recheck to be sure the power is off.

   Caution – There is always a chance that a capacitor is holding a residual charge, so before touching a terminal, discharge the capacitor as explained earlier in this booklet.

   Remove capacitors, visually examine them and test them per instructions given in earlier section on capacitor testing.

   If the capacitors test OK, replace them and carefully reconnect the wires. Be sure the wires are connected to the right terminals.

The fan motor and fans were carefully balanced at the factory, but they are fragile enough that they can be bent by rough handling.

Question: "How can I determine which part of the fan assembly is causing the vibration?"

Answer: "By removing the fan wheels one at a time and running it each time until the vibration stops. To correct the problem, replace the faulty part."

Problem

8. Fan won't run.

The customer turns the system to fan/low or fan/high and nothing happens. When he turns the selector switch to "Cool", the compressor starts but still no fan.

Question: "What could cause the fan to be dead?"

Answer:

1. "The selector switch could be open."

   The safest way to check a selector switch is to turn off all power and check the switch for continuity with an ohm meter.

2. "Circuit could be open in hot lead to "C" (white wire) on fan motor."

   Turn power off at selector switch. Check connection between red and black wire. Be sure wire nut is tight.

3. "Fan motor windings could be open, shorted or grounded."

   Be sure power is still off at selector switch. Check motor windings per instructions.

4. "Fan capacitor may be shorted, weak or open."

   To check fan capacitor, follow same procedure that is outlined for compressor run capacitors.

Problem

9. Compressor runs but won't pump.

The customer turns the selector to a "Cool" position and the thermostat to a low temperature setting (below room temperature). The fan runs OK, but the unit does not cool. On examination we find that the compressor does run. It runs quietly and smoothly. We check the compressor current and find that it is below the FLA rating. The evaporator is warm, the suction line is warm. There are two possible problems, either the compressor valves are broken or the unit is completely out of charge. At this point, you must break into the system to locate the problem.

Problem

10. Compressor cycling off and on.

The customer says he gets inadequate cooling even though he has several times set the thermostat down to call for a lower temperature until it is now all the way down to the lowest possible setting.

On investigation, we find that the compressor is cycling off and on.

Question: "What could cause the compressor to cycle off and on?"

Answer: "Two things."

1. "The thermostat is out of calibration. Turn off power. Check with ohm meter."

2. "The compressor is cycling on the thermal current overload."

   With the power on, check the voltage between the terminals of the overload while the compressor is not running. If the meter reads 115 volts domestic USA models or 240 volts export/overseas models, the compressor is cycling on this switch (see page 8 for description and function of this switch).

Question: "What could cause the switch to open and close?"

Answer: "Compressor is running hot or compressor is drawing excess current or both."

Check by:

1. Feeling the compressor dome - it will normally (during warm weather - above 85℅) be too hot to be comfortable if you keep your hand on it. If it is burning hot, it is probably overheating. The normal compressor housing temperature varies with outside temperature and evaporator load so determining whether or not it is too high is a matter of judgement based on experience.

2. Measuring the current (amperes) through the black wire which leads from #5 on the potential relay to the overload switch. This current may be compared to the unit FLA rating.

c) The compressor temperature will be noticeably higher than normal.

Note: Low charge situations may be mimicked by problems such as dirty filters, dirty evaporator coils, air flow restrictions and low load conditions. Do not attempt to tap into the system unless you are specifically trained in refrigeration system repairs.

6. "Plugged up cap tube."

A cap tube can become stopped up by oil sludge or contaminants in the system. This will only occur if the system has been open to allow moisture or other contaminants to enter the system or if the compressor has been overheated for a lengthy period of time.

It is difficult to determine the difference between a stopped up cap tube and a low charge because the symptoms will be nearly the same.

To repair either a low charge or stopped up cap tube, we will have to install service valves and attach gauge manifold. If after the correct amount of refrigerant has been charged into the system, and it has low charge symptoms, we will know the cap tube is plugged and will have to be replaced.

Problem

12. No heat - Heat Strip.

The customer says that he has turned the selector switch to "Heat" position and the blower works OK, but no heat.

Question: "What are the possible causes of "no heat" problem?"

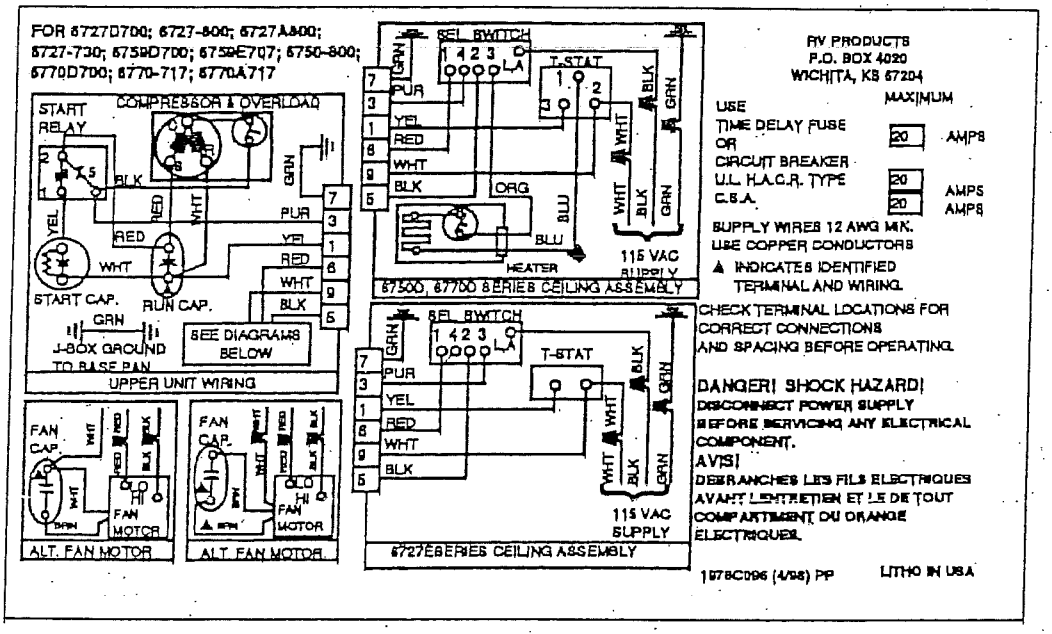
Answer: 1. "The limit switch or the heating element could be open."

2. "The selector switch could be open."

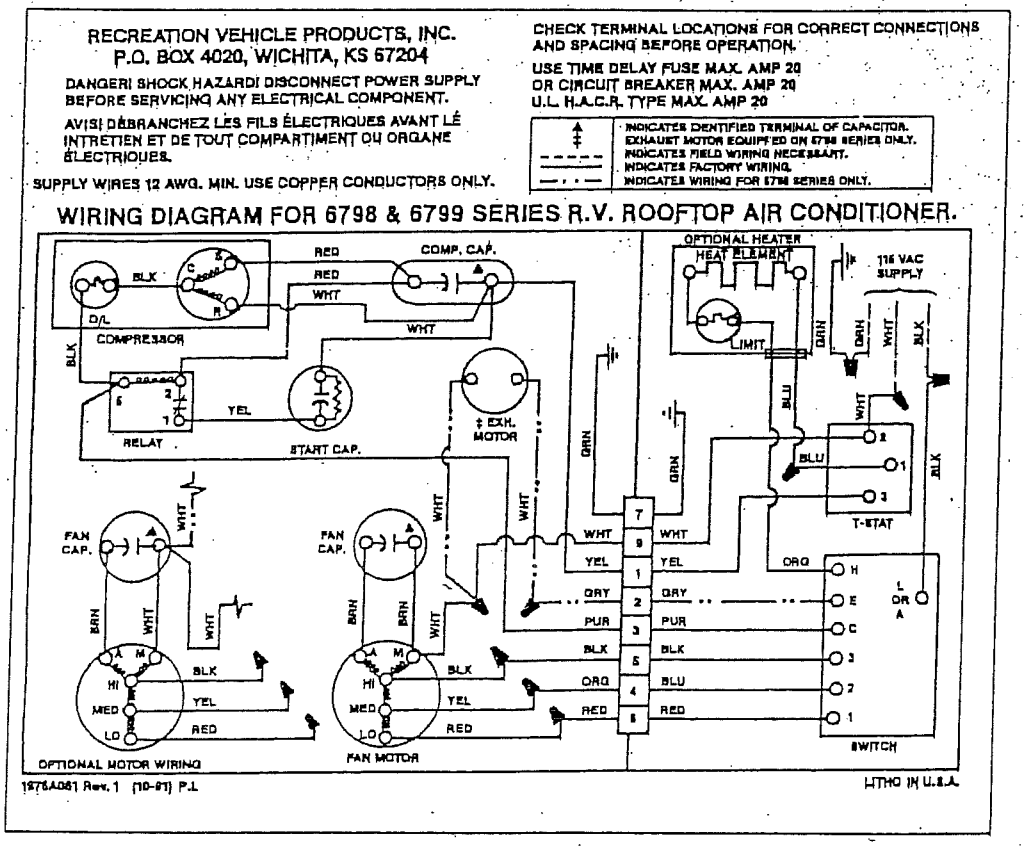
3. "The thermostat could be open."

In all three cases, turn off power and check for continuity with an ohm meter.

6700 SERIES



6798-6799 SERIES



RV Products
A Division of AIRXCEL, Inc.

REPAIR PARTS LIST
FOR
8473 SERIES ROUGHNECK ROTARY
AIR CONDITIONERS 220-240V, 50 HZ

LISTE DE PIÈCES
DE RECHANGE POUR
LES CLIMATISEURS ROTATIFS ROUGHNECK
DE SÉRIE 8473 220-240V, 50 HZ

ERSATZTEILLISTE
FÜR KLIMAALAGEN
SERIE 8473 ROUGHNECK ROTARY 220-240V, 50 HZ

MODELS MODÈLES MODELLES

8473-89X ROTARY
ROOF TOP UNITS

RV Products
A Division of AIRXCEL, Inc.

8473-896

CODE	MODEL USED ON	PART NUMBER	DESCRIPTION	NO. REQ.
1	All	6792-5111	Screw & Washer Package (4/Pkg.)	1
2	All	8333-4161	Shroud (Arctic White) With Logo	1
3	All	1452B1301	Condenser Coil	1
4	All	6792-1071	Fan Shroud	1
5	All	6733-3221	Fan Blade	1
6	All	1450-0031	Overload	1
7	All	1450A2029	Compressor (RK222JT-009)	1
8	All	6759-3081	Compressor Mounting Package (3/Pkg.)	1
9	All	1468-3139	Motor	1
10	All	8333-5151	Motor Mount	1
11	All	1472-1091	Impellor	1
12	All	7473-1351	Cap Tube (Formed)	1
13	All	1497-4141	Start Relay	1
14	All	1499-5661	Run Capacitor (Comp. 25 Mfd/370V)	1
15	All	1497-1081	Start Capacitor (108-130 Mfd/165V)	1
16	All	1499-5461	Fan Capacitor (7.5 Mfd/370V)	1
17	All	6792-5491	Conduit & Wiring Assembly	1
18	All	1452A155	Evaporator Coil	1
19	All	7473A301	Compressor Stabilizer	1
20	All	7473-3021	Flexible Refrigeration Hose	1
21	All	7473-3021	Flexible Refrigeration Hose	1
22	All	6770-3011	Compressor Snubber	1
23	All	7473-501	Top Brace	1
24	All	8333-109	Wirebox Door	1
25	All	8333-507	Side Panel (Left)	1
26	All	8333-505	Side Panel (Right)	1
27	All	8333A5061	Evaporator Cover Assembly with Insulation	1
28	All	8332-3301	Gasket Package	1
29	All	8333-1501	Drain Pan	1
30	All	8333-1011	Basepan w/foam scroll	1
31	All	8333-516	Spacer Plate Assembly	1
32	All	8333-111	Motor Bracket	1
ns	All	8333-1551	Shroud Bracket	2

10 MISCELLANEOUS

LMI & Controller Operator Manual

M220E

SN 1232

FAVELLE FAVCO
The Cranemakers

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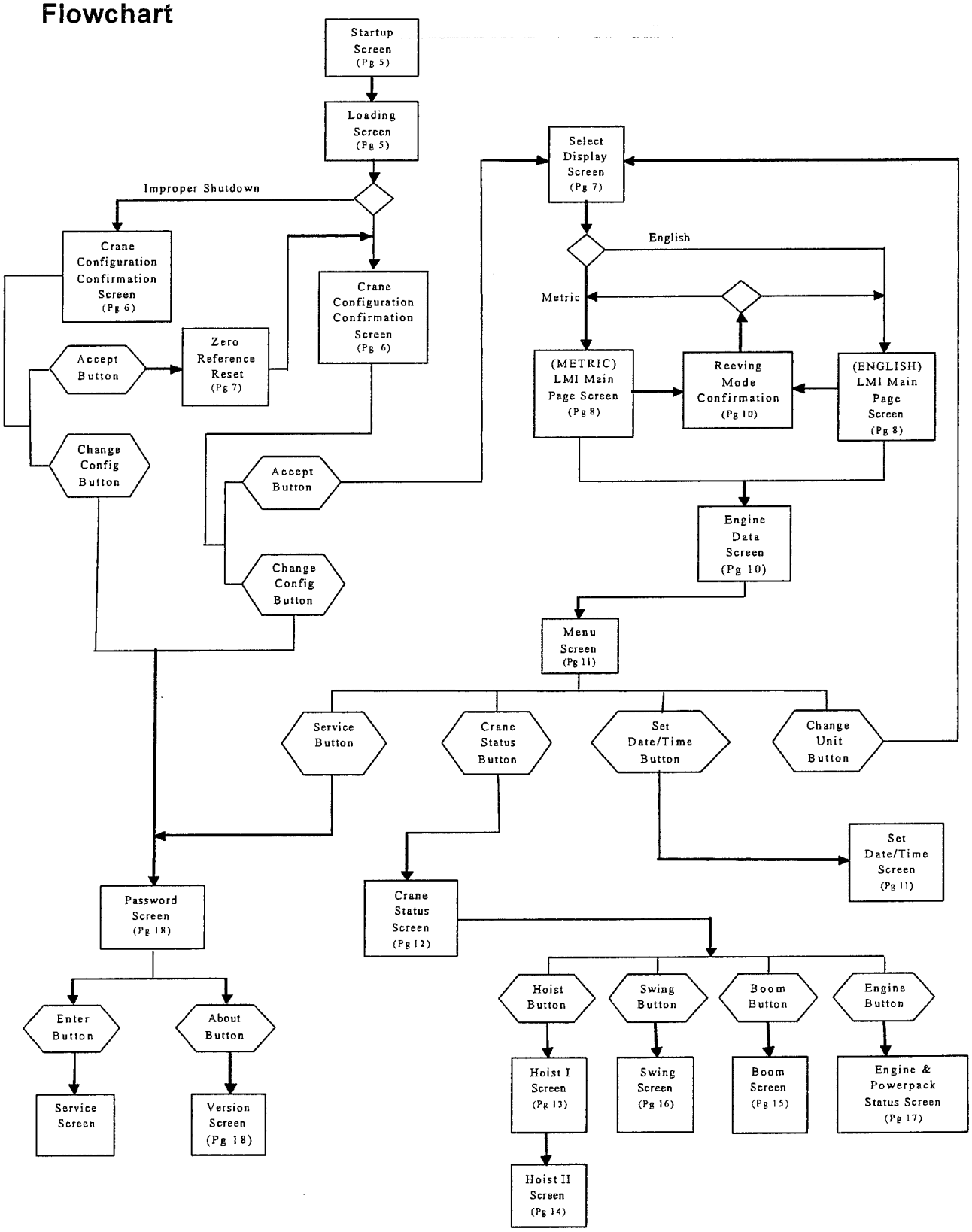
Crane Status 12

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Flowchart


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Startup Screen



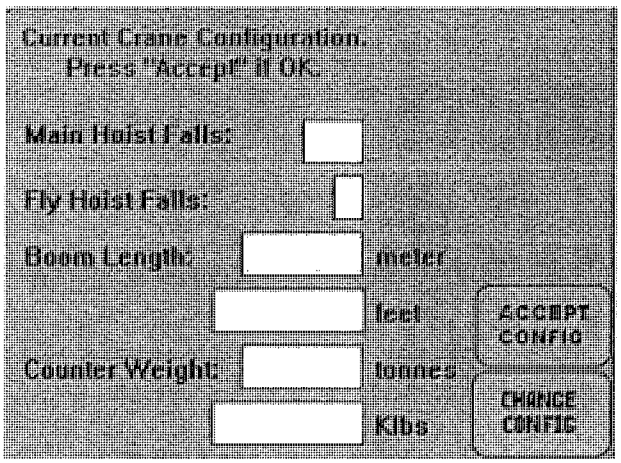
When ignition key is switched on, this startup screen will appear showing the display is trying to establish communication with the controller.

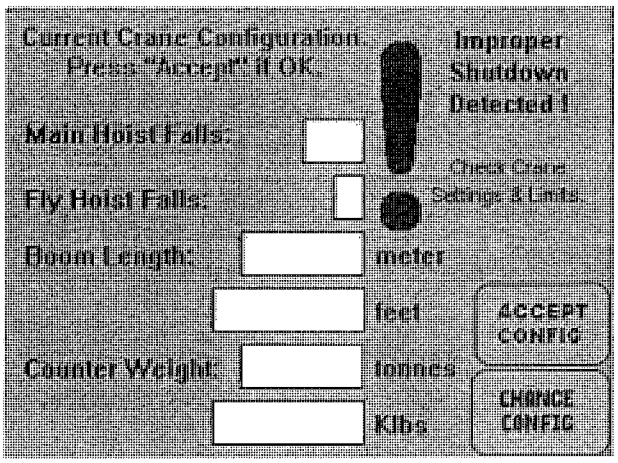
Loading Screen



After approximately 2 seconds this screen will appear. During this period all required data is being loaded.

Crane Configuration Confirmation Screen





Normal Operation

After all the required data has been loaded, this screen will appear. Here, the crane operator is required to confirm the current crane configuration by pressing the **ACCEPT CONFIG** button. If there is a need to change the current crane configuration, press the **CHANGE CONFIG** button.

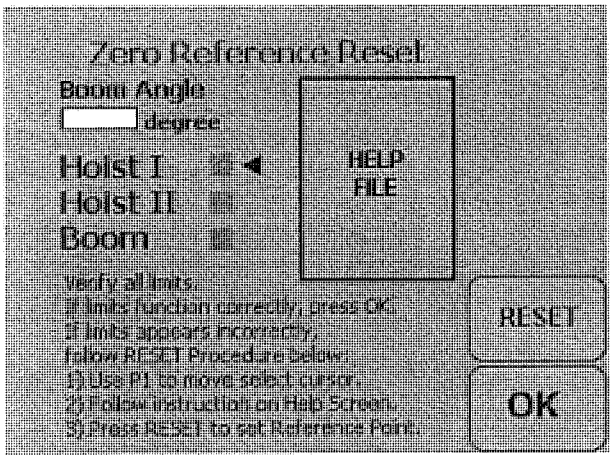
NOTE: Password is required to change the crane settings.

Improper Shutdown

If an improper shutdown is detected, confirmation page screen will look like the above. When the ACCEPT CONFIG button is pressed, the ZERO REFERENCE RESET screen will appear.

Improper Shutdown:
An incident where there is a sudden loss of power to the controller and sensors.

Zero Reference Screen



Zero Reference Reset Page

If there is an improper shutdown, such as power failure, and the operator select the ACCEPT CONFIG Button, this screen would be displayed. Here, the operator needs to Reset the Limits to its Zero Reference Point. After every limits has been resetted to its Zero Reference Point, the operator needs to press the OK button, and this will bring the operator back to the Confirmation Page.

Reference Points Definition and Settings

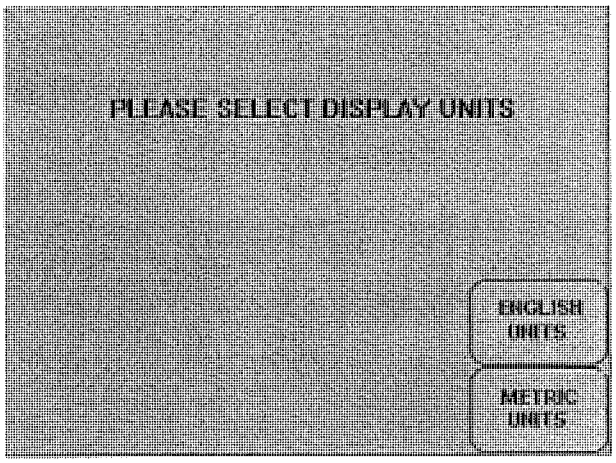
Boom

Boom to 45'. Press OK.

Hoist I & Hoist II

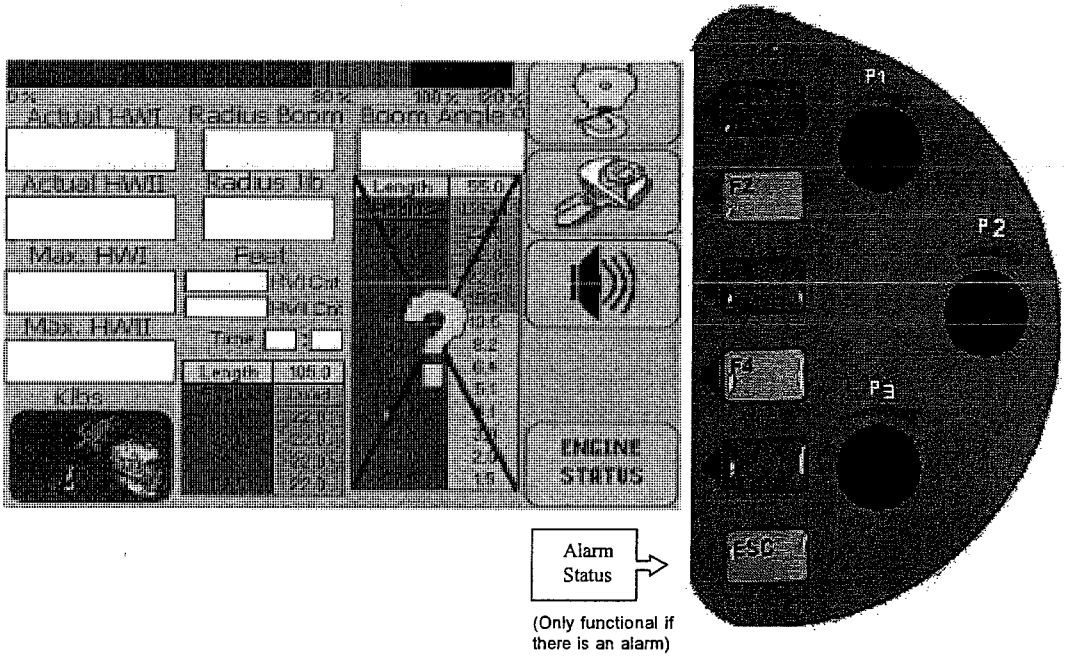
Boom to 75'. Bring the hook to Boom Pivot Point level. Press OK.

Select Display Screen

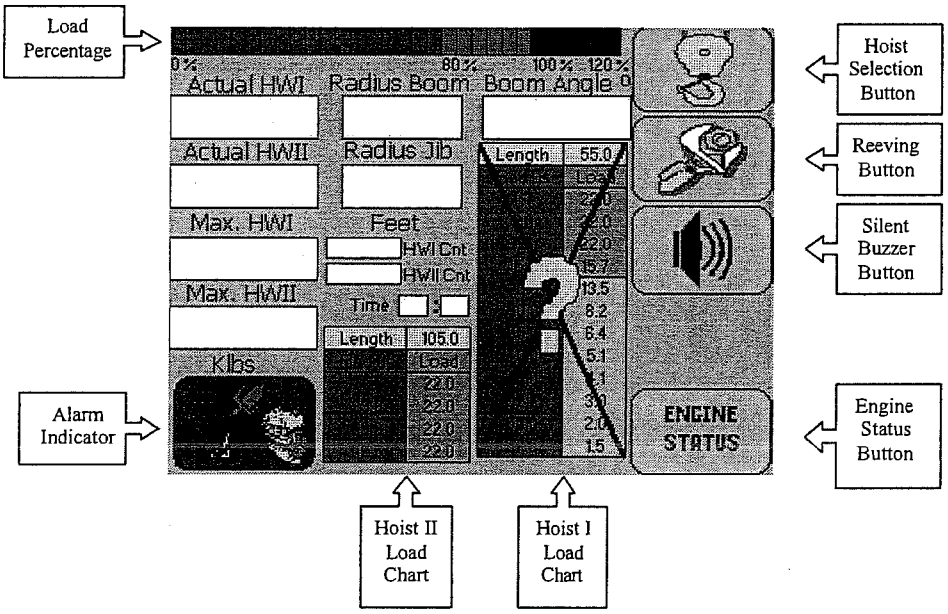


Once the crane configuration has been verified by the operator, the display will be showing this screen. Here, the operator can choose to have the LMI Main Screen in the "English Units" or in the "Metric Units".

LMI Main Page Screen



If "English Units" is selected, the LMI Main Screen will look like the above. "Metric Units" screen is shown below. For the purpose of this manual, the "Metric Units" wil be used to describe all the functions.

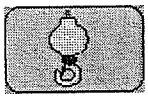


Hoist Selection Button [F1]

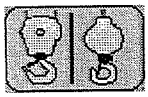
By default, main only indicator will be shown. Other selection is only possible i the crane is configured to have an auxiliary attached.



Main Only
Only the main hoist will be functioning. During this mode, the main hoist will be able to reach its maximum speed.



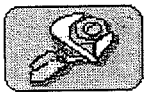
Fly Only
Only the fly hoist will be functioning. During this mode, the fly hoist will be able to reach it's maximum speed.



Main & Fly
The main hoist and fly hoist will be able to work simultaneously. However, the maximum speed of both the main hoist and fly hoist will be reduced.

Reeving Button [F2]

If this button is pressed, the display will show another screen where the crane operator/authorized personnel need to confirm the Reeving Mode selection.



Reeving Mode OFF
During this mode, all crane limits will be in effect.



Reeving Mode ON
During this mode, all the crane limit, Hydraulic Alarm and Engine Alarm will be by-passed. It's the operator's responisbility to ensure the safe handling of the crane.

If the Reeving mode is ON, the indicator below will be displayed at the Hoist II load chart. Under this mode, the crane can only lift up to a max load of 2 tonne. Note that the LMI is not bypassed and there is no loadchart shown.



CAUTION: All limits and alarms will be disabled. This mode should only be used during erection.

Buzzer Indicator [F3]



Buzzer On
Used when the operator wishes to cancel the audible alarms.



Buzzer Off
Pressing this button will mute the audible alarm for a period of 5 minutes.

Alarm Indicator



Indicates that there is a HYDRAULIC ALARM. Press ESC button for more detailed information.

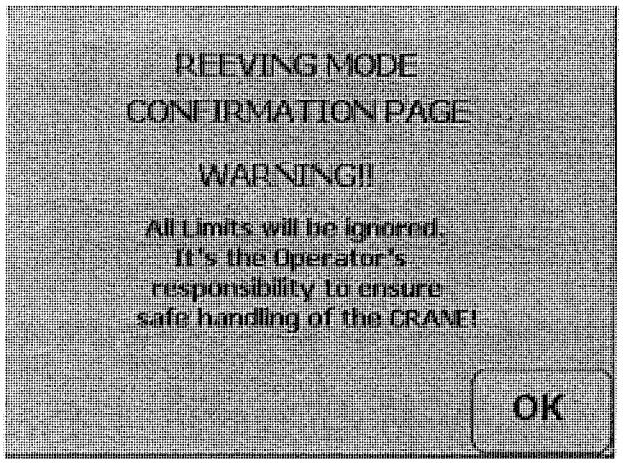


Indicates that there is a CRANE LIMIT ALARM. Press ESC button for more detailed information



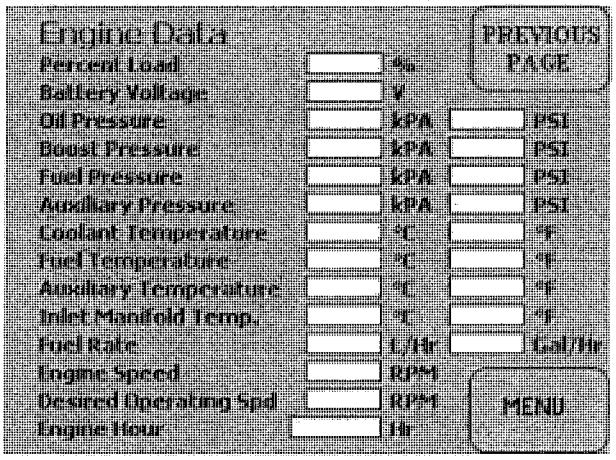
Indicates that there is an ENGINE ALARM. Press ESC button for more detailed information.

Reeving Mode Confirmation Screen



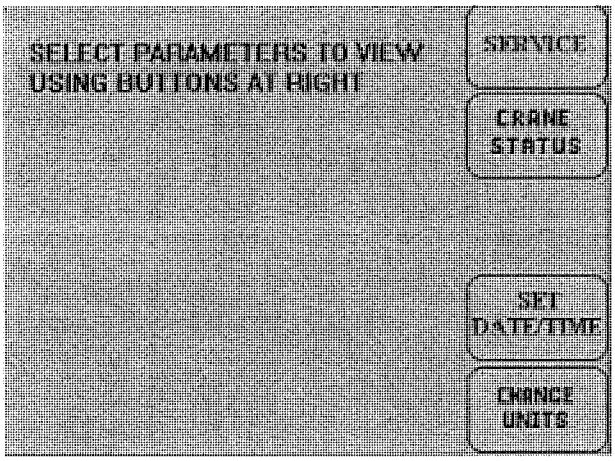
When the Reeving button is pressed, this screen will be displayed. Here the operator is required to confirm the Reeving Mode request by pressing the OK button. If the operator does not want the crane to be in Reeving Mode, ESC button can be pressed to cancel the selection.

Engine Data Screen



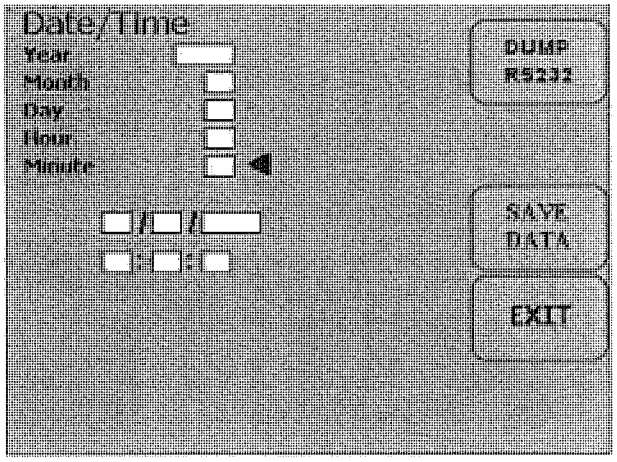
When the Engine Status button is pressed, this screen will appear. Here, the various Engine Data is displayed.

Menu Screen



When the MENU button is pressed, this screen will be shown. Here, the operator can choose to either go to the service menu by pressing the Service button, or view the crane status by pressing the Crane Status button. On this screen, the operator can also change or set the date and time, or change the LMI Main Screen's units, from the Metric Units to English Units, and vice versa.

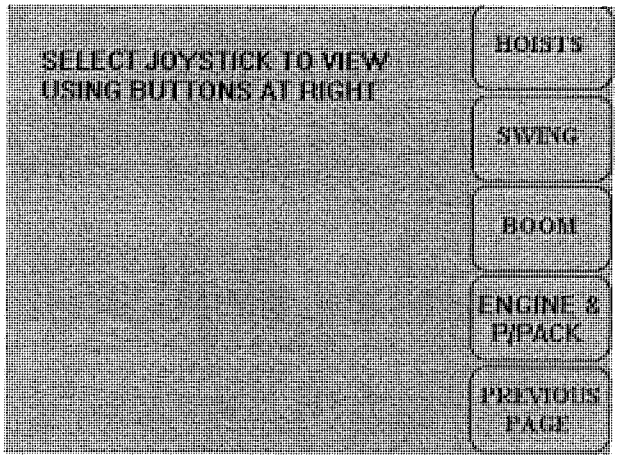
Set Date/Time Screen



When the SET DATE/TIME Button is pressed, this screen will appear on the display.
Here, the operator can change the Date and Time data on the controller. To scroll down the selection, use P1. To change the value of selected data, use P3.

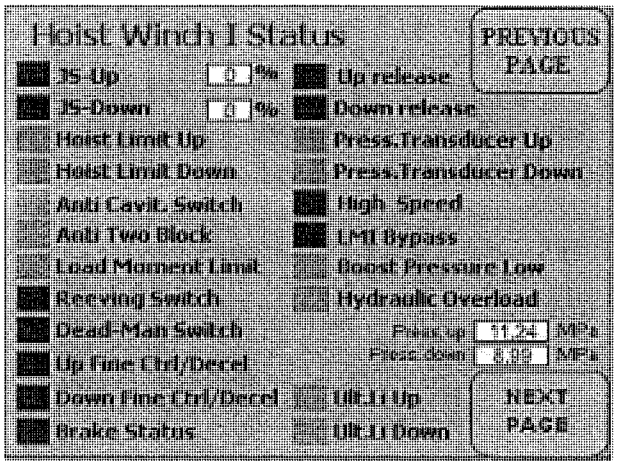
NOTE: All data must be set to current settings even though only one data is to be changed. Time format is military ie. 24:00 = 12 AM.

Crane Status



When the CRANE STATUS button is pressed, this screen will appear on the display. Here the operator can choose which category of crane status to be viewed; the Hoist Status, Swing Status, Boom Status and the Engine Status.

Hoist Winch I Status



Note: This screen shows the status of the Main Hoist Operation. It has 22 indicators.

JS-Up & JS- Down
This indicator will remain RED when there is no movement on the Joystick. It will turn GREEN when the operator presses the Deadman Switch and moves the Joystick. Movement of the Joystick is shown as percentage scale.

Hoist Limit Up, Hoist Limit Down, Ult.Li Up, Ult.Li Down
This indicator will remain GREEN if the crane is operating within the Limits. Once the crane is operating out of specified limits, the appropriate indicator will turn into RED.

Up Fine Ctrl/Decel, Down Fine Ctrl/Decel
This indicator will remain RED. It will change to GREEN once the Fine Control is activated or the crane deceleration limit is reached. It will also turn GREEN if the LMI limit is reached.

Up Release, Down Release
This indicator will remain RED if there is no hoisting or under normal operation, it will change to GREEN if the operator is trying to operate the hoist.

Press Transducer Up, Press. Transducer Down
This indicator shows the "health" of the pressure transducer. GREEN indicates that the pressure transducer is working.

Brake Status
This indicator will change from RED to GREEN if the Brake has been released.

Anti Cavit. Switch
This indicator will only change from GREEN to RED if there is cavitation in the pump.

Anti Two Block (if applicable)
This indicator will remain GREEN until there is a Two Block incident. Then it will turn to RED.

Load Moment Limit
If the load is within the max load at that particular radius, this indicator should remain GREEN. Once the load reaches 100% of the Rated Load on that radius, this indicator will turn RED.

Reeving Switch
This indicator will turn GREEN from RED if the crane is in Reeving mode.

Dead Man Switch
This indicator will turn GREEN once the Deadman switch on the Joystick is pressed

LMI Bypass
This indicator will remain RED under normal operation. It will turn to GREEN when the LMI-Bypass switch is turned ON.

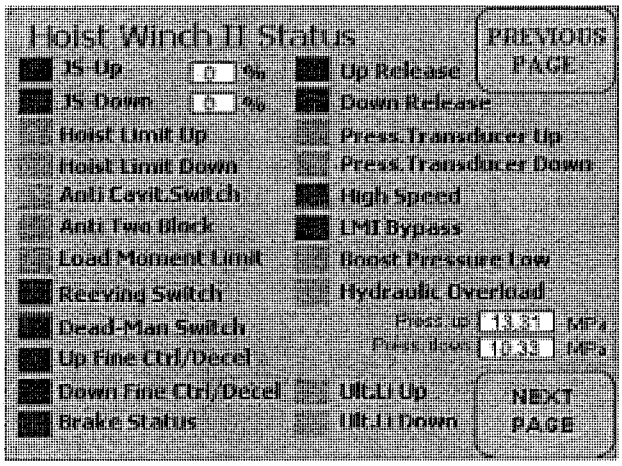
Boost Pressure Low & Hydraulic Overload
These indicators will remain GREEN until there's a problem with the hydraulic system, i.e. a low Boost Pressure is detected.

High Speed
This function is not available on this version.

Press Up - This shows the pressure in the Up line in MPa

Press Down- This shows the presure in the Down line in MPa.

Hoist Winch II Status



Note: This screen shows the status of the Auxiliary Hoist Operation. It has 22 indicators.

JS-Up & JS- Down
This indicator will remain RED when there is no movement on the Joystick. It will turn GREEN when the operator presses the Deadman Switch and moves the Joystick. Movement of the Joystick is shown as percentage scale.

Hoist Limit Up, Hoist Limit Down, Ult.Li Up, Ult.Li Down
This indicator will remain GREEN if the crane is operating within the Limits. Once the crane is operating out of specified limits, the appropriate indicator will turn into RED.

Up Fine Ctrl/Decel, Down Fine Ctrl/Decel
This indicator will remain RED. It will change to GREEN once the Fine Control is activated or the crane deceleration limit is reached. It will also turn GREEN if the LMI limit is reached.

Up Release, Down Release
This indicator will remain RED if there is no hoisting or under normal operation, it will change to GREEN if the operator is trying to operate the hoist.

Press Transducer Up, Press. Transducer Down
This indicator shows the "health" of the pressure transducer. GREEN indicates that the pressure transducer is working.

Brake Status
This indicator will change from RED to GREEN if the Brake has been released.

Anti Cavit. Switch
This indicator will only change from GREEN to RED if there is cavitation in the pump.

Anti Two Block (if applicable)
This indicator will remain GREEN until there is a Two Block incident. Then it will turn to RED.

Load Moment Limit
If the load is within the max load at that particular radius, this indicator should remain GREEN. Once the load reaches 100% of the Rated Load on that radius, this indicator will turn RED.

Reeving Switch
This indicator will turn GREEN from RED if the crane is in Reeving mode.

Dead Man Switch
This indicator will turn GREEN once the Deadman switch on the Joystick is pressed

LMI Bypass
This indicator will remain RED under normal operation. It will turn to GREEN when the LMI-Bypass switch is turned ON.

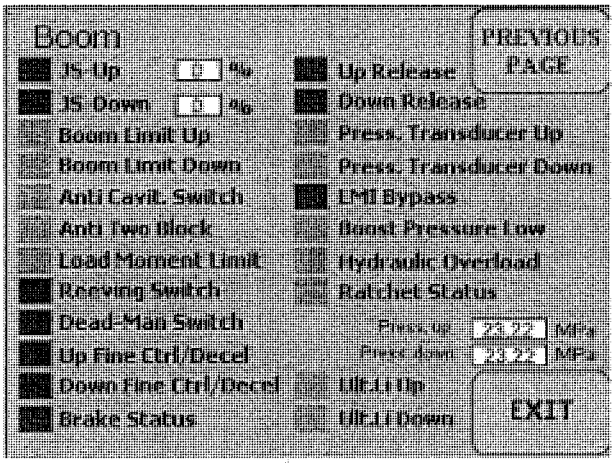
Boost Pressure Low & Hydraulic Overload
These indicators will remain GREEN until there's a problem with the hydraulic system, i.e. a low Boost Pressure is detected.

High Speed
This function is not available on this version.

Press Up - This shows the pressure in the Up line in MPa

Press Down- This shows the presure in the Down line in MPa.

Boom Status



Note: This screen shows the status of the Boom Operation. It has 22 indicators.

JS-Up & JS- Down
This indicator will remain RED when there is no movement on the Joystick. It will turn GREEN when the operator presses the Deadman Switch and moves the Joystick. Movement of the Joystick is shown as percentage scale.

Boom Limit Up, Boom Limit Down, Ult.Li Up, Ult.Li Down
This indicator will remain GREEN if the crane is operating within the Limits. Once the crane is operating out of specified limits, the appropriate indicator will turn into RED.

Up Fine Ctrl/Decel, Down Fine Ctrl/Decel
This indicator will remain RED. It will change to GREEN once the Fine Control is activated or the crane deceleration limit is reached. It will also turn GREEN if the LMI limit is reached.

Up Release, Down Release
This indicator will remain RED if there is no boom hoisting or under normal operation, it will change to GREEN if the operator is trying to operate the boom.

Press Transducer Up, Press. Transducer Down
This indicator shows the "health" of the pressure transducer. GREEN indicates that the pressure transducer is working.

Brake Status
This indicator will change from RED to GREEN if the Brake has been released.

Anti Cavit. Switch
This indicator will only change from GREEN to RED if there is cavitation in the pump.

Anti Two Block (if applicable)
This indicator will remain GREEN until there is a Two Block incident.

Load Moment Limit
If the load is within the max load at that particular radius, this indicator should remain GREEN. Once the load reaches 100% of the Rated Load on that radius, this indicator will turn RED.

Reeving Switch
This indicator will turn GREEN from RED if the crane is in Reeving mode.

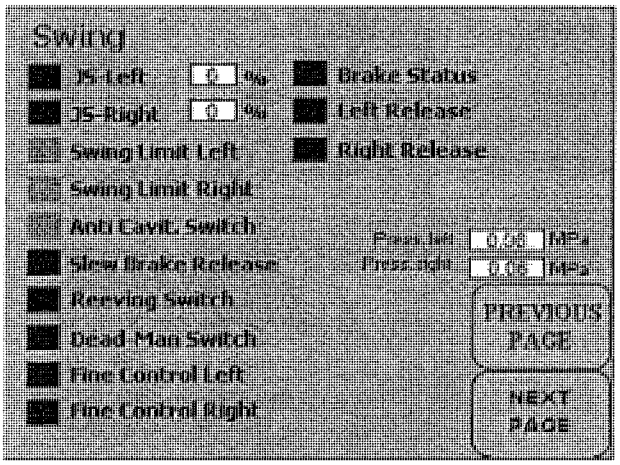
Dead Man Switch
This indicator will turn GREEN once the Deadman switch on the Joystick is pressed

LMI Bypass
This indicator will remain RED under normal operation. It will turn to GREEN when the LMI-Bypass switch is turned ON.

Boost Pressure Low & Hydraulic Overload
These indicators will remain GREEN until there's a problem with the hydraulic system, i.e. a low Boost Pressure is detected.

Ratchet Status
It will turn GREEN when the Luff Ratchet is in 'Open' position. When it is in 'Lock' position it will be RED.

Swing Status



Note: This screen shows the status of the Swing Operation. It has 13 indicators. Press. left and Press right are not applicable for this version.

JS-Left & JS- Right

This indicator will remain RED when there is no movement on the Joystick. It will turn GREEN when the operator presses the Deadman Switch and moves the Joystick. Movement of the Joystick is shown as percentage scale.

Swing Limit Left, Swing Limit Right (If Applicable)

This indicator will remain GREEN if the crane is operating within the Limits. Once the crane is operating out of specified limits, the appropriate indicator will turn into RED.

Fine Ctrl Left /Fine Ctrl Right

This indicator will remain RED. It will change to GREEN once the Fine Control is activated or the crane deceleration limit is reached. It will also turn GREEN if the LMI limit is reached.

Left Release, Right Release

This indicator will remain RED if there is no swinging or under normal operation, it will change to GREEN if the operator us trying to operate the swing.

Brake Status

This indicator will change from RED to GREEN if the Brake has been released.

Anti Cavit. Switch

This indicator will only change from GREEN to RED if there is cavitation in the pump.

Reeving Switch

This indicator will turn GREEN from RED if the crane is in Reeving mode.

Dead Man Switch

This indicator will turn GREEN once the Deadman switch on the Joystick is pressed.

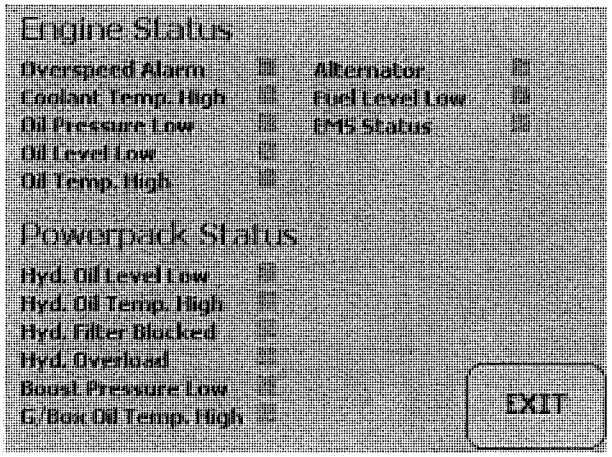
Slew Brake Release

This indicator will turn GREEN if the Slew Brake is released.

Press Left- This shows the pressure in the left line in MPa

Press Right- This shows the presure in the Right line in MPa.

Engine & Powerpack Status Screen



Engine Status

Overspeed Alarm (if applicable)
The indicator turns RED when there is an Engine overspeed Alarm. Under normal condition, it should remain GREEN.

Coolant Temp. High
This indicator turns RED when the Engine Coolant Temperature is high. Under normal condition, it should remain GREEN.

Oil Pressure Low
This indicator turns RED when the Engine Lube Oil Pressure is low. Under normal condition, it should remain GREEN.

Oil Level Low (if applicable)
This indicator turns RED when the Engine Lube Oil Level is low. Under normal condition, it should remain GREEN.

Oil Temp. High (If Applicable)
This indicator turns RED when the Engine Lube Oil Temperature is high. Under normal condition, it should remain GREEN.

Alternator
This indicator turns RED when a faulty alternator is detected.

Fuel Level Low (if applicable)
This indicator turn RED when the Fuel Level is low. Under normal condition, it should remain GREEN.

EMS Status (if applicable)
This indicator turn RED when there is a Warning Alarm on the Engine's EMS. Under normal condition, it should remain GREEN.

Powerpack Status

Hyd. Oil Level Low
This indicator turns RED when the Hydraulic Oil Level in hydraulic tank is low. Under normal condition, it should remain GREEN.

Hyd. Oil Temp. High (if applicable)
This indicator turns RED when the Hydraulic Oil Temperature is high. Under normal condition, it should remain GREEN.

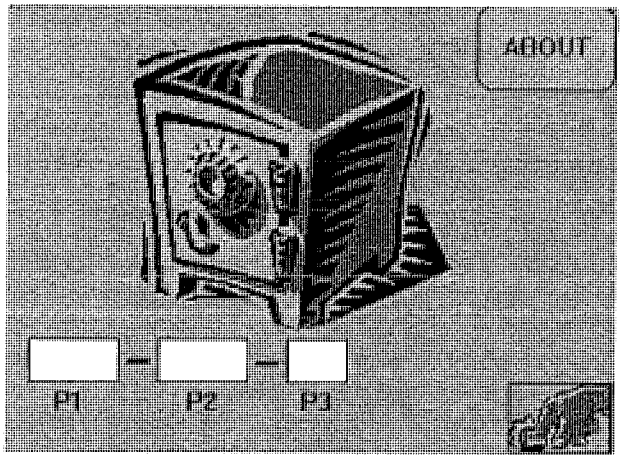
Hyd. Filter Blocked
This indicator turns RED when the Hydraulic Oil Filters are blocked. Under normal condition, it should remain GREEN.

Hyd. Overload
This indicator turns RED when there is a Hydraulic Overload in the system. Under normal condition, it should remain GREEN.

Boost Pressure Low
This indicator turns RED when the Boost Pressure is low. Under normal condition, it should remain GREEN.

G/Box Oil Temp. High
This indicator turns RED when the Pump Drive Gear-box Lube Oil Temperature is high. Under normal condition, it should remain GREEN.

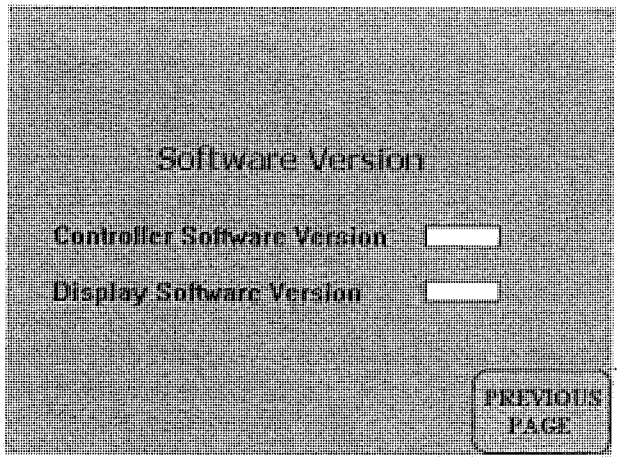
Password Screen



When the operator pressed the Service Button, this screen will be displayed. Here, the operator is required to key in the password to access the crane settings section.

Note: The crane settings should only be changed by Authorized Personnel.

Version Screen



Version Screen

By pressing the About button on the Password page, this screen will be displayed. Here, the current software version of both the display and the controller will be displayed.