OPERATIONS MANUAL

300 MT PEDESTAL MOUNTED CRANE



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PREFACE

The operations manual A17-42000-66-100 describes the 300 mt Pedestal Mounted Crane as supplied to Talent Offshore Company Ltd..

The maintenance of the 300 mt Pedestal Mounted Crane is described in the maintenance manual with document number A17-42000-66-110.

The 300 mt Pedestal Mounted Crane was designed and manufactured in 2017 by Huisman Equipment B.V. under order number A17-42000.

Where the term “Huisman” is used, reference is made to Huisman Equipment B.V.

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Due to the special characteristics of this system, dismantling and transportation of large construction parts are not foreseen. Therefore in this manual NO information is given related to dismantling and transportation of the system.

IMPORTANT SAFETY INFORMATION

This section provides important safety instructions. Detailed safety information is given wherever appropriate in this manual.

- Prior to operating, maintaining or repairing the system, all instructions and safety regulations in this manual, as well as in the suppliers documentation, must have been read and fully understood by all personnel who will be working with, or in the vicinity of, the 300 mt Pedestal Mounted Crane.
- Always restrict the use of the equipment to use strictly in accordance with this manual.
- The load specifications as well as the environmental conditions as described in this manual may NOT be exceeded. It is strongly advised to STOP the 300 mt Pedestal Mounted Crane before the limits set forth in this manual or otherwise are reached. In case of any doubt on the definition of the operating conditions, do not hesitate to consult Huisman.
- The keys of key switches used for operation must be kept in a safe place by an authorized person (supervisor) when not in use. The key switches may only be used when the person concerned has full knowledge and understanding of any possible consequences of doing so.
- External noise level from operations can be considerable. Use suitable hearing protection is deemed necessary.
- During sea travel, or when the maximum operating conditions are exceeded, the system must be sea fastened.

Operations:

- No persons are allowed near or on the system during operation without the prior knowledge and consent of the operator.
- The system may only be operated by an authorized operator, who is suitable trained and experienced in operating similar equipment, and who has full knowledge and understanding of the contents of this manual. Operators, maintenance engineers and all other personnel working with the system must have a sufficient level of education and / or training.
- The operator must have clear view of the system and its direct vicinity during operation.
- During sea travel, or when the maximum operating conditions are exceeded, the system must be sea fastened in accordance with internationally recognized standards.

Maintenance:

- Regular maintenance, service and inspection are required in order to guarantee safe use of the system for the duration of its lifetime. Maintenance may only be carried out by well-trained, certified and experienced personnel.
- Before starting maintenance or repair activities, make sure that all electrical power is disconnected and that all components are in a safe position. Always secure movable parts that could present a risk of injury or damage.
- Welding operations or any other heat treatment of the main structure can influence the system's integrity or fatigue life and may lead to serious damages to the equipment and its. All welding, grinding or cutting operations should never be undertaken without the prior written approval of Huisman.
- Pad eyes could be present on the construction. These pad eyes are used for installing or removing of that part of the construction. Using these pad eyes is prohibited during

the operation. The pad eye can be used for operations provided they are marked with Huisman safe working load (SWL) and have been tested.

Transport:

- During sea travel, or when the maximum operating conditions are exceeded, the system must be sea fastened in accordance with internationally recognized standards.

EQUIPMENT SPECIFIC SAFETY

300 mt PMC during thunderstorms

WARNING



Operating the 300 mt PMC during thunderstorms is highly hazardous, with a high risk of personal injury due to a lightning strike on the 300 mt PMC, and an electrical discharge to various objects of the 300 mt PMC and the vessel.

Danger regarding electronic equipment

Lightning can cause defects in the electronic equipment of the PMC. The the load measurement equipment can particularly be affected. The behavior of lightning is unpredictable and the strike can hit various parts of the 300 mt PMC. Even without a direct lightning strike, the Lightning Electromagnetic Pulse effect can cause damage to the electronic equipment.

Danger to personnel

Continue to work on the 300 mt PMC during a thunderstorm may be considered an unsafe action, with a high potential for personal injuries due to a lightning strike and an electrical discharge. The following precautions are recommended:

- leave the deck area
- stay inside the vessel

CAUTION



Check the weather forecast before operating the 300 mt PMC.

SAFETY SYMBOLS

In this manual, the symbols and indications are used to highlight important parts of information. Below you find the explanation of the indication types.

WARNING 	*Indicates a hazardous or potentially hazardous situation which, if not avoided, could result in serious injury or death and considerable mechanical damage.*

CAUTION 	*Indicates a potentially hazardous situation which, if not avoided, could result in minor injury or mechanical damage.*

NOTE	*Indicates important information of the system or the documentation which requires special attention.*

1 READING GUIDE

This reading guide gives an overview of the available chapters in the operations manual of the 300 mt Pedestal Mounted Crane.

The PMC consists of several subsystems, the detailed technical descriptions are given in separate chapters:

- Chapter 2: General description p.21
- Chapter 3: Mechanical description p.31
- Chapter 4: Hydraulic system p.81
- Chapter 5: Electrical description p.115
- Chapter 6: Operation p.141

Each chapter consists of the following sections (if applicable):

- Introduction; A short introduction of the sub-system
- Functional description; The function of the sub-system
- System description; A brief explanation of all main parts

Appendices will comprises access to e.g. reference drawings, documents, specifications and diagrams.

Information on components supplied by third parties can be found in technical documentation of the supplier.

WARNING



The 300 mt PMC shall only be used for the purpose for which it was designed, and only within the limits of the design criteria.

WARNING



Dangerous machinery!
Ignoring safety regulations can result in personal injury or machine damage.
Read and thoroughly understand all safety information in this Operations manual
Only qualified operators are allowed to work on this equipment. Before starting up:
- ensure all essential maintenance has been carried out;
- there are no unauthorized persons within the danger zone.

2 GENERAL DESCRIPTION

2.1 INTRODUCTION

This manual was produced for the 300 mt Pedestal Mounted Crane (PMC) as supplied for Talent Offshore Company Ltd.. The PMC is designed to be installed on the ship with identification number CQS-029.

This chapter of the manual includes a brief description of the system and its main characteristics as well as the overall technical specifications. Detailed technical data on subsystems or components are given in the following chapters.

The PMC is designed and built in accordance with ABS Guide for Certification of Lifting Appliances (2013).

2.2 PURPOSE OF THE SYSTEM

Reference drawing:

- A17-42000-00-001: General arrangement

The PMC is permanently installed on the ship and is especially designed for lift operations at sea or open water.

The PMC has the following main systems for hoisting:

- Main hoist
- Whip hoist
- Boom hoist

There are 3 independent systems for hoisting. The main hoist system has the highest lifting capacity. It is mainly operated for construction and deconstruction operations. The whip hoist is mainly used for the similar operations but with a lower hoist capacity and a higher operation speed. Tugger hoist serves to stabilize the load and to reduce the off lead. The whip hoist and the tugger hoist are equipped with constant tension (CT). The slewing is able to rotate around the pedestal for transferring loads. For an overview of the hoisting systems, see Figure 2-1 p.24.

2.2.1 MAIN CHARACTERISTICS

- The PMC is outfitted with:
  - Main hoist
  - Whip hoist
  - Tugger
- To increase the hook travel and hoisting speed, the main hoist can be reeved from 8 into 4 falls for lighter loads.
- The whip hoist and tugger hoist can be used in constant tension (CT) mode.
- The PMC boom is equipped with Ex Proof (zone 2) components only.
- All major equipment is installed inside a closed crane house where it is protected from the marine environment.
- To save valuable deck space, the compact design of the crane results in a small tail swing (radius control cabin approximately 7 m).
- The PMC is electro-hydraulic driven.
- An emergency diesel driven generator is installed in the crane. With this generator the crane can be operated with limited speeds.
- The PMC is equipped with a data logging and remote support system.

WARNING



The 300 mt Pedestal Mounted Crane may only be used for the purpose it was designed for, and only within the limits of the design criteria.

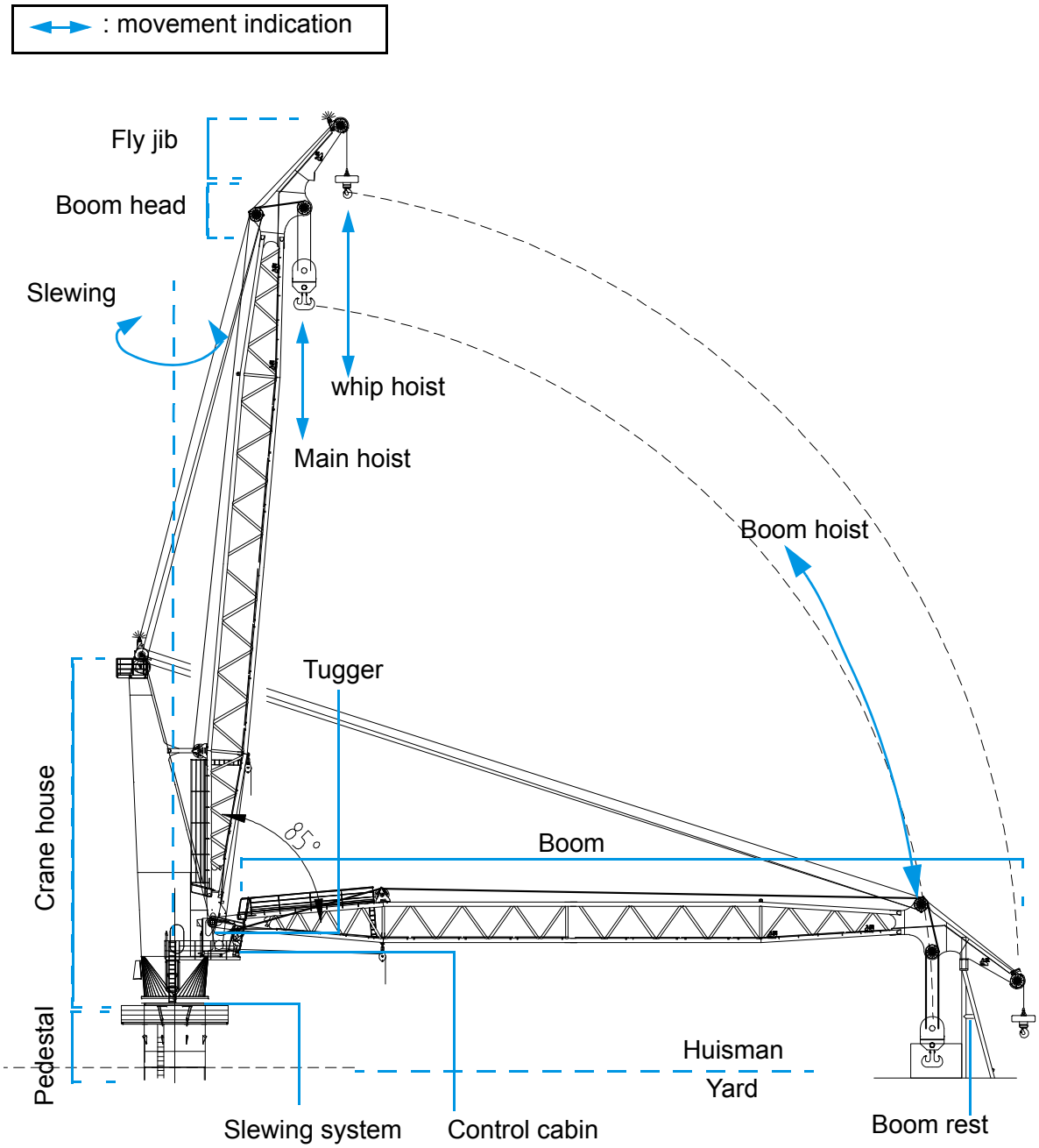


Figure 2-1: Overview 300 mt Pedestal Mounted Crane

2.3 SYSTEM OVERVIEW

The PMC comprises the following main components:

Component	Function
Fly jib	The extension of the boom which supports the whip.
Whip hoist	Hoist with less hoisting capacity than main hoist and larger outreach.
Tugger hoist	To stabilize the load and reduce off lead.
Main hoist	Hoist with largerst hoisting capacity
Boom hoist	The hoisting mechanism to change the angle of the boom.
Boom	The steel arm which is actually holding the load.
Crane house	It is a housing for all inner components.
Pedestal	The connection between the vessel and the crane house.
Slew platform	To revolve the crane house and load.
Control cabin	The control room for the operator.
Boom rest	The on-board structure to store the boom in unused situations.

Table 2-1: Crane components

NOTE *Pad eyes could be present on the construction. These pad eyes are used for installing or removing of that part of the construction. Using these pad eyes is prohibited during the operation.*

2.4 TECHNICAL SPECIFICATION

2.4.1 INTRODUCTION AND DEFINITIONS

Operations

The technical specifications define under which conditions the 300 mt Pedestal Mounted Crane (PMC) should be operated. If any operation takes place outside these conditions, the PMC might be seriously damaged or there could be great danger to the operator or bystanders. Disregarding the technical specifications could also result in the loss of load.

Lift types

The PMC is designed for the following lift types:

Lift type	Description
Heavy lift	Lifting in sheltered waters without vessel motion due to waves.
Offshore fixed - fixed	Lifting to or from the own deck of the crane vessel.
Offshore fixed - floating	Lifting to or from another floating object.

Table 2-2: Lift types

The type of lifting is related to the load charts, see Appendix B: "Reference documentation".

2.4.2 ENVIRONMENTAL OPERATING CONDITIONS

Environmental condition	Measure
Minimum ambient temperature	0 [°C]
Maximum ambient temperature	55 [°C]
Maximum operating wind speed	15.5 [m/s]
Maximum survival wind speed	51.5 [m/s]
Area classification crane	Safe zone
Area classification boom electrical equipment	Ex zone 1

2.4.3 POWER SUPPLY

Power supply	Measure
Main power	AC 690 V / 60 Hz
Auxiliary power	AC 230 V / 60 Hz

2.4.4 MAIN HOIST

Capacity (ABS heavy lift jack-up)	Fall configuration	Measure
SWL at approximate 15 [m] radius	8 falls	300 [mt]
SWL at approximate 35 [m] radius	8 falls	90 [mt]
Capacities given for the following conditions		
F_d		1.1
Side lead (inc. 0.5° heel)		2.5 [°]
Off lead (inc. 0.5° trim)		0.5 [°]

Hoisting speed (at outer layer of drum)	Fall configuration	Speed [m/min]
Full load	8 falls	3
Reduced load	8 falls	5
Full load	4 falls	6
Reduced load	4 falls	10

Working range	Fall configuration	Measure
Minimum radius	4 or 8 falls	8 [m]
Maximum radius	4 or 8 falls	48 [m]
Hook travel	8 falls	60 [m]
Hook travel	4 falls	120 [m]

Specification	Measure
Wire rope diameter	40 [mm]

2.4.5 WHIP HOIST

Hoist capacity (ABS offshore lift, H_{sig}= 1m, jack up)	Fall configuration	Measure
SWL a 53.5 m (single line)	1 fall	30 [mt]
Capacities given for the following conditions		
F_d		According to ABS
Off lead		According to ABS
Side lead		According to ABS

Hoisting speed (at standard outer layer of drum)	Fall configuration	Speed [m/min]
Full load	1 fall	Approx 30
Reduced load	1 fall	Approx 50

Working range	Fall configuration	Measure
Minimum radius	1 fall	11 [m]
Maximum radius	1 fall	54 [m]
Hook travel (single line)	1 fall	100 [m]

Specification	Measure
Wire rope diameter	40 [mm]

2.4.6 LOAD TUGGER

Hoisting capacity	Fall configuration	Measure
SWL	Single line	10 [mt]

Hoisting speed (outer layer of drum)	Speed [m/min]
Full load	30

Specification	Measure
Wire rope diameter	20 [mm]
Hook travel (single line)	60 [m]

Boom hoist (10 falls)

Hoisting time	time [min]
Time low speed (from 15° to 75°)	7.5
Time high speed (from 15° to 75°)	4.4

Working range	Measure
Minimum boom angle storage	0 [°]
Maximum boom angle	85 [°]
Minimum boom angle working	0 [°]

Specification	Measure
Wire rope diameter	40 [mm]

2.4.7 SLEW SYSTEM

Slewing speed	Speed [rpm]
Full torque	0.35

Slewing range	Range
Slewing range	Full revolving

2.4.8 WEIGHT OVERVIEW

Specification	Weight [mt]
Pedestal (4.1m)	Approx. 27
Total weight (excl. pedestal)	Approx. 215

3 MECHANICAL DESCRIPTION

3.1 INTRODUCTION

This chapter describes the mechanical and constructional aspects of the PMC. The following subsystems will be described
(see Figure 3-2 p.32):

- Section 3.2: "Pedestal"
- Section 3.3: "Slewing system"
- Section 3.4: "Crane house"
- Section 3.5: "Boom"
- Section 3.6: "Main hoist"
- Section 3.7: "Whip hoist"
- Section 3.8: "Tugger"
- Section 3.9: "Mechanically actuated sensors and switches"
- Section 3.10: "Outfitting".

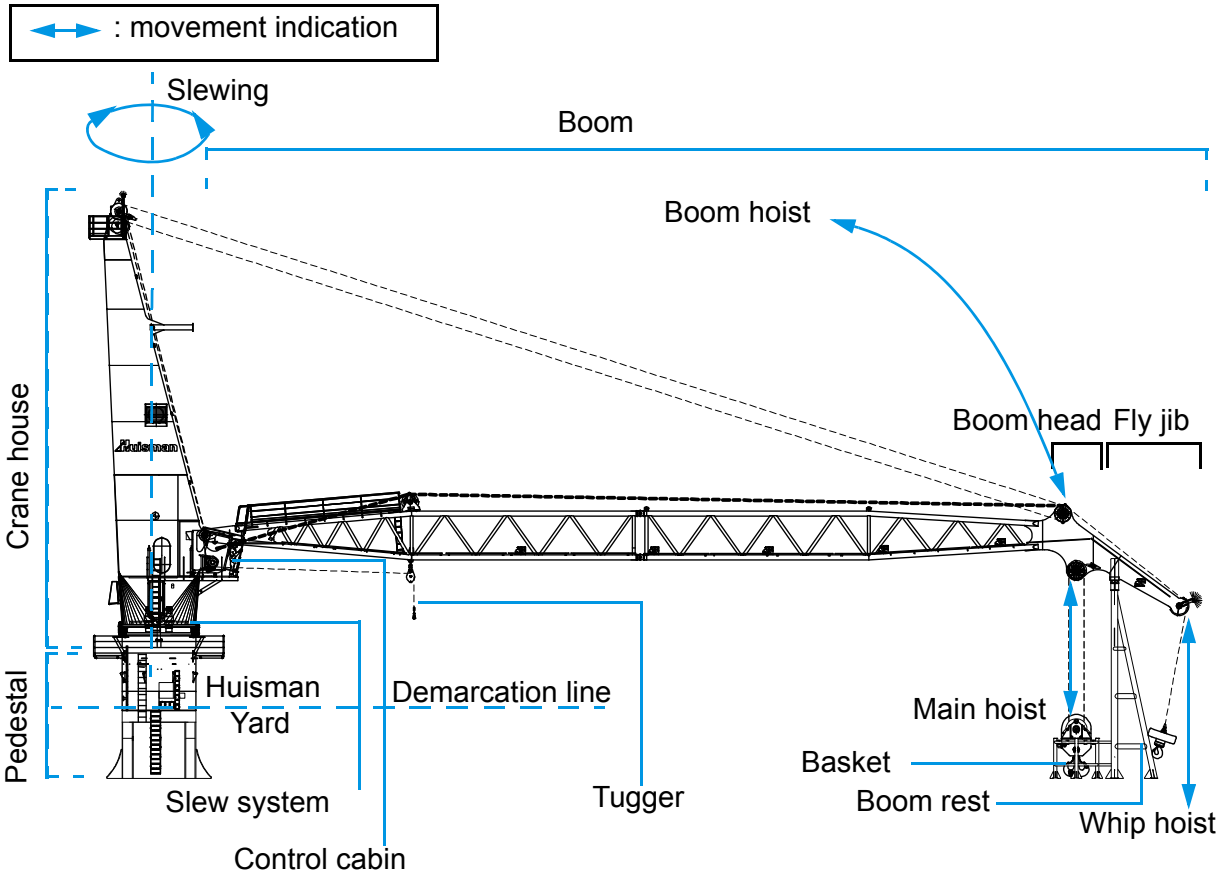


Figure 3-2: PMC overview

For an overview of the main components, see Chapter 3: "Mechanical description". Each section gives an overview of accessory reference drawings and can be found in Appendix A: "Reference drawings". Further information about components supplied by third parties can be found in the supplier documentation.

3.2 PEDESTAL

The pedestal (see Figure 3-2 p.32 for location) is designed to withstand all load cases which can be applied by the crane. It is a fixed structure which provides a footprint to spread the crane loads on the ground. The pedestal section is the support for the slewing system. It furthermore elevates the boom pivot to the requested level.

Huisman has delivered the parts above the demarcation line (see Figure 3-2 p.32); Yard has delivered the parts below the demarcation line.

All power cables necessary for the crane are to be routed through the pedestal.

3.3 SLEWING SYSTEM

The slewing system turns the crane around the vertical axis. The system consists of a large roller bearing driven by means of four slew drives, each consisting of a planetary gearbox with a pinion and driven by a hydro motor. The pinions on the driving shafts of the gearboxes engage in the internal gear ring of the slew bearing.

This section describes the following parts:

- Section 3.3.1: "Slew bearing"
- Section 3.3.2: "Slip ring"
- Section 3.3.3: "Slew drives"

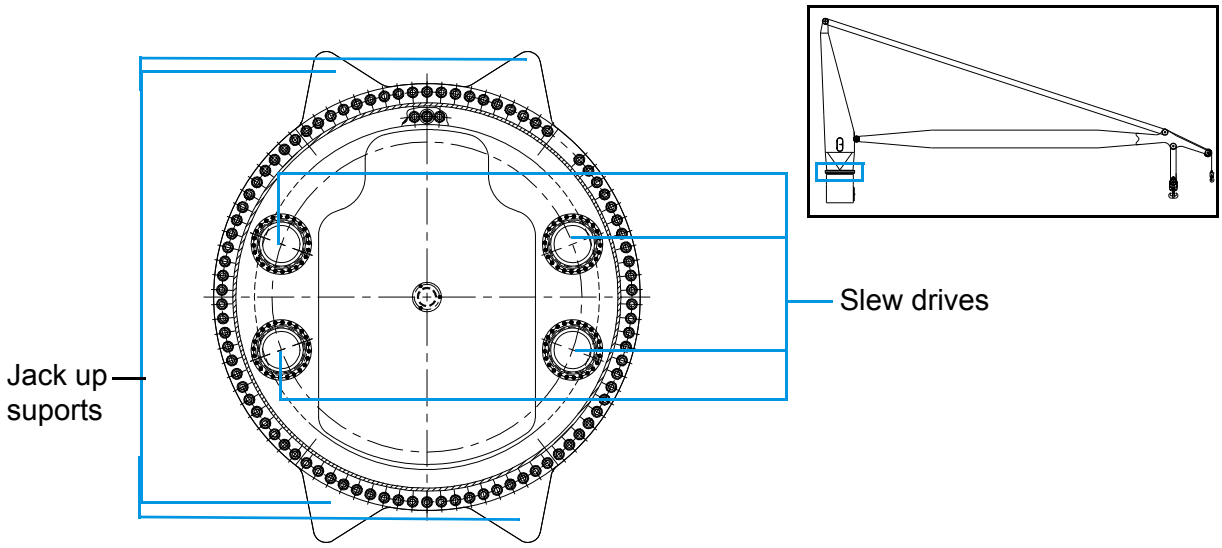


Figure 3-3: Slewing system top view

3.3.1 SLEW BEARING

Slew bearing which is a three row roller bearing is mounted to connect the crane house and the pedestal.

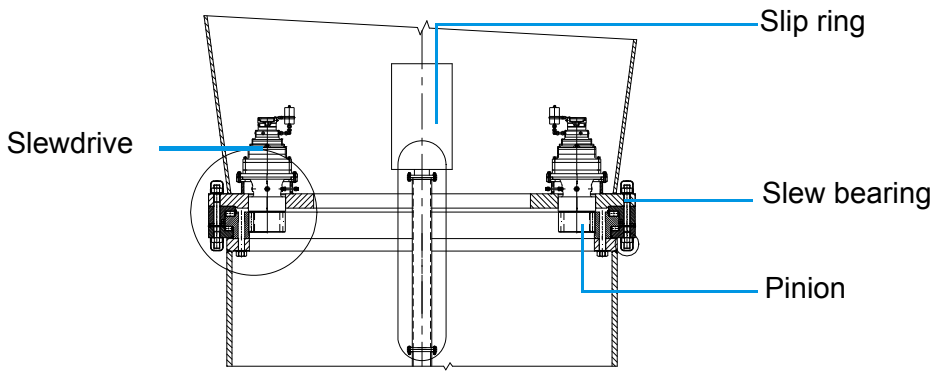


Figure 3-4: Slewing system section

3.3.2 SLIP RING

A slip ring unit is used for transfer of the electrical power from the pedestal to the crane house. The slip ring unit is located in the crane house lower section (see Figure 3-2 p.32). For more information about slip ring, see Section 5.7.2.4: "Slip ring unit".

3.3.3 SLEW DRIVES

The electro-hydraulic drive system is used for slewing. Four hydraulic motors and one pump are used as slew drives. Each hydro motor is an axial piston motor with a fixed swash plate. The hydraulic motors are mounted on the gearboxes that drive the bearing.

For detailed information on the slew drives, see supplier documentation. See Figure 3-5 p.36 for slew drive gearboxes. For more information on hydraulic system, see Chapter 4: "Hydraulic system".

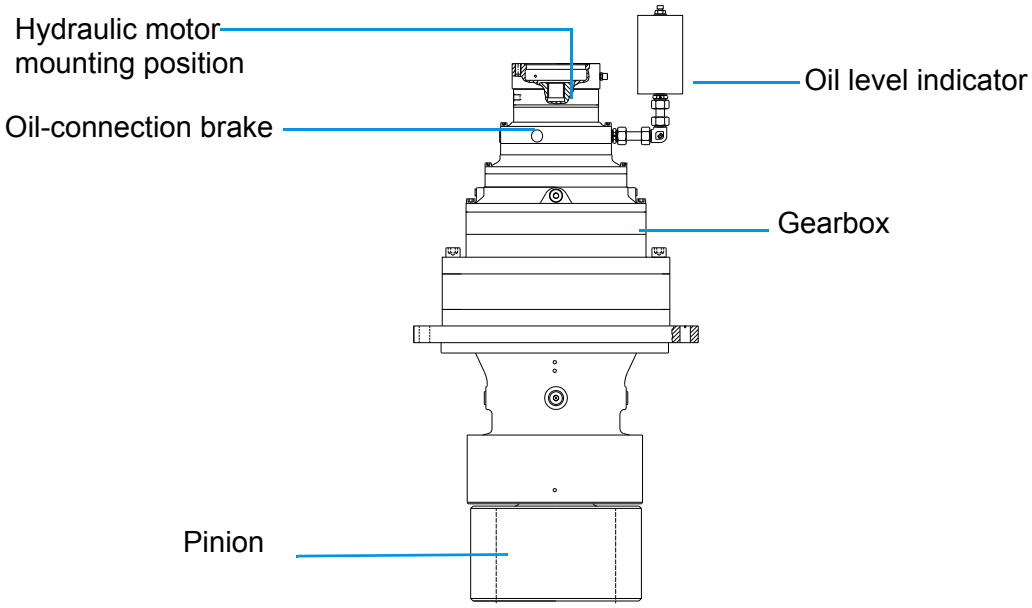


Figure 3-5: Slew drive

3.4 CRANE HOUSE

Reference drawing:

- A12-48000-12-000: Crane house

The crane house (see Figure 3-6 p.37) is the center piece of the crane. It forms the connection between the pedestal and the boom. The lower part is connected to pedestal with slew bearing. Winches and machinery are installed inside the crane house. The crane house contains multiple sections. In this chapter, the crane house sections are described more in detail.

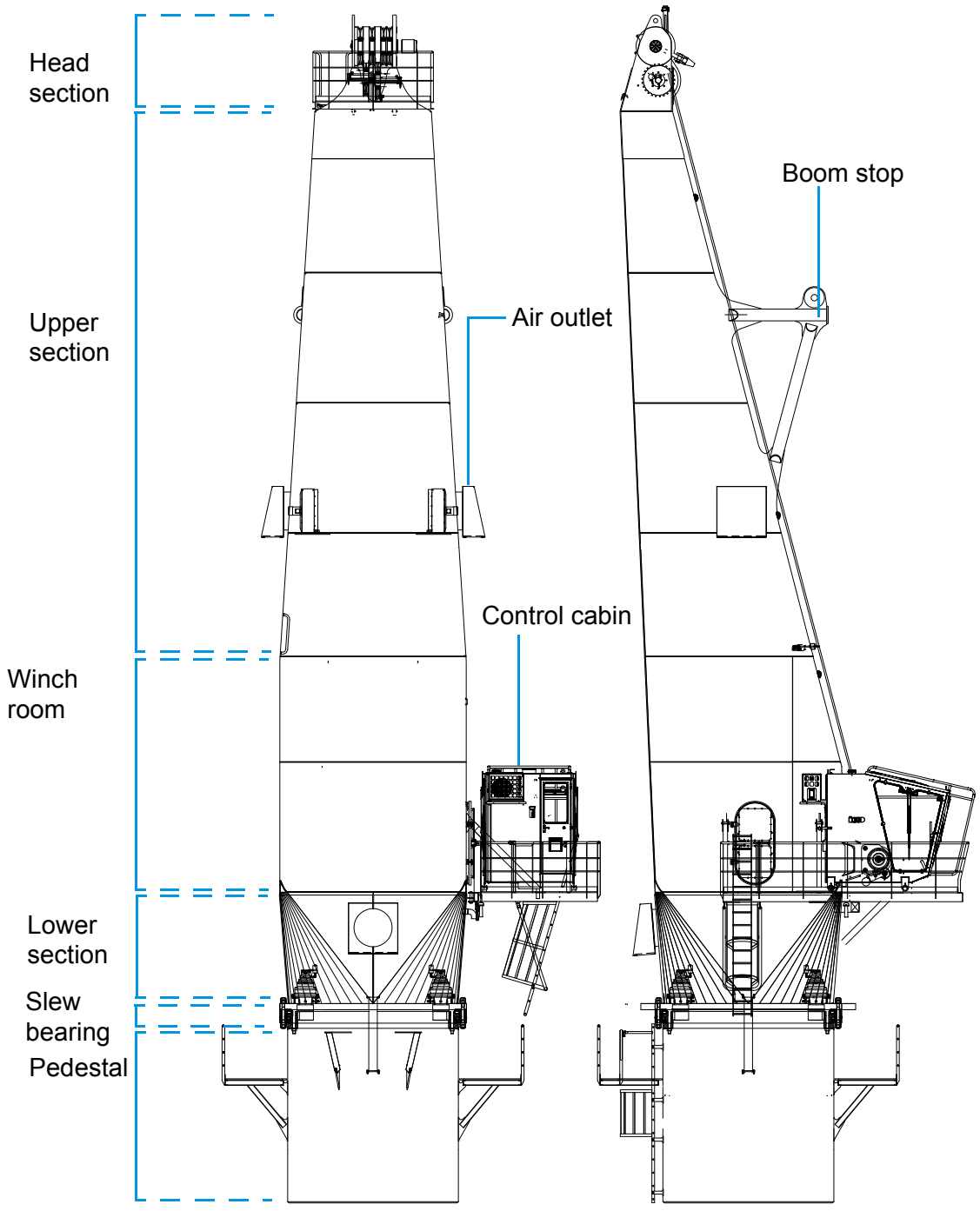


Figure 3-6: Crane house sections overview

Because the crane house is connected to the pedestal with the slew bearing, the boom can fully rotate around the pedestal.

The crane house contains the following sections:

- Crane house head section:

  The crane house head section is the base for the sheaves of the main hoist, whip hoist and boom hoist. For more information, see 3.4.1 Crane house head section p.38.

- Crane house upper section:

  The crane house upper section give inner access to the crane house head. It provides space to contain the machinery. For more information, see 3.4.2 Crane house upper section p.40.

- Crane house winch room section:

  The crane house winch room section provides inner space for containing boom hoist winch, main hoist winch and whip hoist winch. The tugger winch is mounted outside of the crane house section below the boom pivot. For more information, see 3.4.3 Crane house winch room section p.41.

- Crane house lower section:

  The crane house lower section is the connection between the crane house and the pedestal. The lower side is mounted with outer roller bearing, and the inner roller bearing is mount on the top of the pedestal. The crane house lower section contains slew drives, slip ring and electrical cabinet. For more information, see 3.4.4 Crane house lower section p.42.

- Control cabin:

  The control cabin is the location where the crane operations are controlled. The control cabin support is connected to the crane house. For more information, see 3.4.5 Control cabin p.43.

3.4.1 CRANE HOUSE HEAD SECTION

Reference drawing:

- A17-42000-12-040: Crane house - head section
- A17-42000-31-010: Reeving diagram

The crane house head section is fixed on top of the crane house and is the foundation for the main, whip and boom hoist sheaves. See Figure 3-7 p.39 for the information about crane house head section overview.

The hoist wires run from the winches through the crane house up to the crane head over the sheave assemblies on the crane head section to the corresponding tackles. See the reeving diagram in Appendix A: "Reference drawings" for the information about the main, whip and boom hoist reeving system. More detailed information about the individual reeving system, see the following subsections of hoist wires.

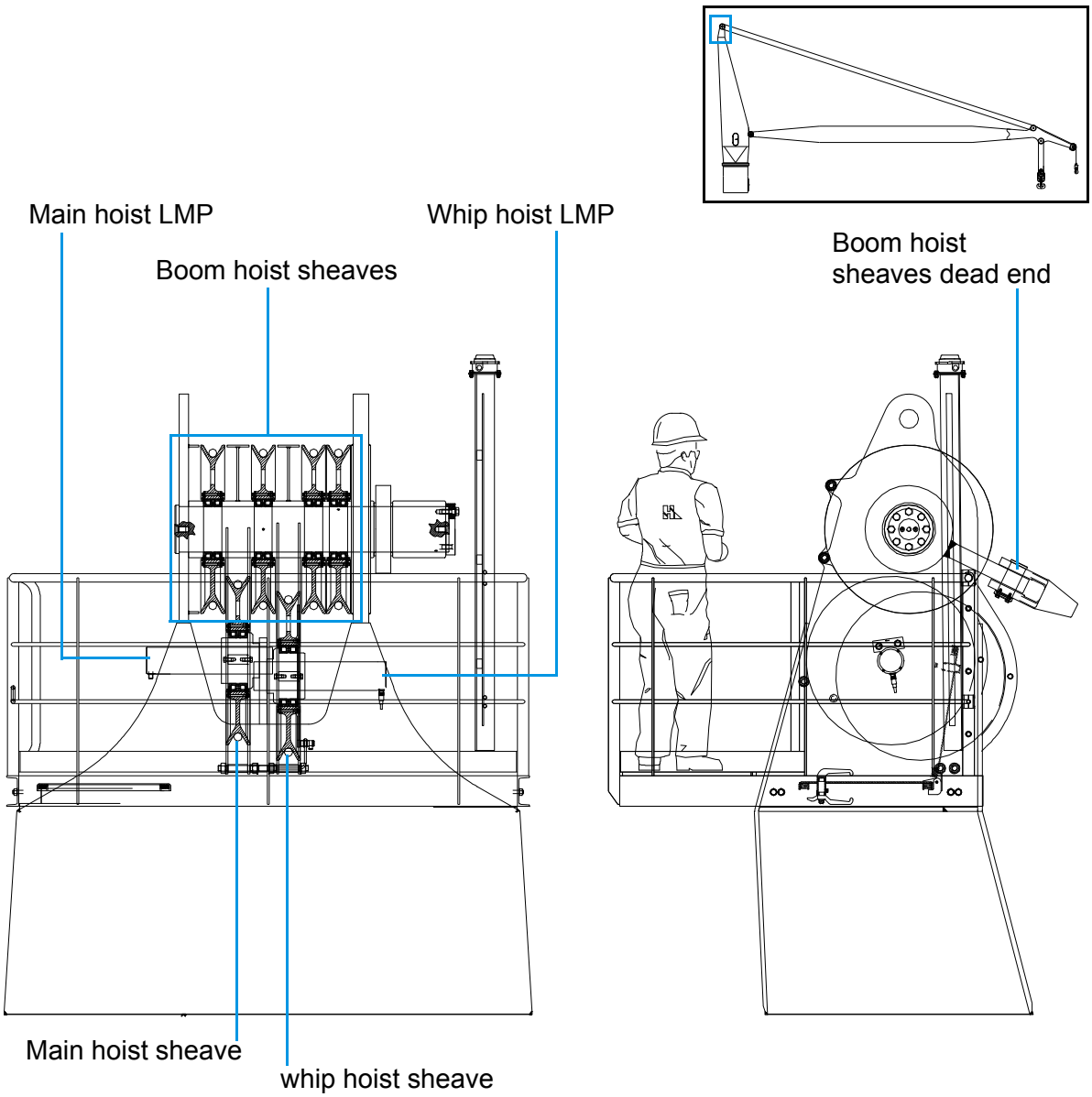


Figure 3-7: Crane house head section

3.4.2 CRANE HOUSE UPPER SECTION

The crane house upper section (see Figure 3-8 p.40) contains:

- Ventilator coolers.
- Air outlets.
- Oil tank.
- Boost pump.

For more information about the electrical components, see Chapter 5: "Electrical description".
For more information about the hydraulic components, see Chapter 4: "Hydraulic system".

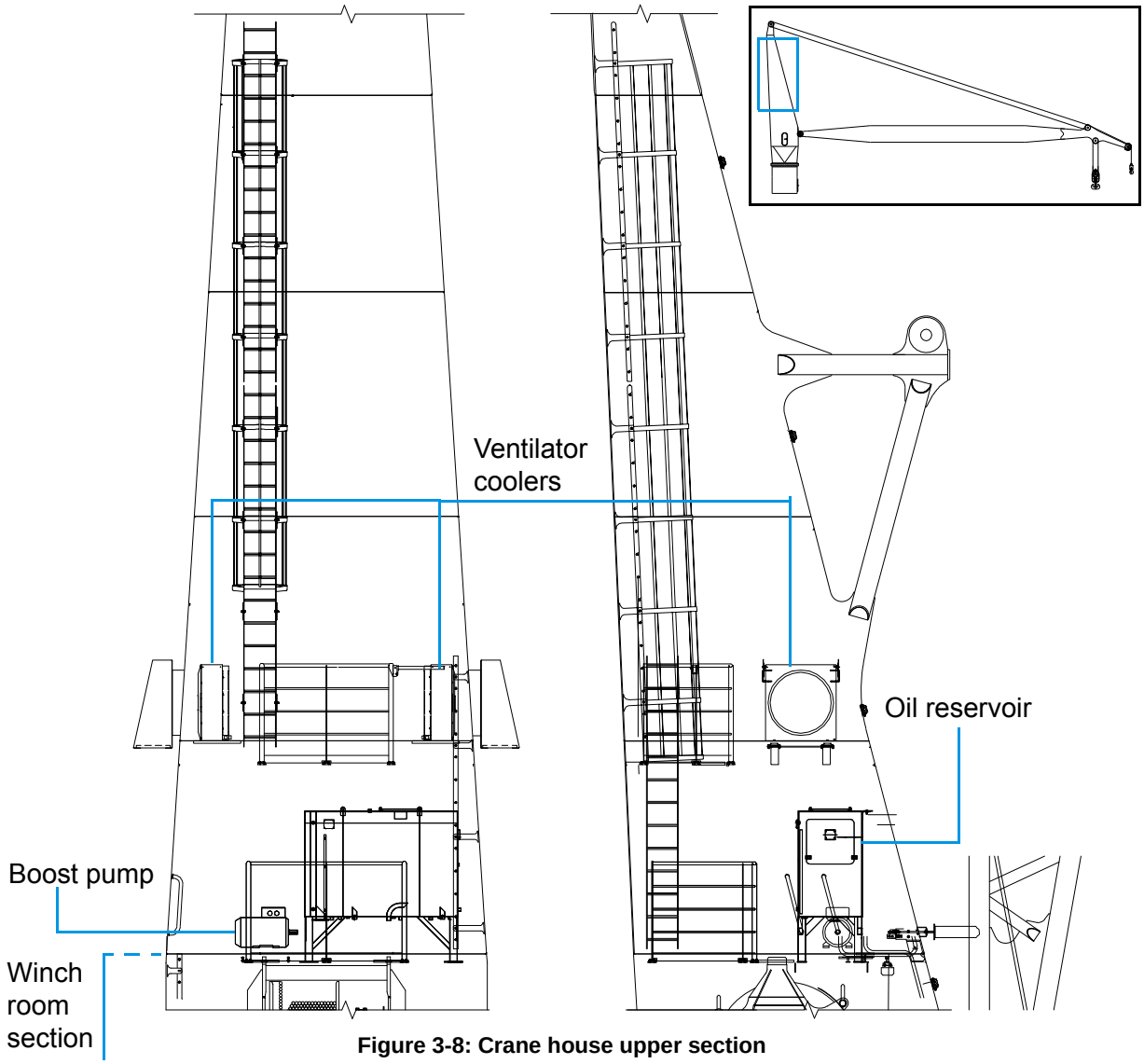


Figure 3-8: Crane house upper section

3.4.3 CRANE HOUSE WINCH ROOM SECTION

Reference drawing:

- A12-48000-21-0508: Winch frame

The crane house winch room section is located on top of the crane house lower section. The crane house winch room section (see Figure 3-9 p.41) contains:

- Boom hoist winch.
- Whip hoist winch.
- Main hoist winch.
- Tugger winch (outside).
- Electrical motor (main pumps driver).
- Hydraulic pumps (main pumps).
- Emergency (diesel) HPU.

For more information about the electrical components, see Chapter 5: "Electrical description".

For more information about the hydraulic components, see Chapter 4: "Hydraulic system".

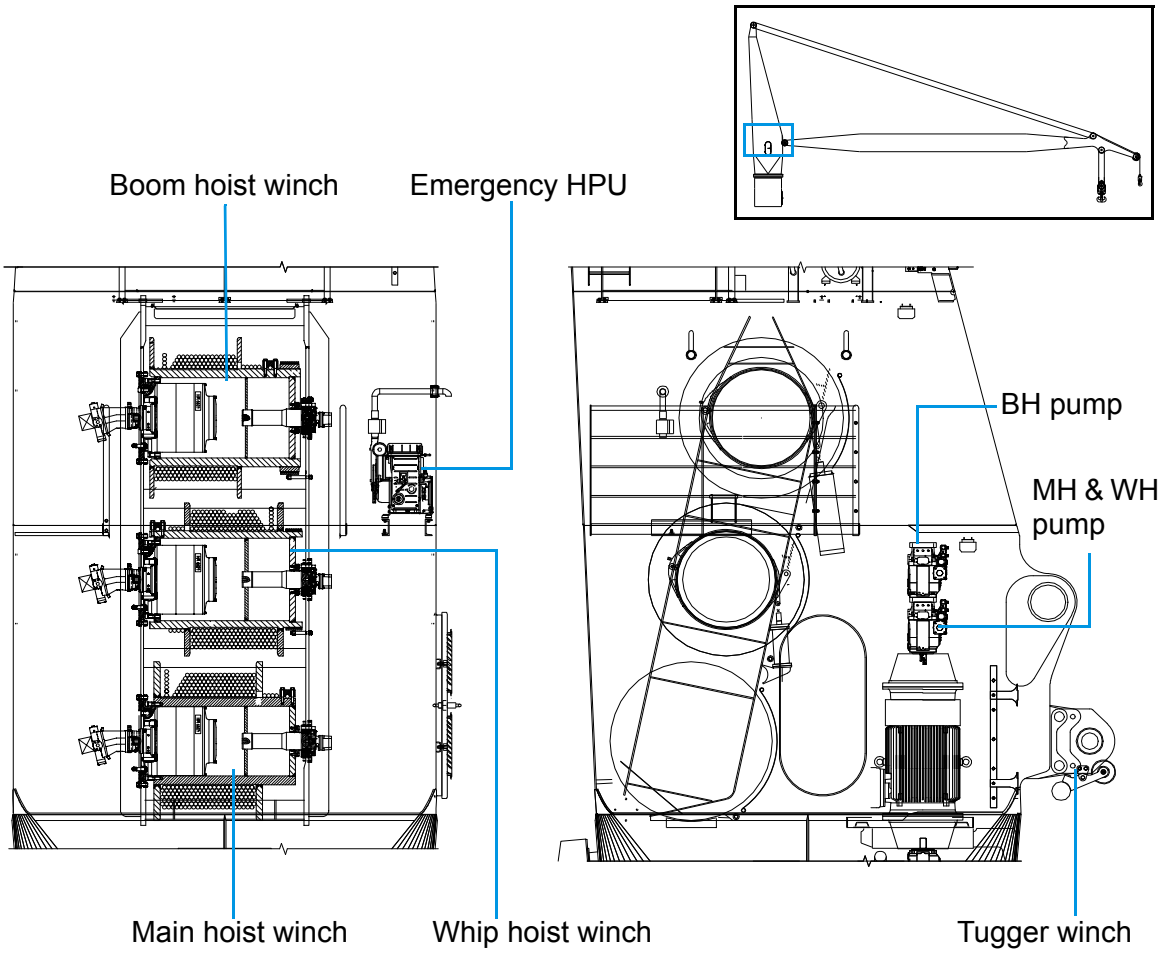


Figure 3-9: Crane house winch room section

3.4.4 CRANE HOUSE LOWER SECTION

The crane house lower section is connected to the bearing. The crane house lower room section (see Figure 3-10 p.42) contains:

- Hydraulic motors.
- Gearboxes.
- Hydraulic pumps (main pumps).
- Slip ring.
- Air intake.
- Electrical cabinet.

For more information about the electrical components, see Chapter 5: "Electrical description".

For more information about the hydraulic components, see Chapter 4: "Hydraulic system".

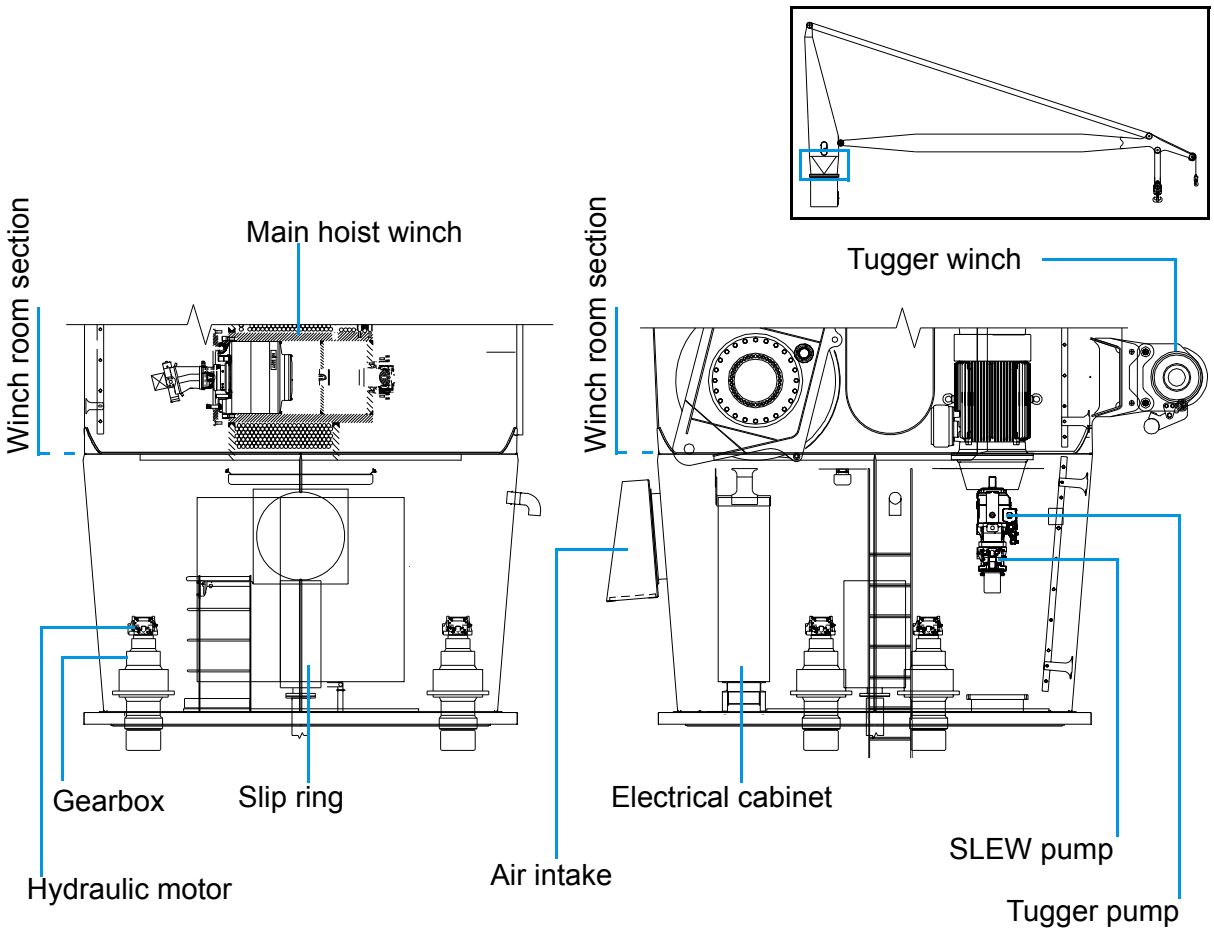


Figure 3-10: Crane house lower section

3.4.5 CONTROL CABIN

Reference drawing:

- A12-48000-51-0208: Crane cabin access

The control cabin (see Figure 3-11 p.43) support is connected to the crane house. The platform on the cabin foundation also provides access to the crane house.

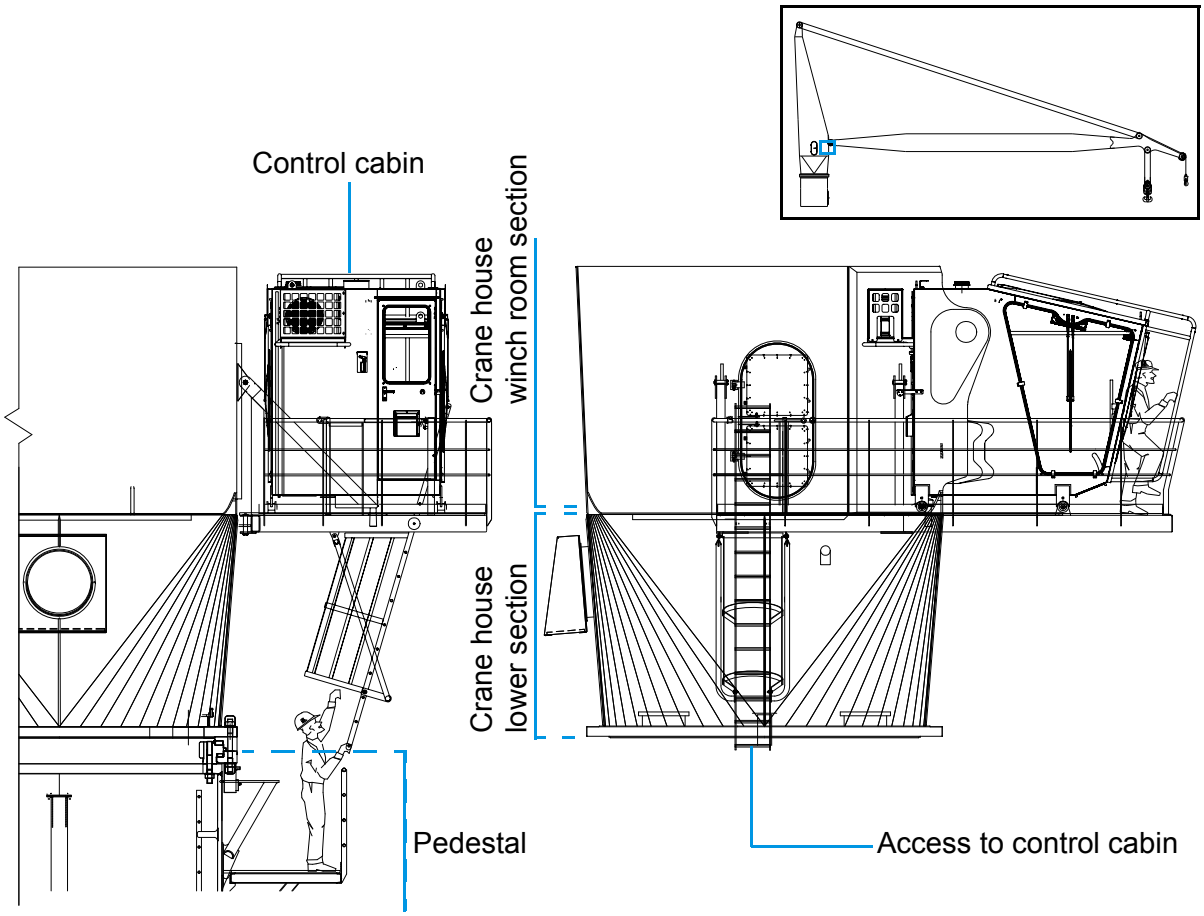


Figure 3-11: Control cabin

The control cabin is outfitted with the following functions (see Figure 3-12 p.44):

- Control panel.
- Swivel operator chair with crane controls integrated in the arm rest.
- An additional chair for supervisor or instruction purposes.
- Crane capacity monitoring on displays (SCADA visualization and winch camera).
- Lighting control panel.
- Heating, Ventilation and Air Conditioning (HVAC) system.
- Protective cage.

- Water tank.
- Window wiper.
- Smoke detector.
- Fire extinguisher.
- Horns & speaker.
- Chair sensor.

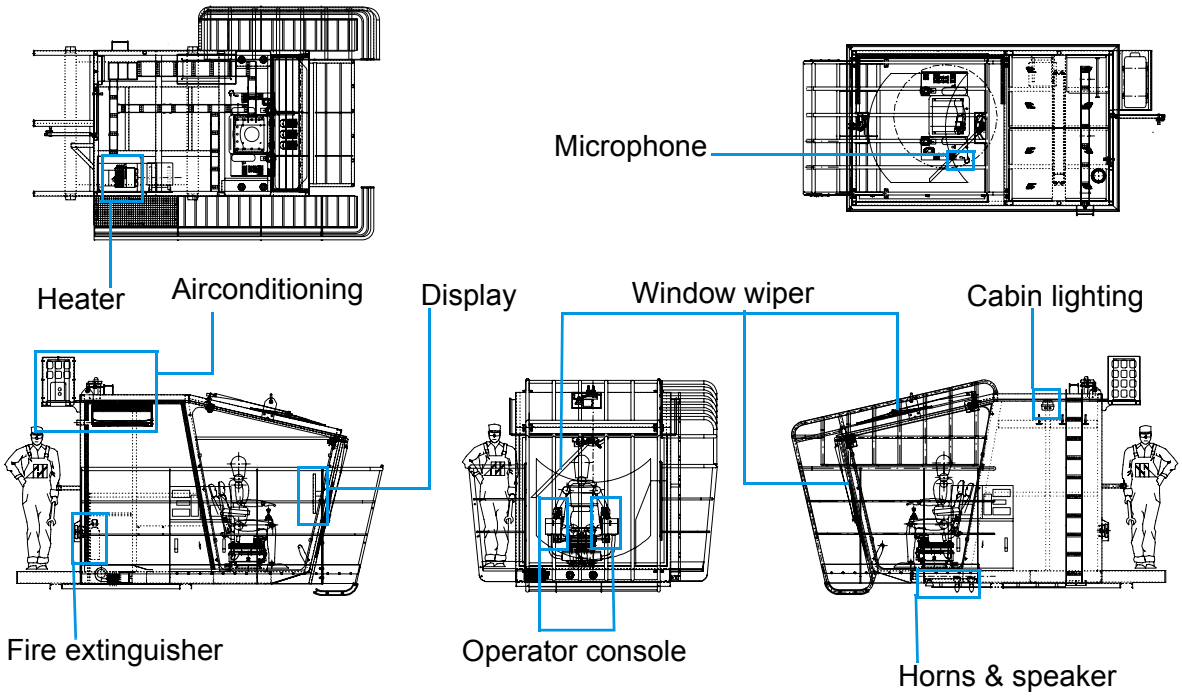


Figure 3-12: Control cabin outfitting (typical)

3.5 BOOM

The boom (see Figure 3-13 p.45) is a lattice construction consisting of 3 parts:

- Boom pivot section.
- Boom rectangular section.
- Boom head & fly jib.

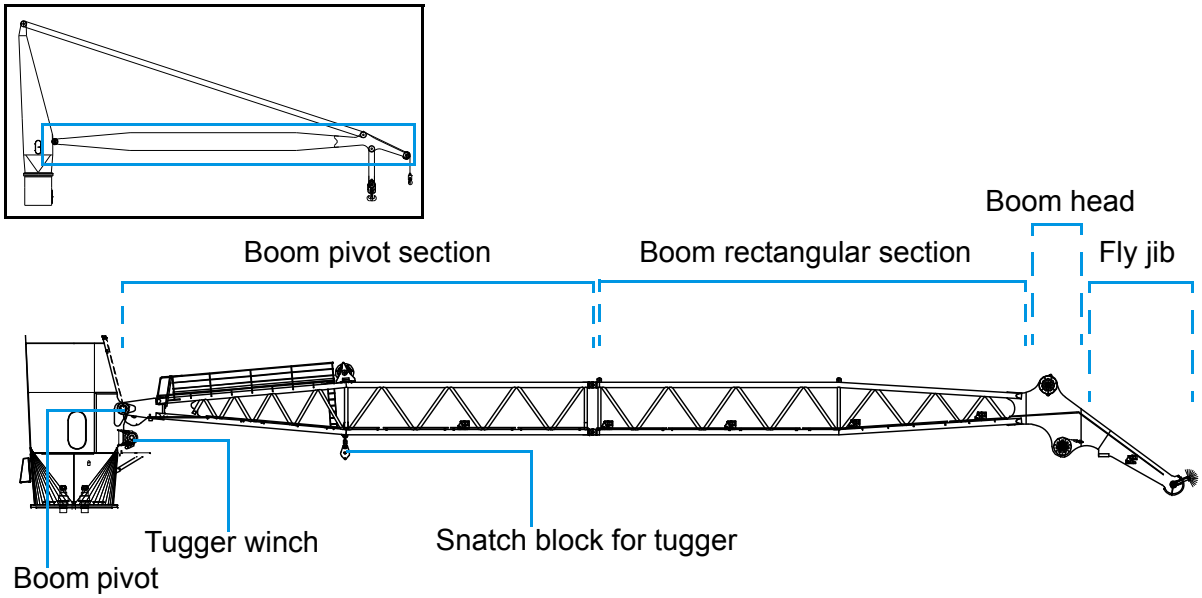


Figure 3-13: Boom overview

The boom is connected with the crane house and suspended from the crane house head by means of the boom hoist tackle. The boom head contains main hoist, whip hoist and boom hoist sheaves. The fly jib contains one whip hoist sheave.

This section describes the following parts:

- Section 3.5.1: "Boom hoist winch"
- Section 3.5.2: "Boom hoist safety device - band brake"
- Section 3.5.3: "Boom pivot section"
- Section 3.5.4: "Boom rectangular section"
- Section 3.5.5: "Boom head & fly jib"
- Section 3.5.6: "Boom hoist reeving"
- Section 3.5.7: "Mechanically actuated sensors"

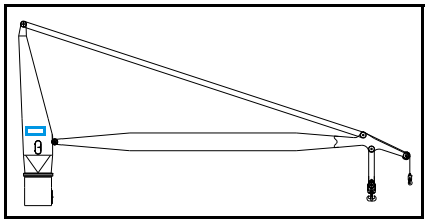
3.5.1 BOOM HOIST WINCH

Reference drawing:

A12-48000-21-0308: Boom hoist winch

The function of the boom hoist winch (see Figure 3-14 p.46) is to vary the angle of the boom.

The boom hoist winch is located in the upper part of the winch frame in the crane house.



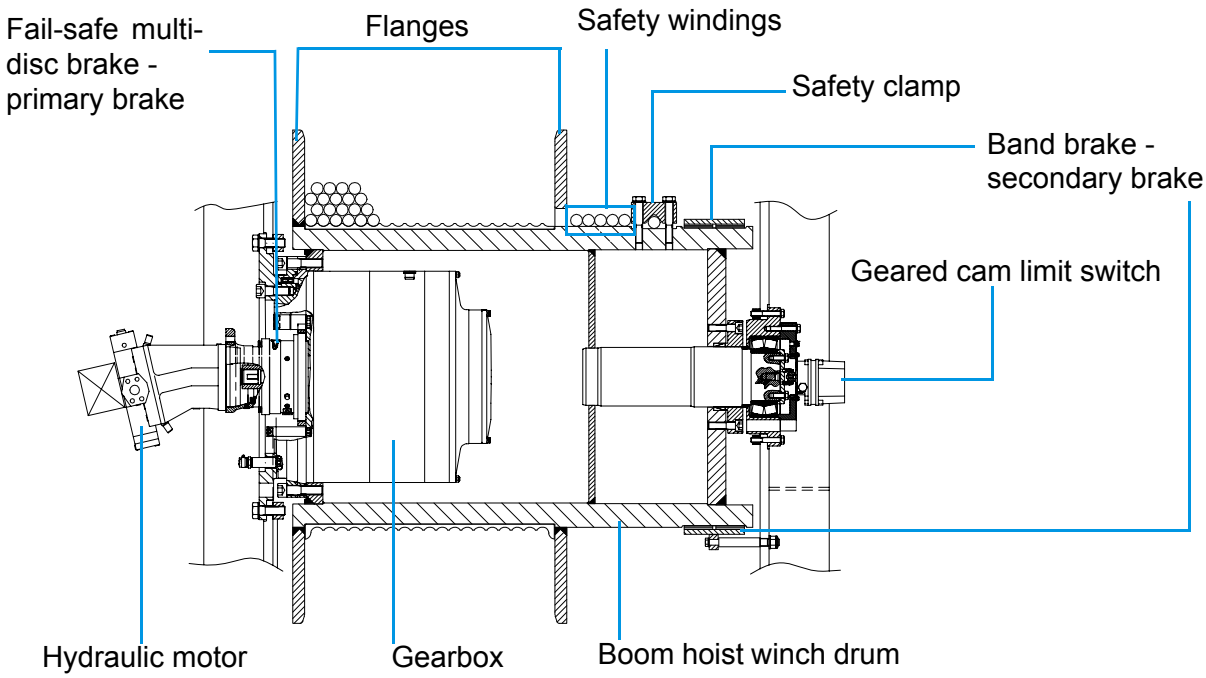
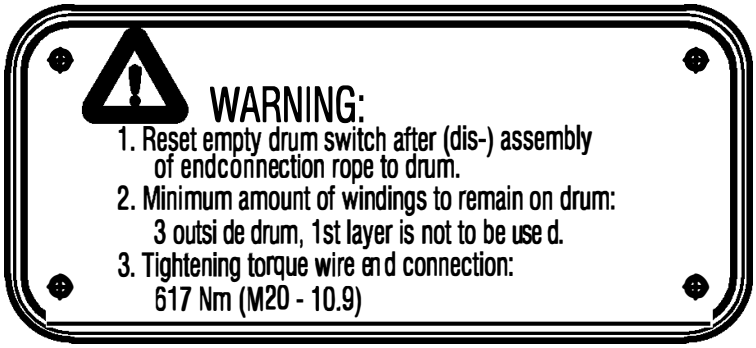


Figure 3-14: Boom hoist winch (typical)

The boom hoist right handed drum is able to store 4 operational layers (+ 4 storage layers). The boom hoist winch drum has 3 safety windings outside of the flanges and 2 inside the drum.The wire is clamped to the boom hoist drum with a safety clamp (see Figure 3-14 p.46). The clamp bolts must be tightened according to the tag plate. See Figure 3-15 p.46.



gure 3-15: Boom hoist drum tag plate

3.5.2 BOOM HOIST SAFETY DEVICE - BAND BRAKE

A band brake is added on the hoist drum as a secondary brake which is an extra safety device (see Figure 3-16 p.47). The band brake is applied when the hoist drum stop turning. When the crane is in operation and the hoist brake is released, the band brake is lifted as well.

For more information on the safety device, see 4.4.3 Boom hoist p.108.

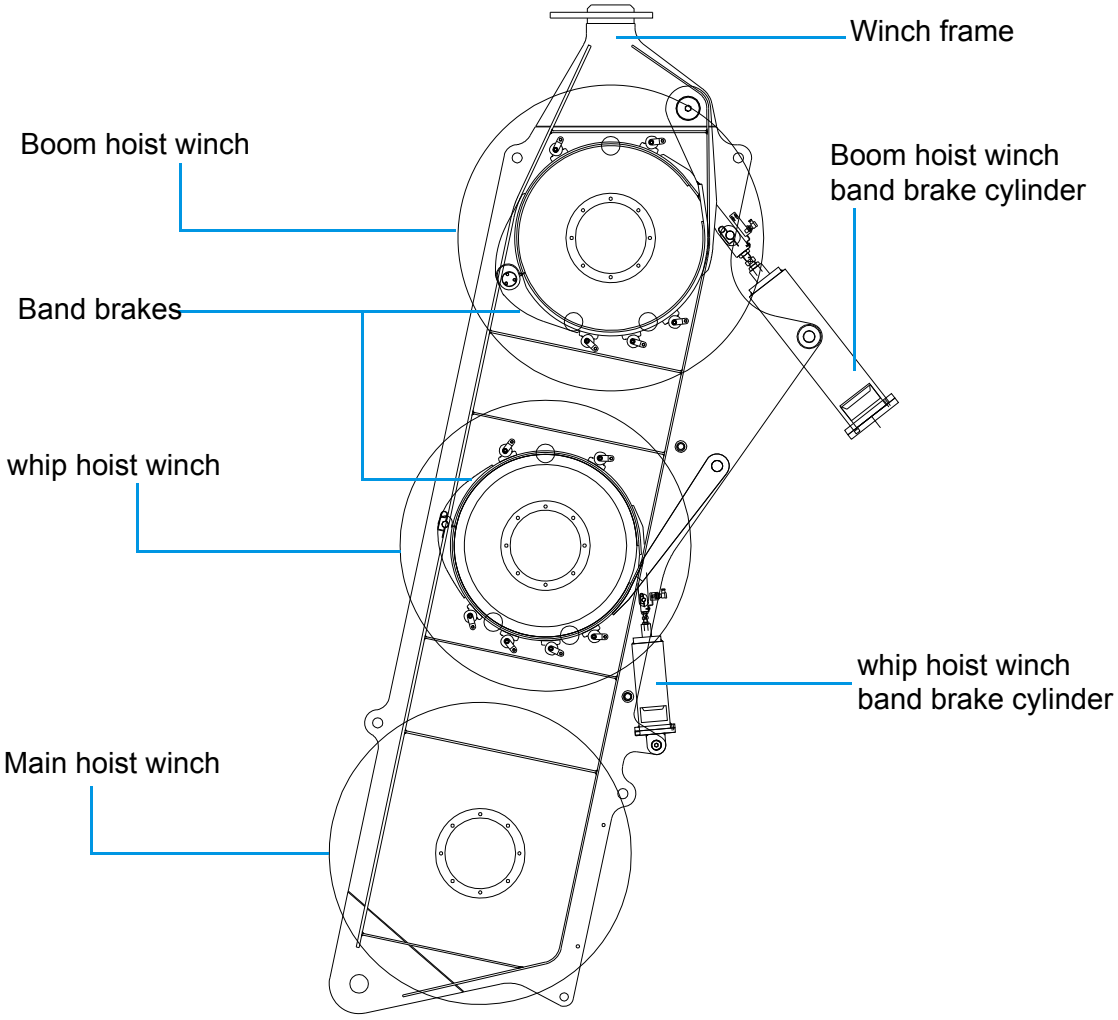


Figure 3-16: Safety device - band brakes

3.5.3 BOOM PIVOT SECTION

Reference drawing:

- A12-48000-15-0108: Boom pivot section

The boom pivot section consists of the boom pivot, two of the main hoist sheaves, two of the whip hoist sheaves, the tugger winch and the snatch block for tugger wire (see Figure 3-17 p.48).

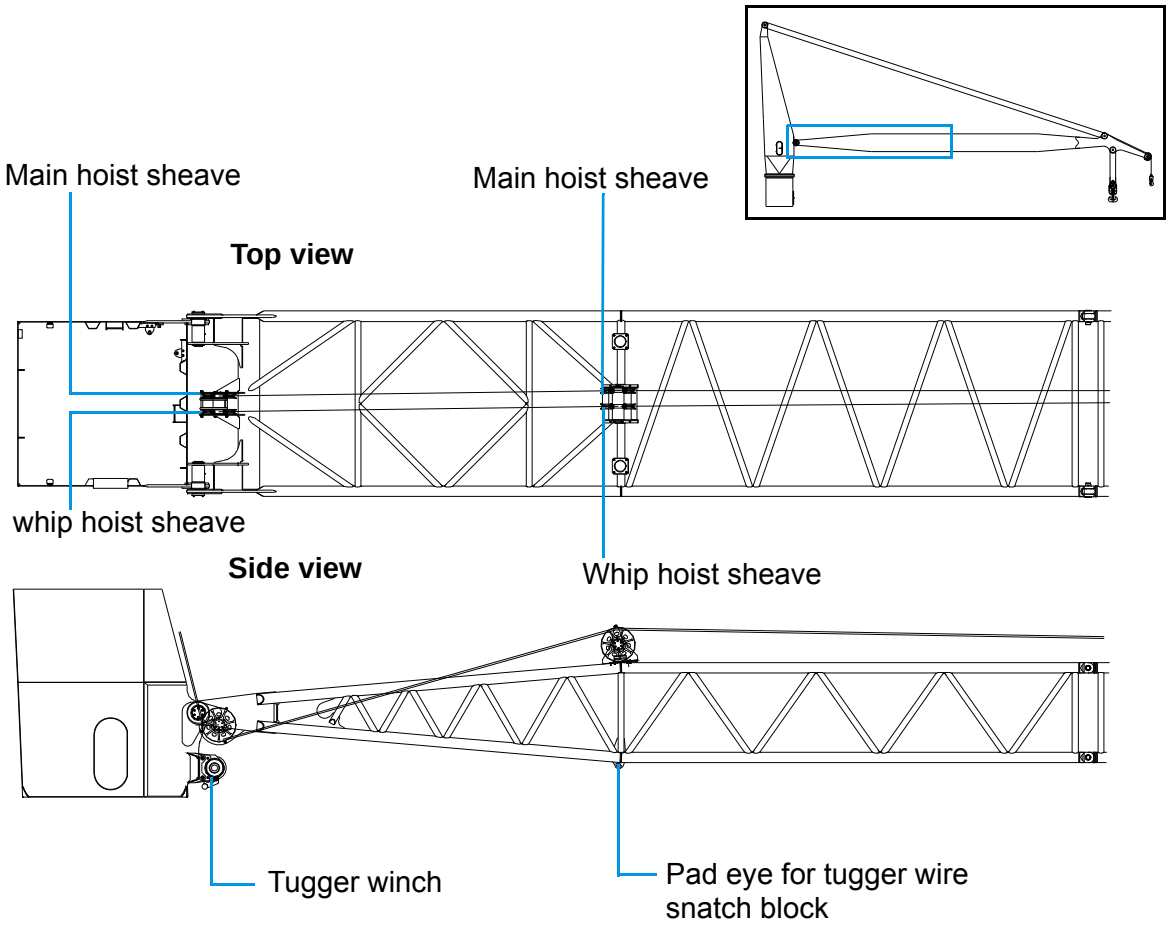


Figure 3-17: Boom pivot section

3.5.4 BOOM RECTANGULAR SECTION

Reference drawing:

- A12-48000-15-0208: Boom rectangular section

The boom rectangular section connects the boom pivot section with the boom head (see Figure 3-18 p.49).

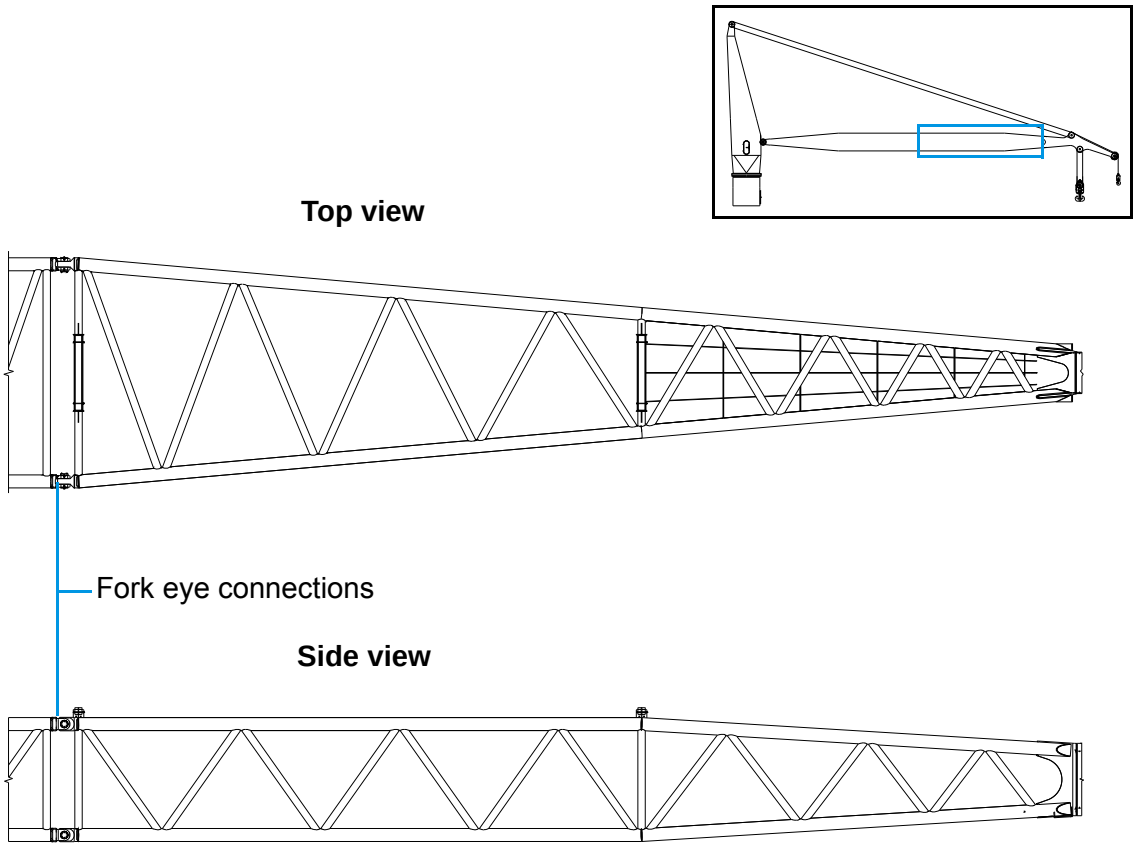


Figure 3-18: Boom rectangular section

3.5.5 BOOM HEAD & FLY JIB

Reference drawing:

- A17-42000-15-030: jib head & fly jib

Boom head section consists of two parts: boom head and fly jib (see Figure 3-19 p.50). The boom head is designed for a 300 mt 8 falls main hoist. The dead end of the main hoist is attached to the boom head. This dead end is equipped with a load measuring pin for main hoist.

The fly jib is connected to the boom head. The fly jib is designed for a single fall whip hoist, with loads up to 30 mt.

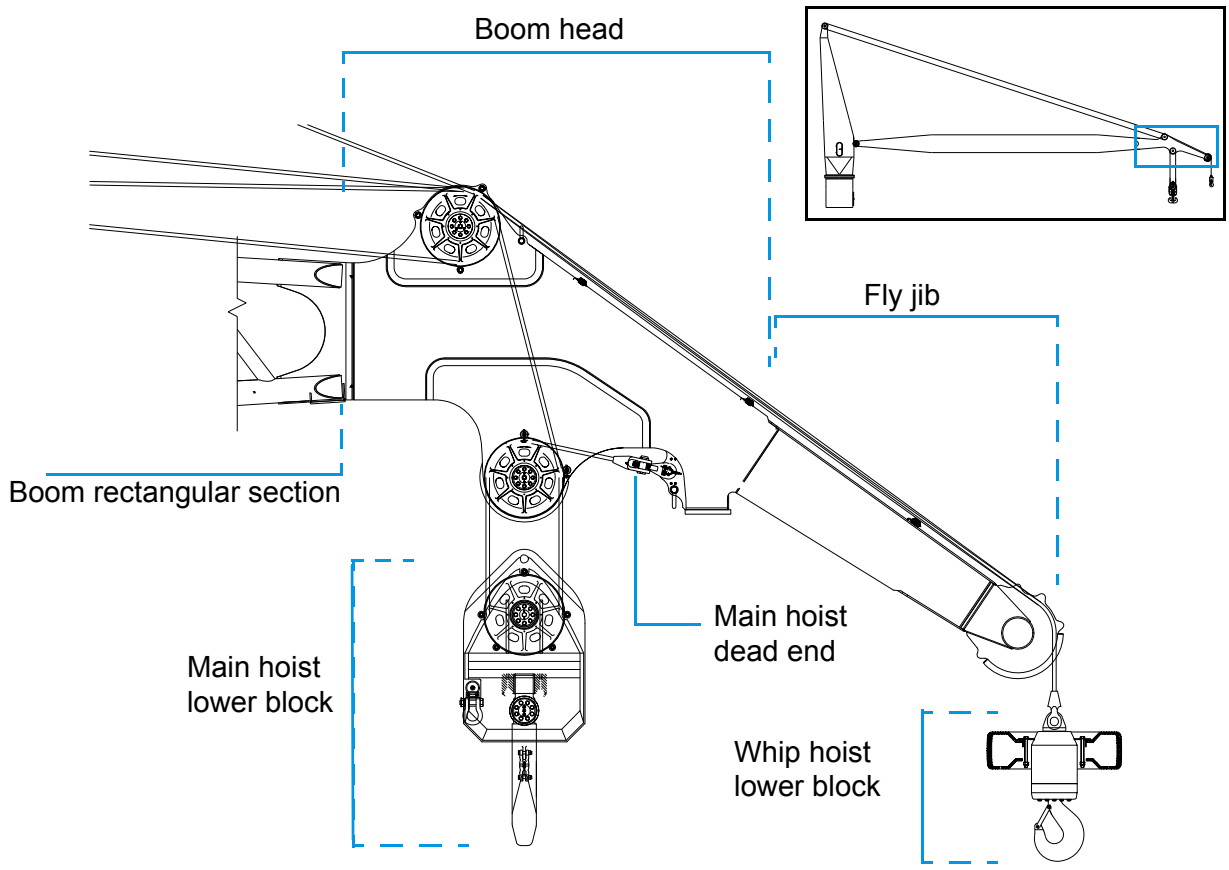


Figure 3-19: Boom head & fly jib

3.5.6 BOOM HOIST REEVING

Reference drawing:

- A17-42000-31-010: Reeving diagram

The 10 falls boom hoist reeving system (see Figure 3-20 p.51) consists of three parts:

- Boom hoist winch in the winch room (see Figure 3-14 p.46).
- Boom hoist sheaves in the crane house head section (see Figure 3-7 p.39).
- Boom hoist sheaves on the boom head (see Figure 3-19 p.50).

The boom hoist dead end is connected to the crane house head with a spelter socket.

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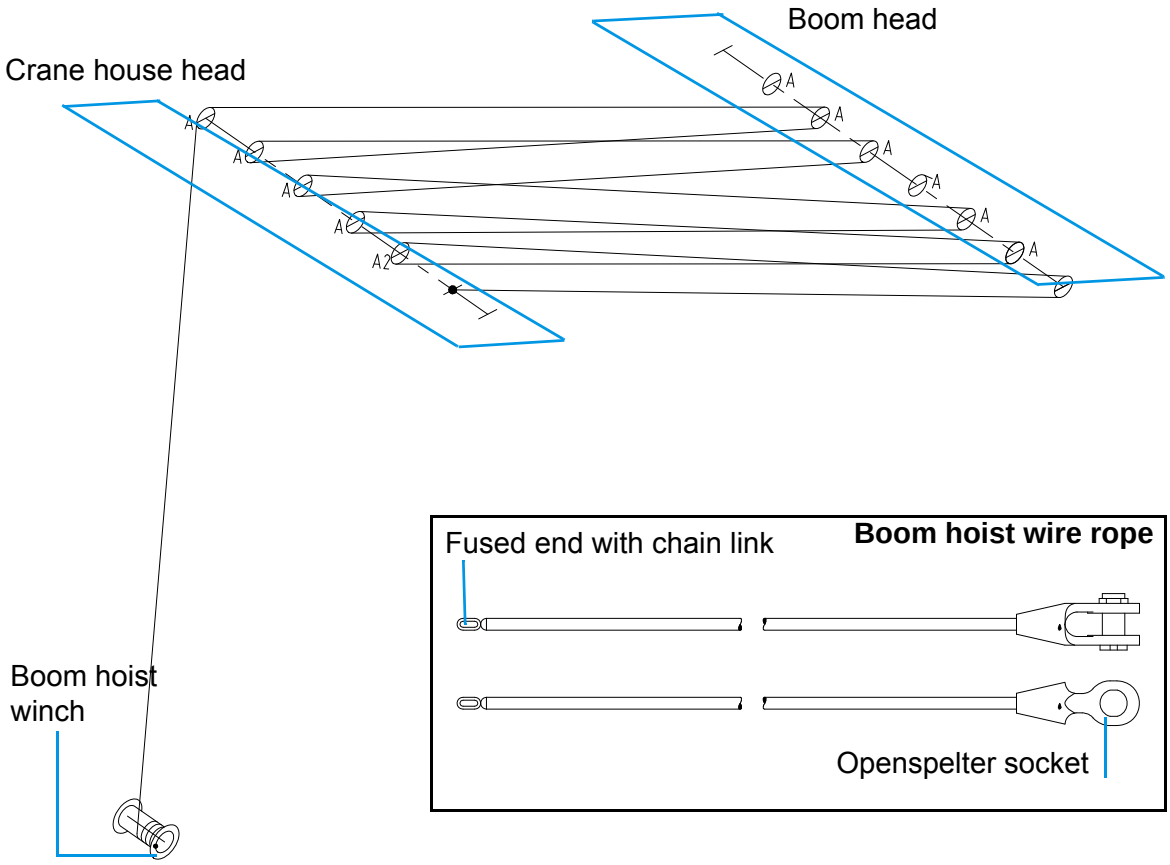


Figure 3-20: Boom hoist reeving

3.5.7 MECHANICALLY ACTUATED SENSORS

3.5.7.1 Geared cam limit switch

The geared cam limit switch on the boom hoist winch is mounted on the gear wheel on the outgoing shaft. This is used to count the number of revolutions of the winch drum and to determine the spooled length of the hoist wire. See Figure 3-14 p.46 for the location of the geared cam limit switch.

For more information about geared cam limit switches, see 3.9.1 Geared cam limit switch p.69.

NOTE *Must adjust the geared cam limit switches after reeving a new wire.*

3.5.7.2 Slack rope switch

A slack rope switch is mounted on the boom hoist winch drum. For more information about slack rope switch, see 3.9.2 Slack rope switch p.70".

3.5.7.3 Highest position switch

The highest position switch is placed on the crane house at about the height of the winch room section (see Figure 3-21 p.53).
The switch ensures that the boom hoist boom is stopped on time when hoisting. The mechanism works by means of a blade spring which consists of two blades in combination with a proximity switch.

When the boom pushes the bar inward, it extents the distance between the two blades of the blade spring. As a result, the contact between the blade spring and the proximity switch is broken, and the boom hoist winch is stopped.

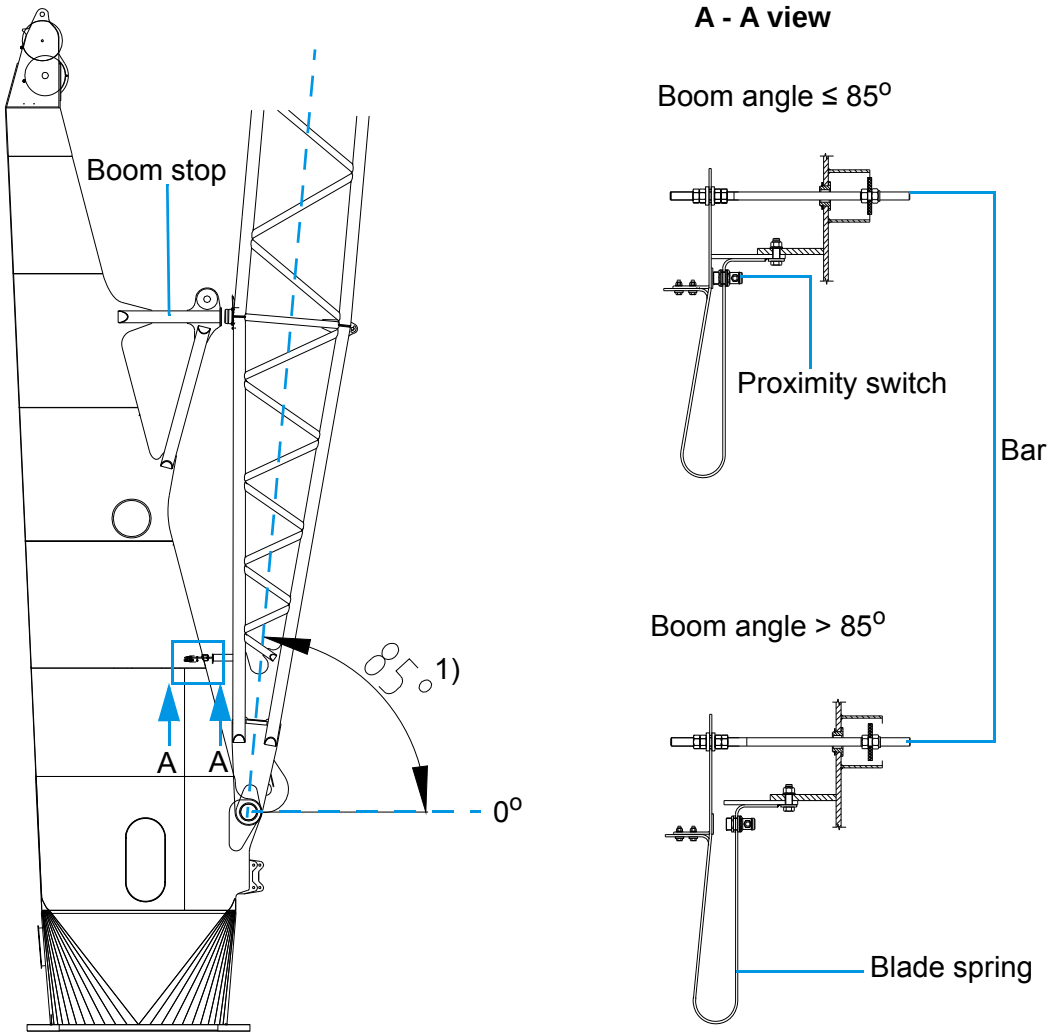


Figure 3-21: Boom hoist highest position switch

1) Maximum boom hoist working angle is 85°.

3.5.7.4 Inclinometer

An inclinometer is mounted on the boom pivot section. It is used to measure the boom angle relative to the horizon and to calculate the hoisting radius for the overload protection system.

Top view

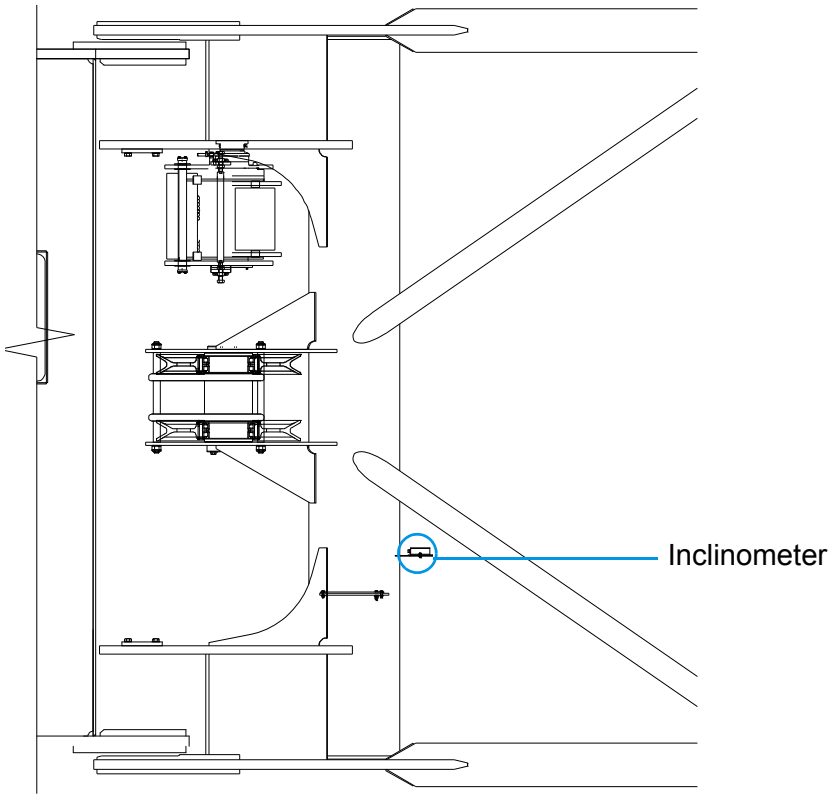


Figure 3-22: Inclinometer

3.6 MAIN HOIST

The main hoist system hoists and lowers the main hoist lower block. This section describes the following parts:

- Section 3.6.1: "Main hoist winch"
- Section 3.6.2: "Main hoist lower block"
- Section 3.6.3: "Main hoist reeving"
- Section 3.6.4: "Mechanically actuated sensors"

The main hoist winch is located in the lower part of the winch frame which is inside the crane house.

3.6.1 MAIN HOIST WINCH

Reference drawings:

- A12-48000-21-0108: Main hoist winch

The main hoist winch is driven by means of a gearbox-hydraulic motor combination.

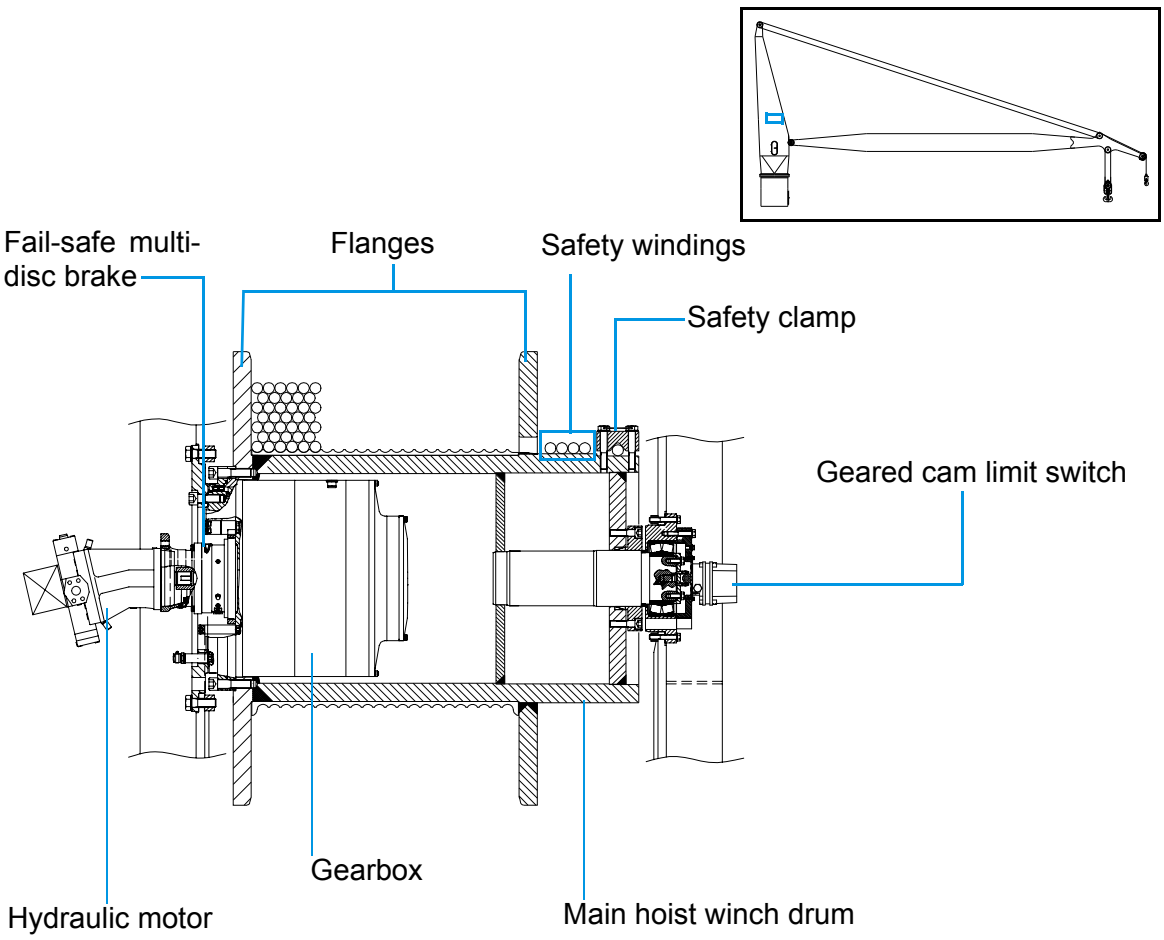


Figure 3-23: Main hoist winch (typical)

The main hoist winch drum has 3 safety windings outside of the flanges. The first layer in between the flanges is not to be used. The wire is clamped to the main hoist drum with a safety clamp (see Figure 3-23 p.55). The bolts of the clamp must be tightened according to the tag plate on the main hoist drum. See Figure 3-24 p.56.

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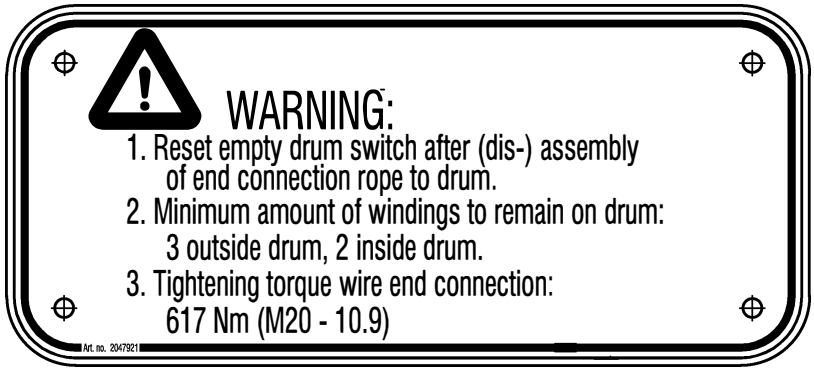


Figure 3-24: Tag plate main hoist drum

3.6.2 MAIN HOIST LOWER BLOCK

Reference drawing:

- A12-48000-33-0108: Main hoist lower block

The main hoist lower block (see Figure 3-25 p.57) is equipped with a double hook. Spring driven safety latches are mounted to prevent slings from slipping out of the hook.

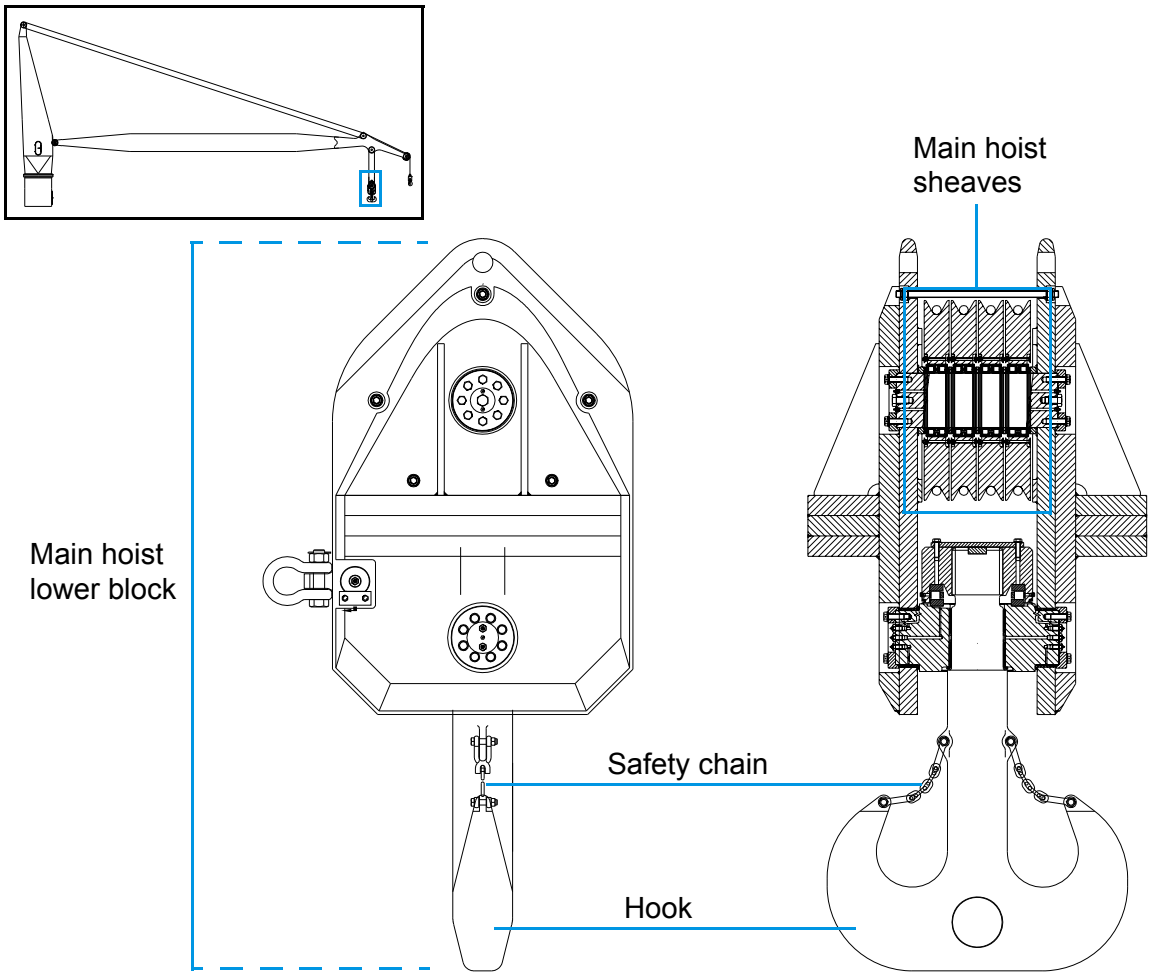


Figure 3-25: Main hoist lower block

3.6.3 MAIN HOIST REEVING

Reference drawing:

- A17-42000-31-010: Reeving diagram

The 8 falls or 4 falls main hoist reeving system (see Figure 3-26 p.58) consists six parts:

- Main hoist winch in the winch room (see Figure 3-9 p.41).
- Main hoist sheave in the crane house head section (see Figure 3-7 p.39).
- Main hoist sheaves in the boom pivot section (see Figure 3-17 p.48).
- Main hoist sheaves on the boom head (see Figure 3-19 p.50).
- Dead end on the fly jib (see Figure 3-19 p.50).
- Main hoist sheaves on the main hoist lower block (see Figure 3-25 p.57).

The main hoist dead end is connected to the fly jib with an open spelter socket and a main hoist Load Measuring Pin (LMP). For more information about LMP, see Appendix B: "Reference documentation".

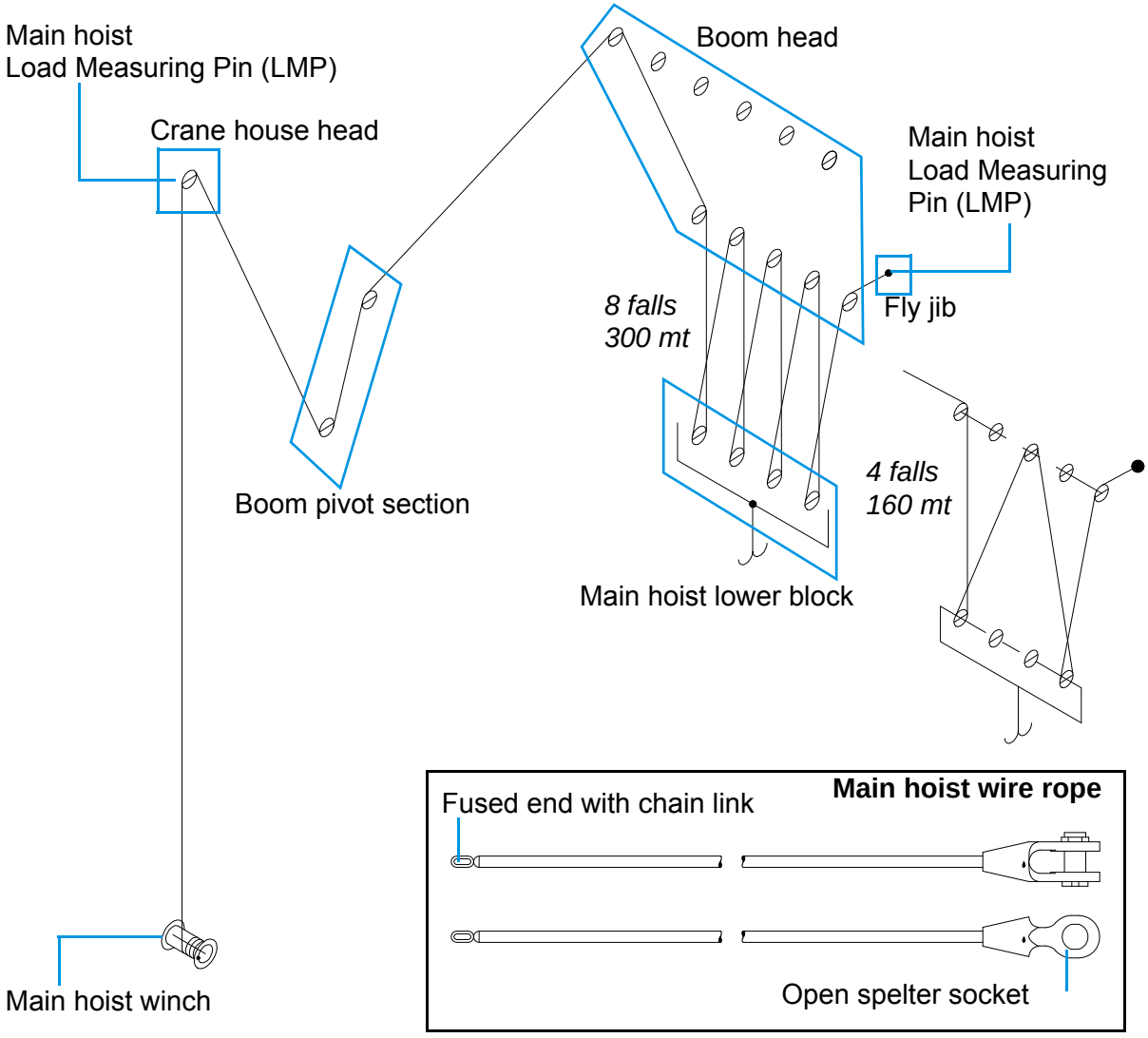


Figure 3-26: Main hoist reeving

3.6.4 MECHANICALLY ACTUATED SENSORS

3.6.4.1 Geared cam limit switch

The main hoist system is provided with a geared cam limit switch. This is used to count the number of revolutions of the winch drum, to determine the spooled length of the hoist wire and the highest position.

See Figure 3-23 p.55 for the location of the main hoist geared cam limit switch. For more information about geared cam limit switches, see 3.9.1 Geared cam limit switch p.69.

NOTE *Must adjust the geared cam limit switches after reeving a new wire.*

3.6.4.2 Slack rope switch

The boom hoist, whip hoist and the mainhoist winch are provided with a slack rope switch mechanism. This is used to stop the drum in case of a wire slack. For detailed information about slack rope switch, see 3.9.2 Slack rope switch p.70.

3.6.4.3 Load Measuring Pins

The main hoist system is provided with two Load Measuring Pins (LMPs). This is used to measure the load acting on the hoist. It is located in two of the sheaves in the reeving (see Figure 3-26 p.58).

For more information about LMP, see 3.9.3 Load Measuring Pin p.72.

3.7 WHIP HOIST

The whip hoist system hoists and lowers the whip hoist lower block suspended from the fly jib. This section describes the following parts;

- Section 3.7.1: "Whip hoist winch"
- Section 3.7.2: "Whip hoist safety device - band brake"
- Section 3.7.3: "Whip hoist lower block"
- Section 3.7.4: "Whip hoist reeving"
- Section 3.7.5: "Mechanically actuated sensors"

The whip hoist winch is located in the upper part of the winch frame which is inside the crane house (see Figure 3-9 p.41).

3.7.1 WHIP HOIST WINCH

Reference drawings:

A12-48000-21-0208: Whip hoist winch

The whip hoist winch is driven by means of a gearbox-hydraulic motor combination . The winch is provided with a band brake.

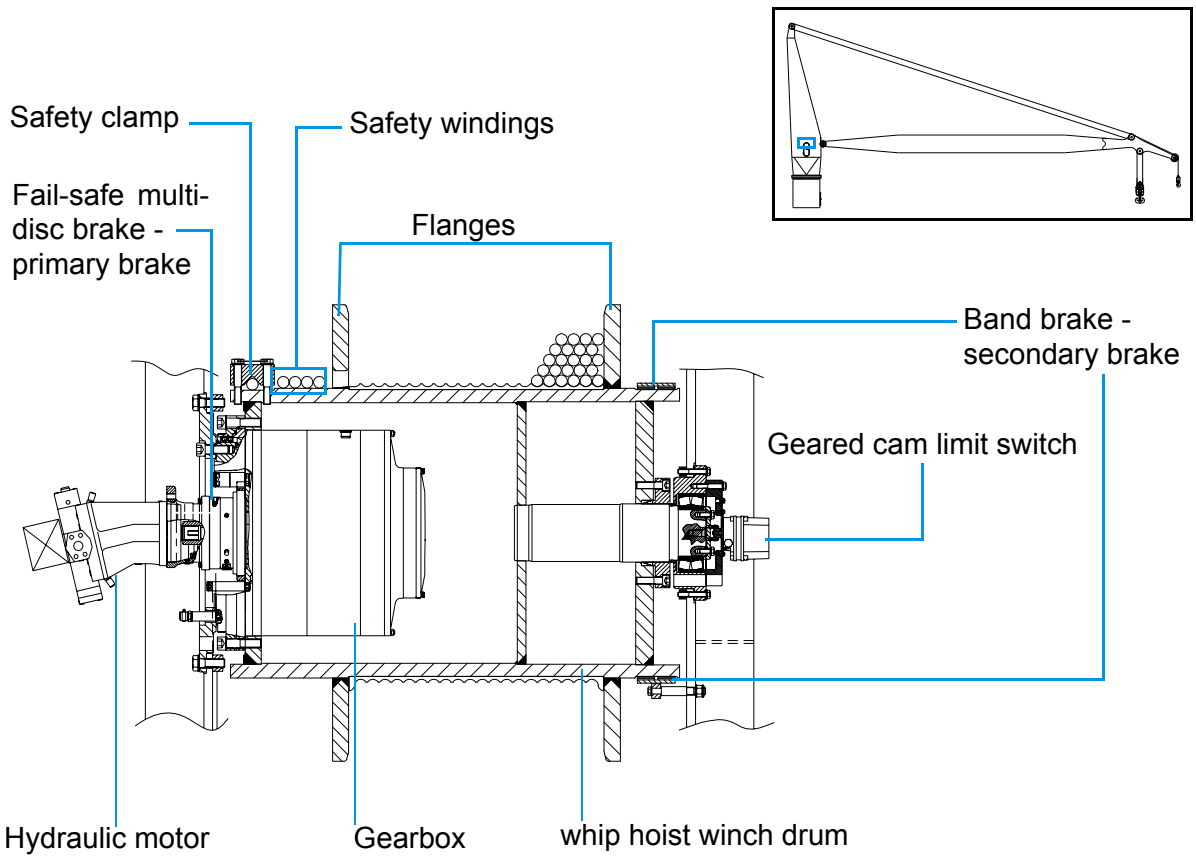


Figure 3-27: Whip hoist winch (typical)

The whip hoist winch drum has 3 safety windings outside of the flanges and 2 inside the drum. The wire is clamped to the whip hoist drum with a safety clamp (see Figure 3-27 p.60). The bolts of the clamp must be tightened according to the tag plate. See Figure 3-28 p.61.

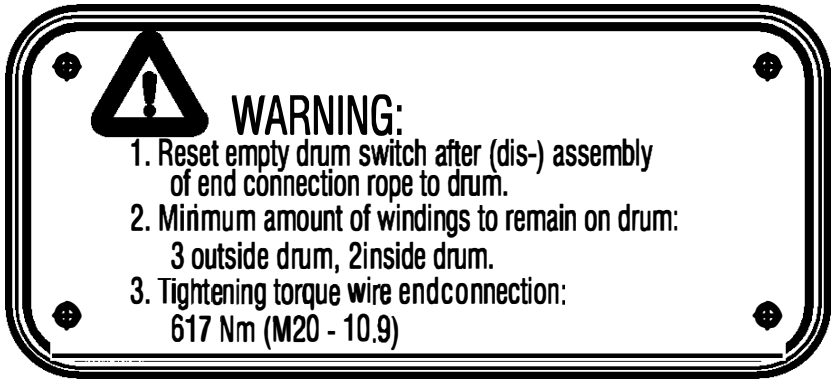


Figure 3-28: Whip hoist drum tag plate

3.7.2 WHIP HOIST SAFETY DEVICE - BAND BRAKE

A band brake is added on the hoist drum as a secondary brake (see Figure 3-27 p.60). The band brake is applied when the whip hoist drum stop turning. When the crane is in operation, and the whip hoist brake is released, the band brake is lifted as well.

For more information on the safety device, see 4.4.2 Whip hoist p.103.

3.7.3 WHIP HOIST LOWER BLOCK

Reference drawing:

- A17-42000-33-020: Whip hoist lower block 30 mt

The whip hoist lower block (see Figure 3-29 p.62) has a single hook. It works with 40 mm wire in a single fall configuration, which can cope with a SWL of 30 mt. The hook can travel for approximately 100 m.

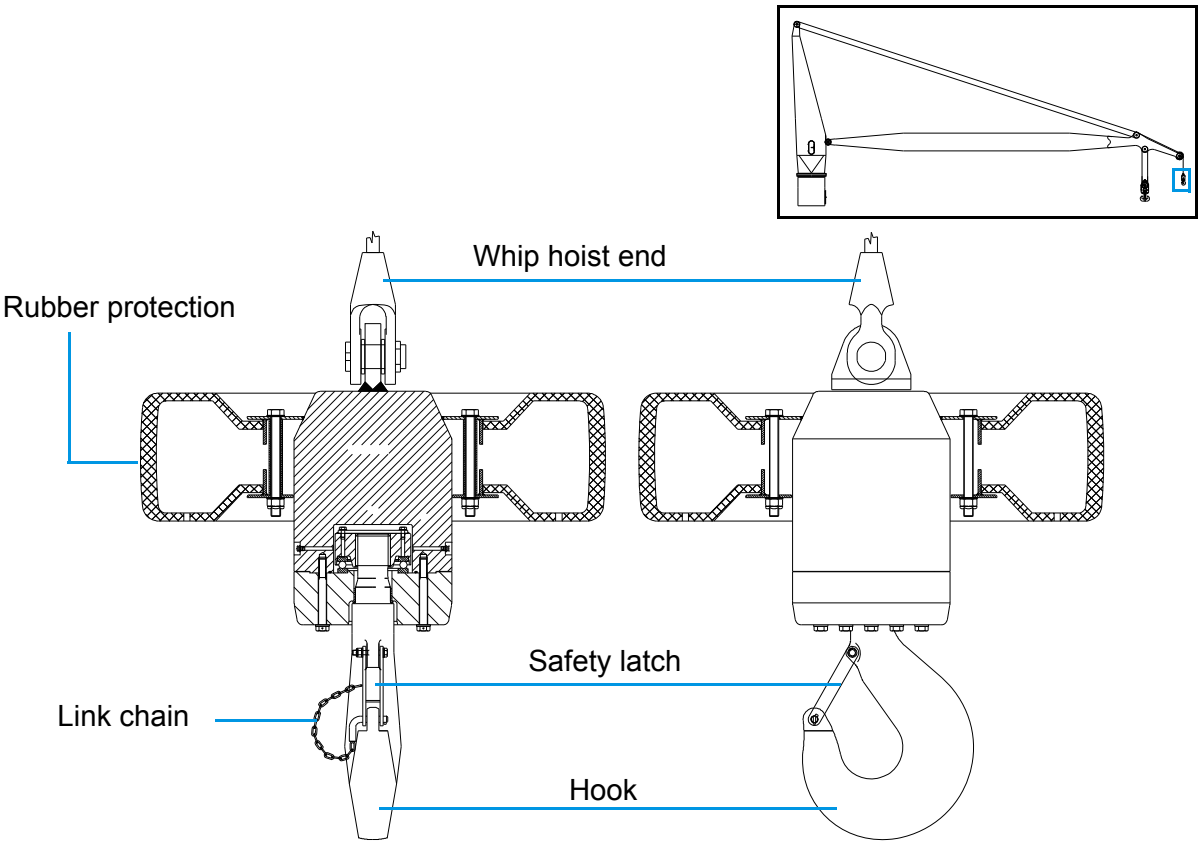


Figure 3-29: Whip hoist lower block

3.7.4 WHIP HOIST REEVING

Reference drawing:

- A17-42000-31-010: Reeving diagram

The 1 fall whip hoist reeving system (see Figure 3-30 p.63) consists of the following parts:

- Whip hoist winch in the winch room (see Figure 3-9 p.41).
- Whip hoist sheave in the crane house head section (see Figure 3-7 p.39).
- Whip hoist sheaves in the boom pivot section (see Figure 3-17 p.48).
- Whip hoist sheave on the boom head (see Figure 3-19 p.50).
- Whip hoist sheave on the fly jib (see Figure 3-19 p.50).
- Whip hoist end on the whip hoist lower block (see Figure 3-29 p.62).

The whip hoist dead end is connected to the fly jib with a open spelter socket. The whip hoist LMP is mounted in the whip equalizer block on the crane house head. For more information about LMP, see Appendix B: "Reference documentation".

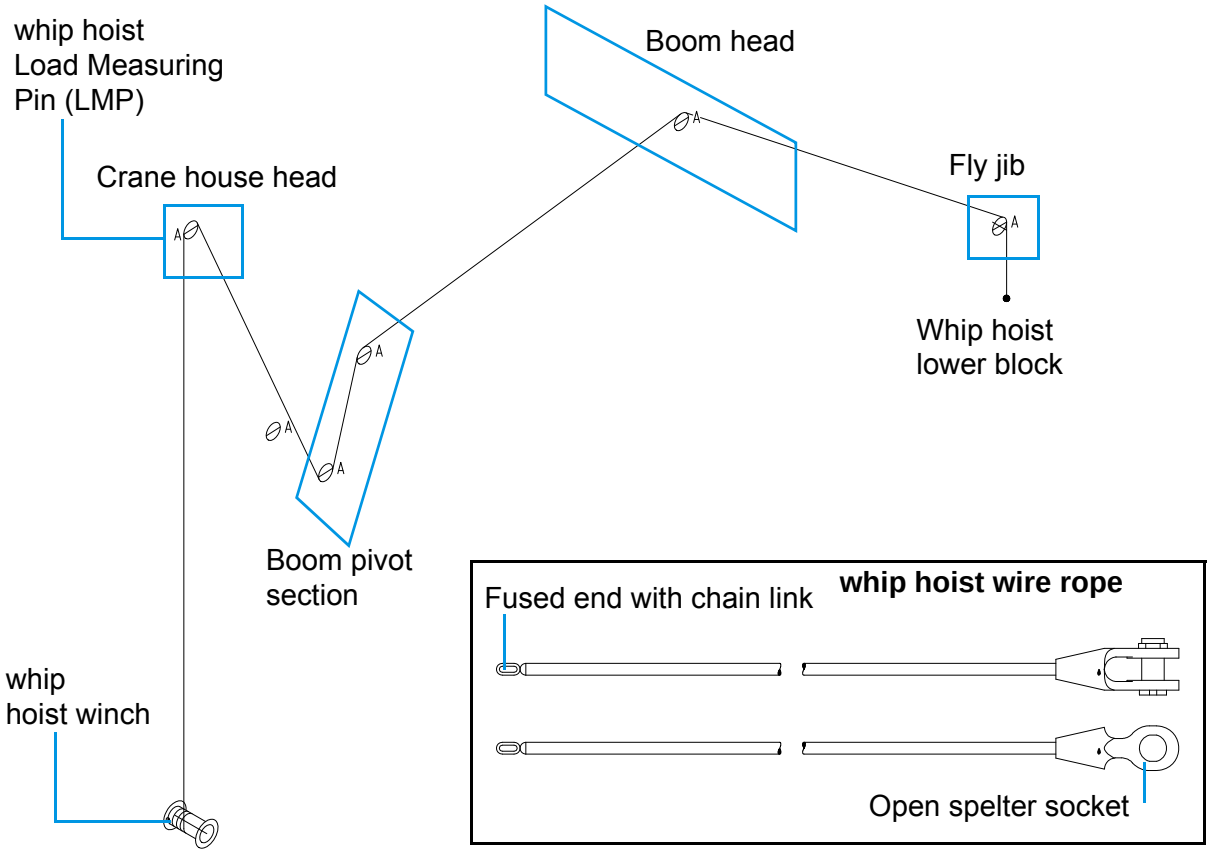


Figure 3-30: Whip hoist reeving

3.7.5 MECHANICALLY ACTUATED SENSORS

3.7.5.1 Geared cam limit switch

On the whip hoist winch, the geared cam limit switch mounted on the gear wheel on the outgoing shaft. This is used to count the number of revolutions of the winch drum and to determine the spooled length of the hoist wire.

See Figure 3-27 p.60 for the location of the whip hoist geared cam limit switch. For more information about geared cam limit switches, see 3.9.1 Geared cam limit switch p.69.

NOTE *Adjust the geared cam limit switches after reeving a new wire.*

3.7.5.2 Slack rope switch

A slack rope switch is mounted on the whip hoist winch drum. For detailed information about slack rope switch, see 3.9.2 Slack rope switch p.70.

3.7.5.3 Load Measuring Pin

The whip hoist Load Measuring Pin (LMP) is located on crane house head (see Figure 3-30 p.63).

For more information about LMP, see 3.9.3 Load Measuring Pin p.72.

3.8 TUGGER

The tugger serves to stabilize the load and reduce off lead. These can be attached to the hook or to strong points on the load.

This section describes the following parts:

- Section 3.8.1: "Tugger winch"
- Section 3.8.2: "Tugger roller"
- Section 3.8.3: "Tugger snatch block"
- Section 3.8.4: "Tugger reeving"

3.8.1 TUGGER WINCH

Reference drawing:

A12-48000-21-0708: Tugger winch

The tugger winch (see Figure 3-31 p.65) is driven by means of a gearbox-hydraulic motor at one side of the drum. The gearbox is provided with a fail safe multi-disc brake.

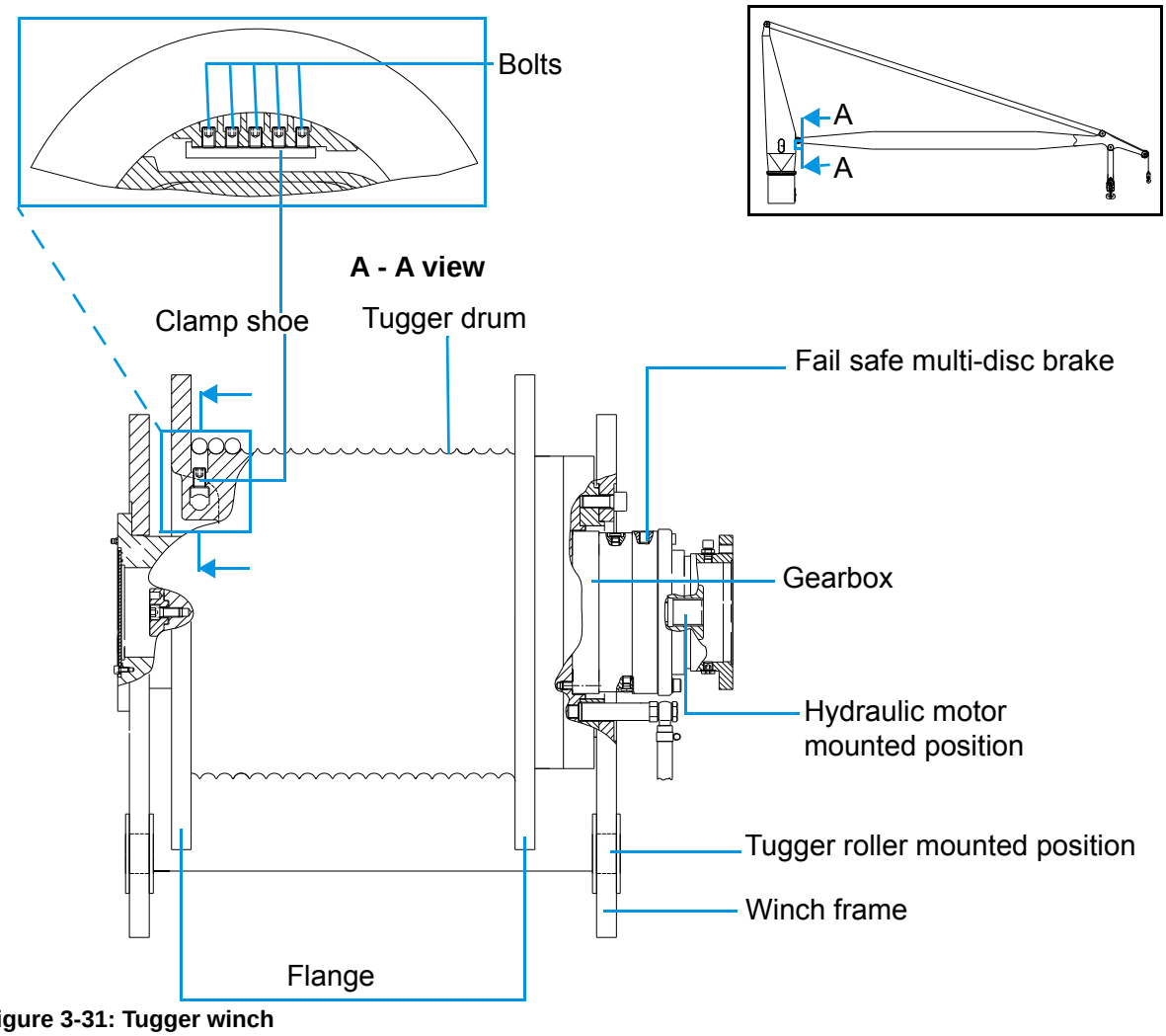


Figure 3-31: Tugger winch

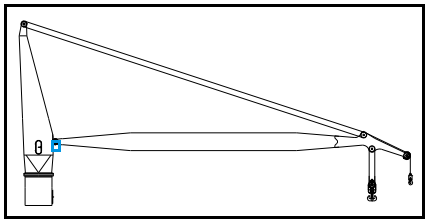
The tugger winch drum has 3 safety windings within the flanges. The wire is clamped to the tugger drum with a clamp shoe which is fixed by five bolts. The bolts of the clamp must be tightened with a torque of 136 Nm.

3.8.2 TUGGER ROLLER

Reference drawing:

- A12-48000-21-0408: Tugger roller

The tugger roller makes sure the wire spools correctly on the tugger drum (see Figure 3-32 p.66). The level principle (spring) keeps the tugger roller pressed against the tugger winch



Side view

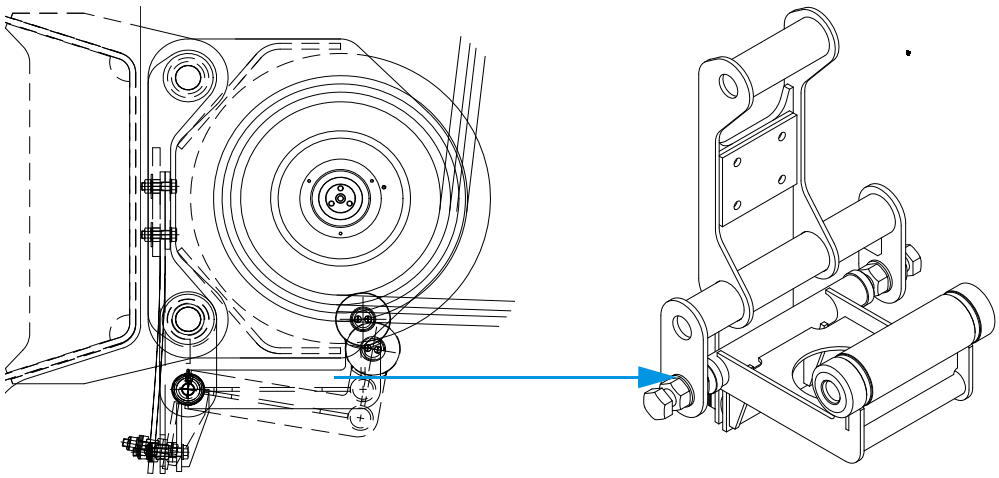


Figure 3-32: Tugger roller on the tugger winch (typical)

3.8.3 TUGGER SNATCH BLOCK

Reference drawing:

- A12-48000-33-0308: Snatch block for tugger wire

The tugger snatch block is used change the direction in which a rope is running. It guides the wire rope from the tugger winch spooling direction to the main hoist lower block.

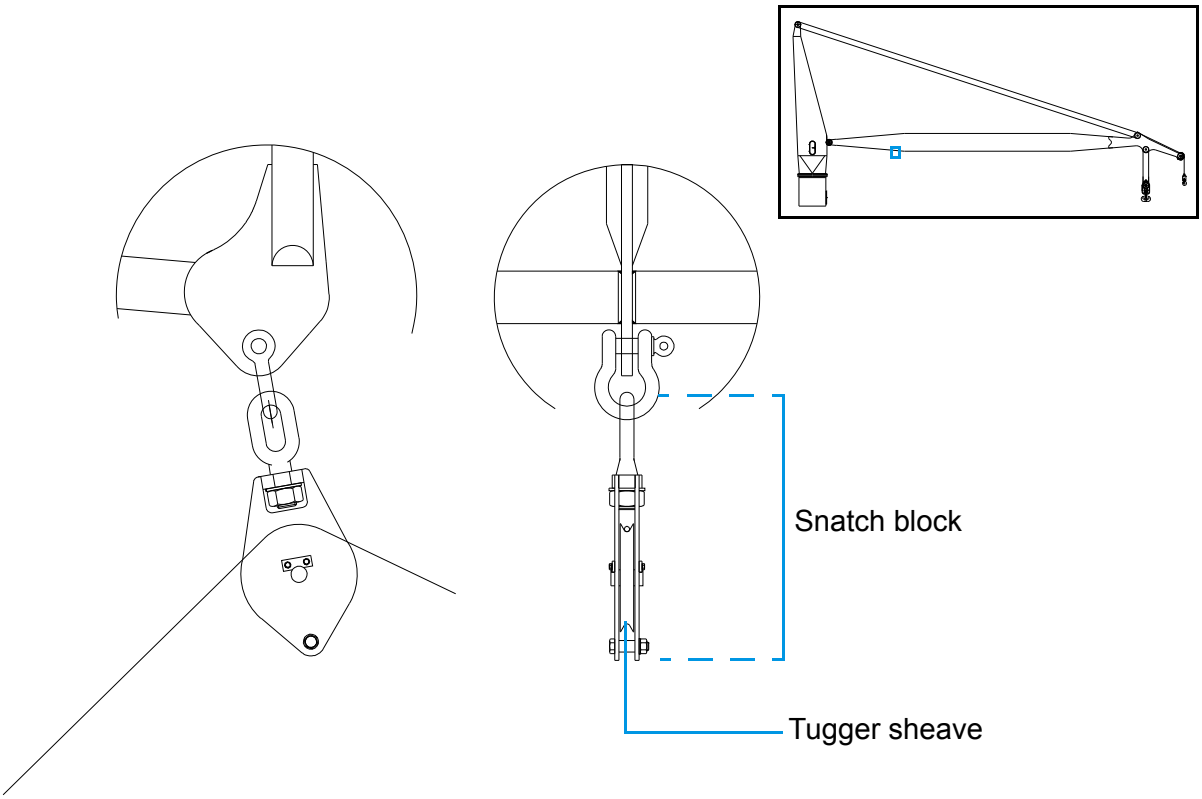


Figure 3-33: Tugger snatch block

3.8.4 TUGGER REEVING

Reference drawing:

A17-42000-31-010: Reeving diagram

The single fall tugger reeving systemconsists of three parts:

- Tugger winch in the boom pivot section.
- Tugger snatch block in the boom pivot section.
- The open wedge socket connected to the main hoist lower block.

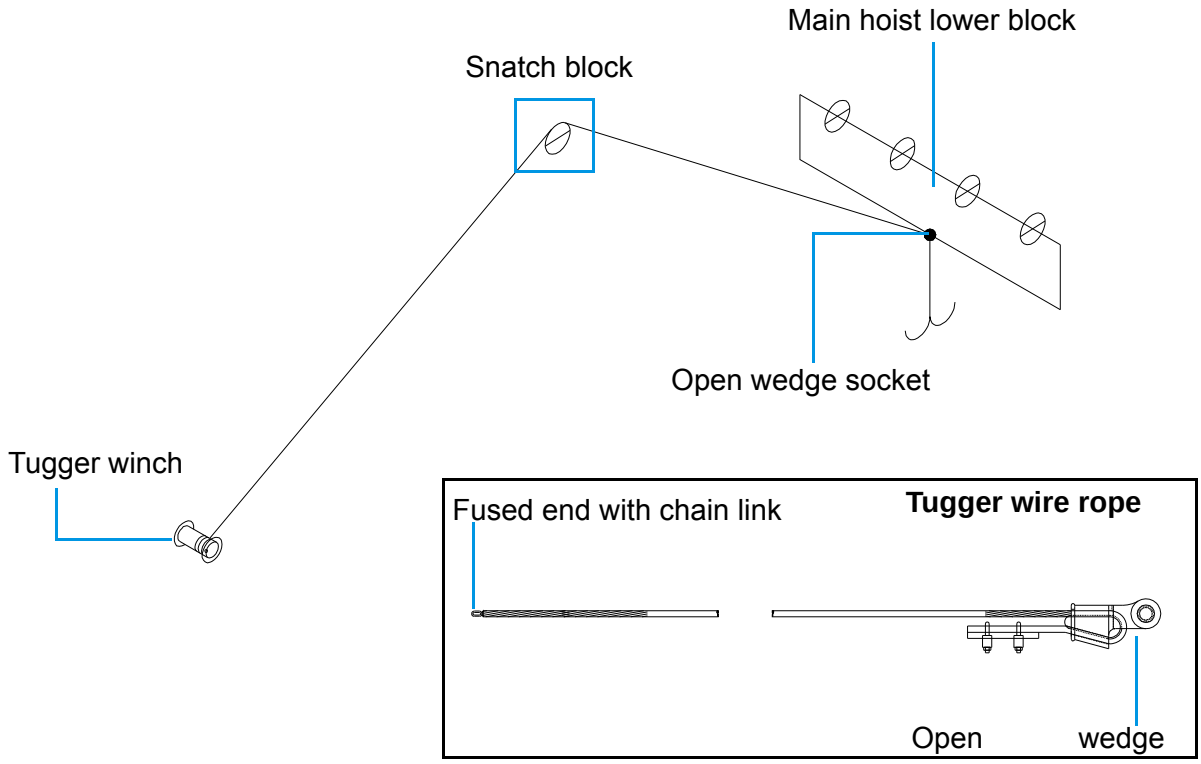


Figure 3-34: Tugger reeving

3.9 MECHANICALLY ACTUATED SENSORS AND SWITCHES

This section describes the following sensors and switches:

- Section 3.9.1: "Geared cam limit switch"
- Section 3.9.2: "Slack rope switch"
- Section 3.9.3: "Load Measuring Pin"
- Section 3.9.4: "Length measuring sensor"

3.9.1 GEARED CAM LIMIT SWITCH

The following systems are provided with a geared cam limit switch:

- Main hoist winch
- Whip hoist winch
- Boom hoist winch

Geared limit switches are used to count the number of revolutions of a winch drum to determine the spooled length of the hoist wire. On winches, the internal mechanism in the switch housing keeps track of the number of revolutions of the drum. The switching contacts inside the housing are adjusted such that the winch is stopped at a number of predefined positions (i.e. “empty drum” position, when only the safety windings are left on the drum).

Geared cam limit switches are placed on the outgoing shaft (axis) of the drum. These are provided with a cam disc that is actuated by the rotation of the shaft (see Figure 3-35 p.69).

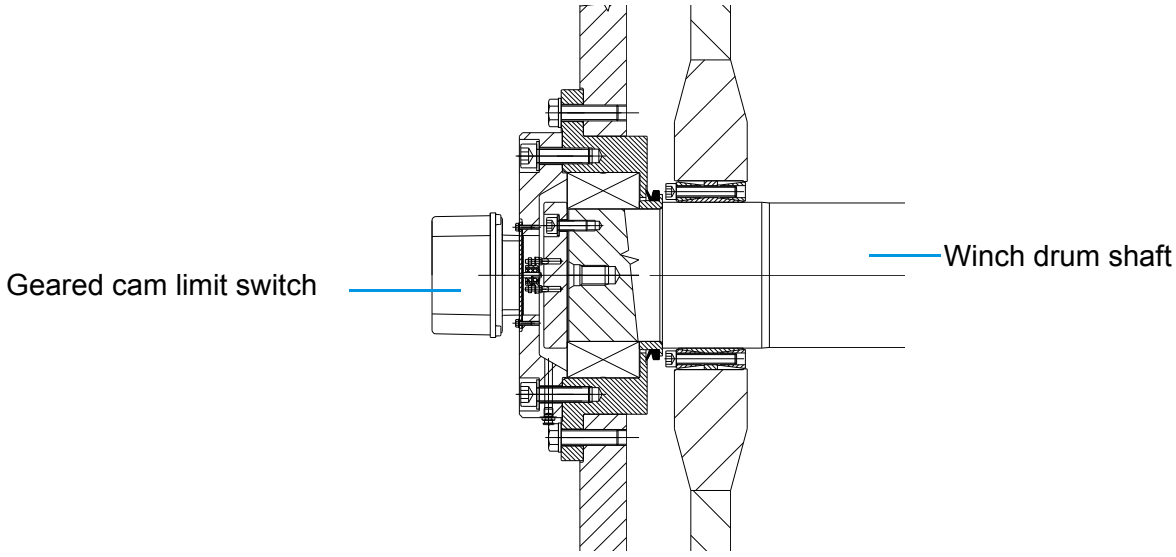


Figure 3-35: Geared cam limit switch on shaft (typical)

For details about the implementation of the geared cam limit switches, see geared cam limit switch in Section 5.7.3: "Winch room" and the electrical diagrams in Appendix A: "Reference drawings".

3.9.2 SLACK ROPE SWITCH

WARNING



Always check the rope leading, sheaves and other items that could have caused the slack, and do not reset until the cause of the slack rope has been removed.

The boom hoist, main hoist and whip hoist winches are equipped respectively with a slack rope safety mechanism (see Figure 3-36 p.71). When it is activated, the movement is stopped automatically.

The slack rope mechanism consists of a slack rope bar mounted underneath the drum. A slack rope pushes the slack rope bar downward which causes the detection plate being lifted up and undetected from the proximity switch with array indicating the movement). As a result, the control system stops the winch. Consequently, the necessary follow up actions should be taken, see.

The slack rope bar must be reset manually in order to regain a working position with which operation can be continued. It can be done by pulling the proximity switch bar away from the detection plate, the detection plate will fall back to the working position due to gravity as long as there is no slack rope.

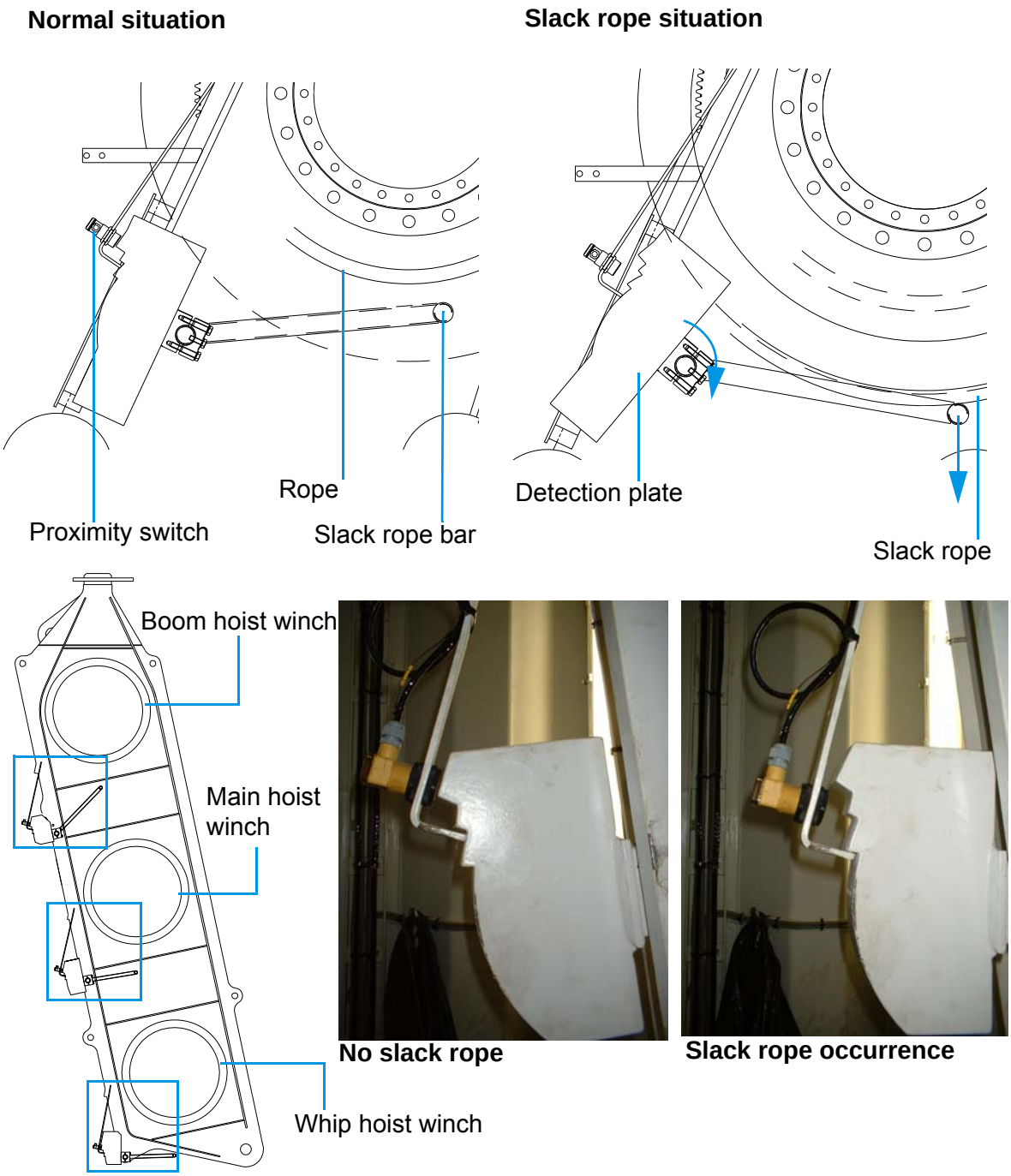


Figure 3-36: Slack rope mechanism

3.9.3 LOAD MEASURING PIN

The following Load Measuring Pins (LMPs) are provided:

- Main hoist system (2x)
- Whip hoist system.

LMPs are integrated in sheave shafts or at the wire end and serves to measure the load acting on the hoist. The positions of the LMPs are indicated in the reeving diagram.. The load is measured by strain gauge. This value is amplified and calculated to a weight value (tons) by the control system. If the Safe Working Load (SWL) for the given conditions is exceeded, the overload protection system will be activated and the movement will be stopped.

For a detailed description of the load measuring pins, see “Manual load measuring pin” in Appendix B: "Reference documentation". Further details are also given in and in the electrical diagrams.

3.9.4 LENGTH MEASURING SENSOR

The paid out length of the whip hoist wire is measured by means of a toothed disc in combination with two proximity switches. The proximity switch detects each rotation of the sheave. The input can be used to record the length of the hoist (see Figure 3-37 p.72). For more information, see 5.7.5 Boom p.137.

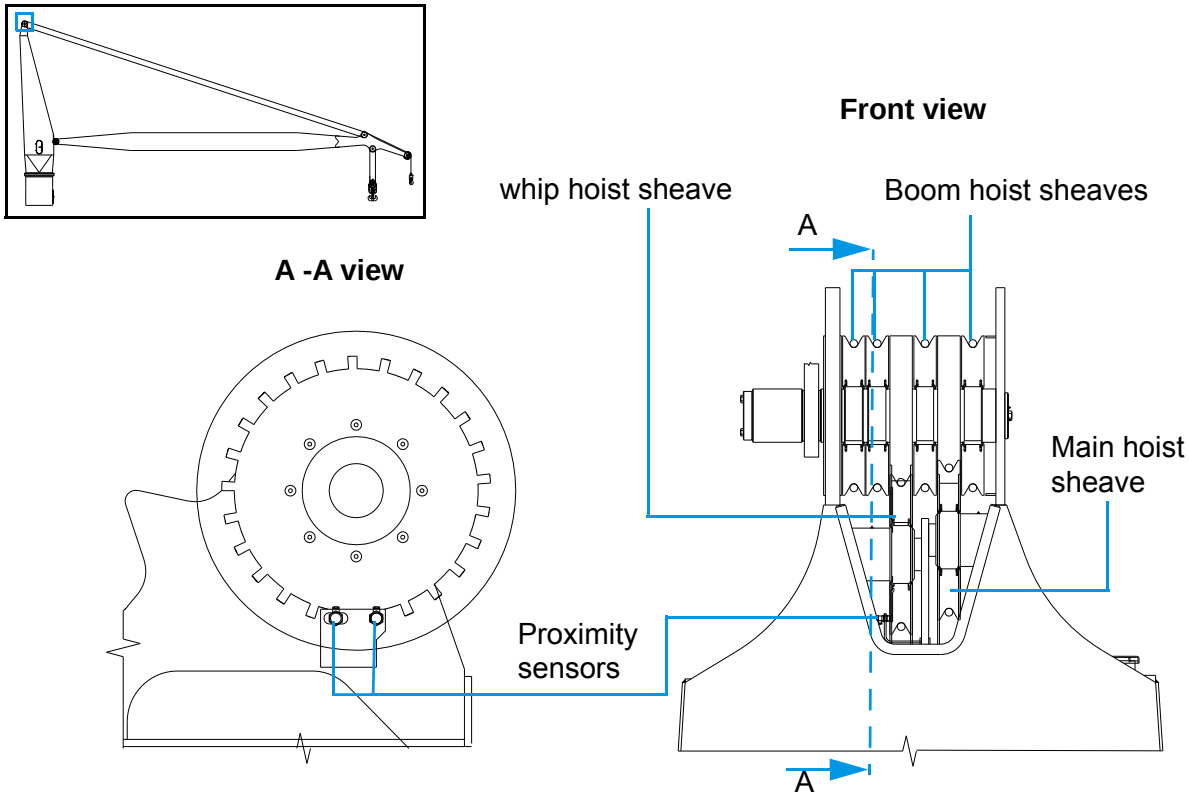


Figure 3-37: Length measuring whip hoist sheave

3.10 OUTFITTING

This section describes the outfitting characteristics of the 300 mt PMC.

3.10.1 STAIRS & PLATFORMS

For easy and safe access, the crane is provided with stairs and platforms. Access to the winch room and other inner components of the crane are safely accessible by stairs and platforms.

A circular platform is installed on the slew platform on the outer side of the pedestal. From here the control cabin and the boom are accessible.

3.10.1.1 Access categories

Access to the crane is divided in 3 different categories:

- Operational access:

  Work areas and control cabins need to be accessed frequently. No personal safety measures are needed to access these areas.

- Maintenance access:

  For access to areas which need maintenance with a frequency lower than once a month, provisions may be present. However, personal safety measures may be needed.

- Repair access:

  Some locations have no access provisions. All control consoles, junction boxes and manifold are considered repair access areas.

3.10.1.2 Pedestal

Stairs and platforms inside of pedestal allow to reach the slew bearing and the crane house lower section where the slew drive system motors and E-cabinet are located.

Stairs and platforms outside of pedestal allow to reach the circular platform which is installed on the slew platform on the outer side of the pedestal, from where the control cabin is accessible.

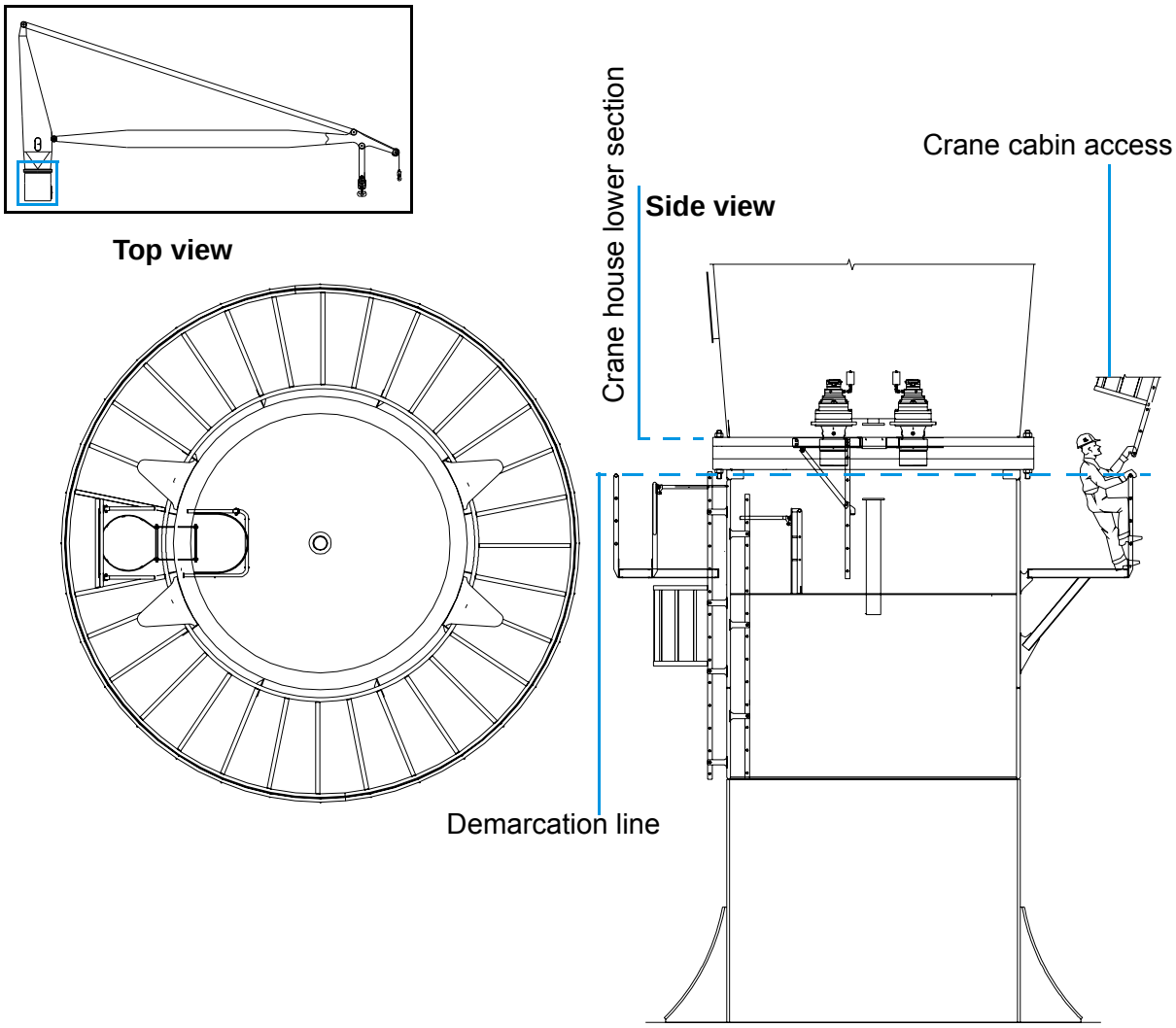


Figure 3-38: Pedestal stairs & platforms

3.10.1.3 Crane house lower section & winch room

Stairs and platforms inside of crane house lower section allow to reach the tugger winch platform and winch room.

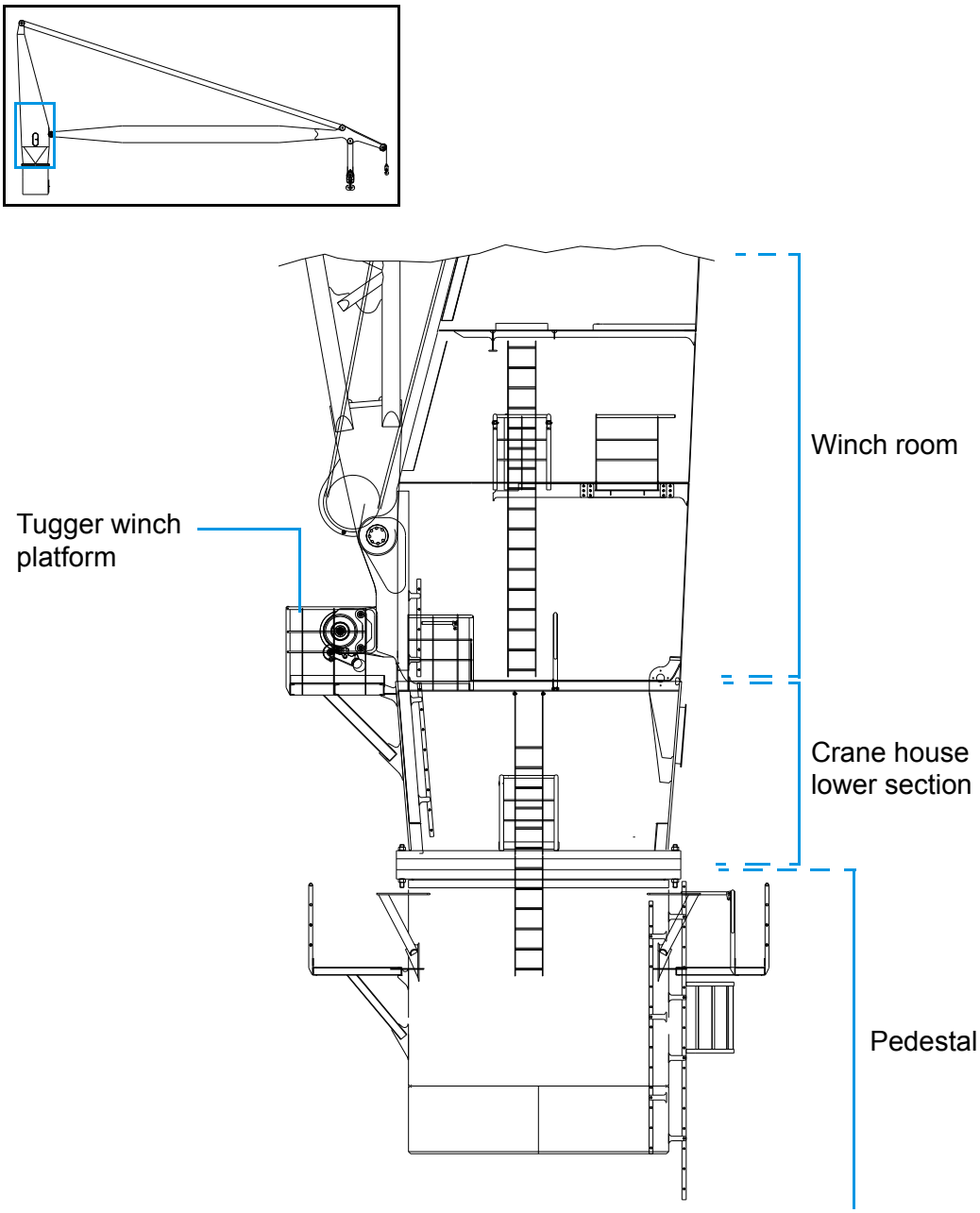


Figure 3-39: Crane house lower section & winch room stairs & platforms

3.10.1.4 Stairs & platforms crane house upper/head section

Stairs and platforms inside of crane house upper part allow to reach the crane house head section where the hoist sheaves are located.

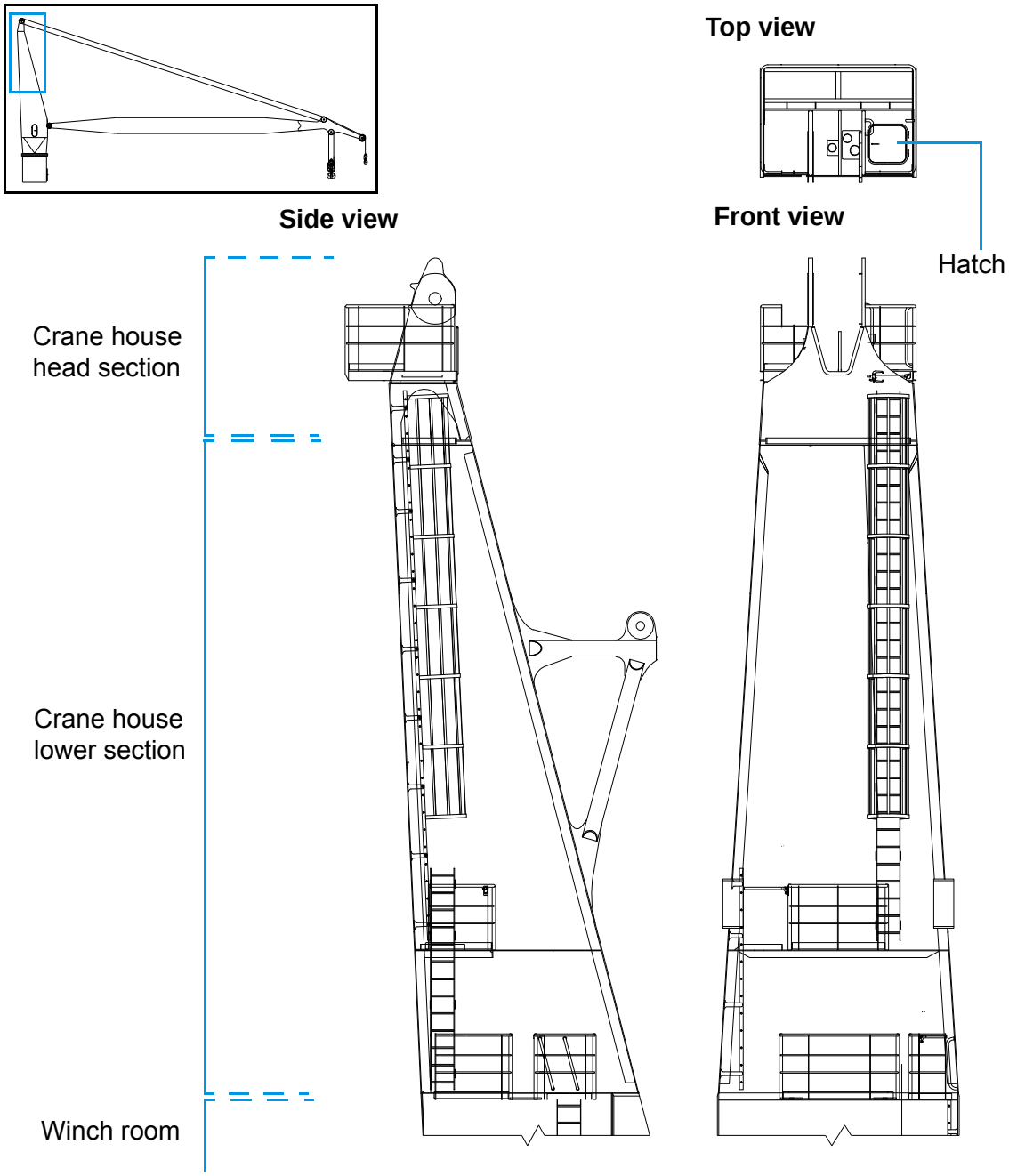


Figure 3-40: Crane house upper/head section stairs & platforms

3.10.1.5 Tugger winch platform

The tugger winch platform allow to reach the tugger winch mounted underneath the boom pivot.

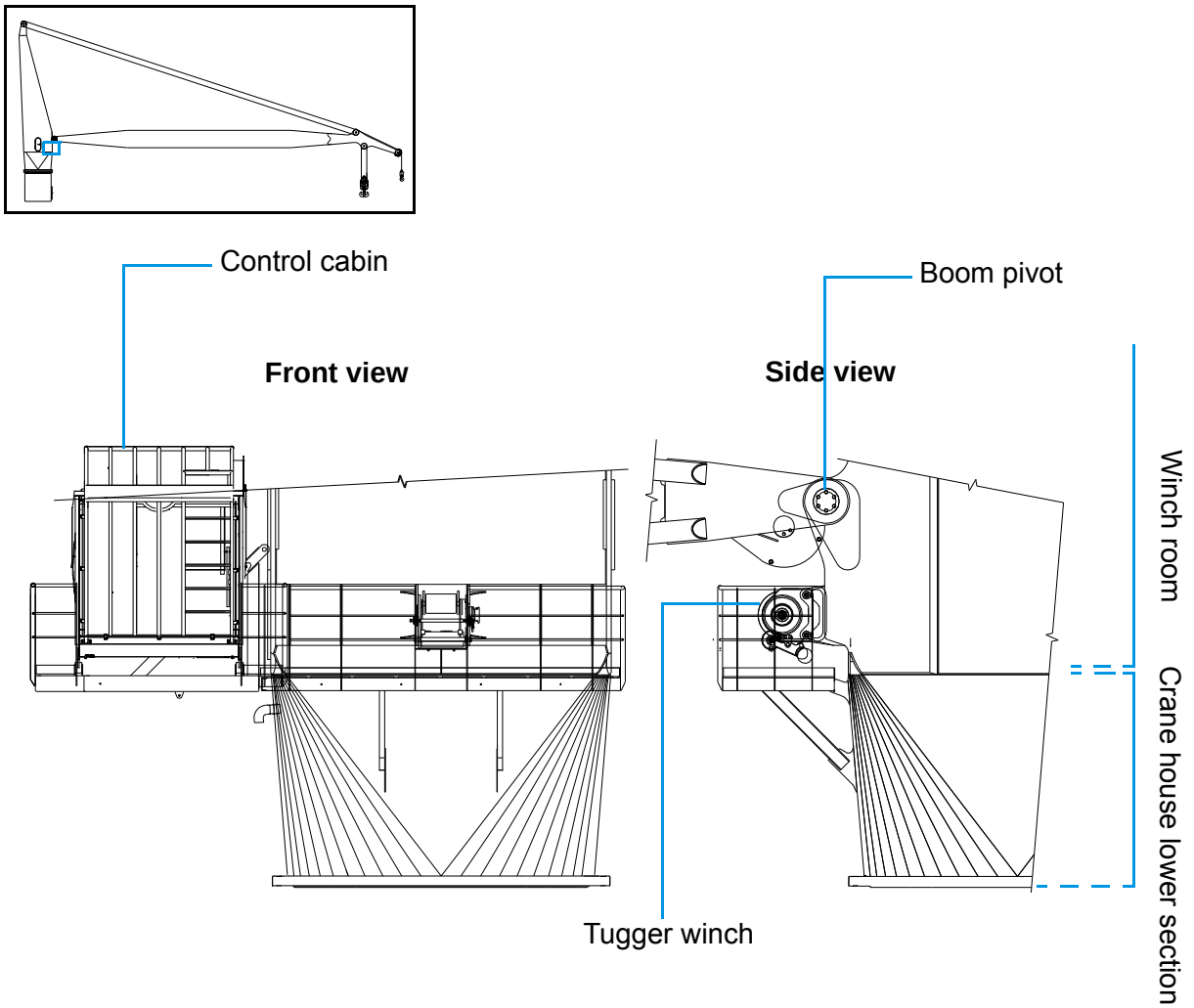


Figure 3-41: Tugger winch platforms

3.10.1.6 Boom

The boom stairs and platform allow to reach the sheaves mounted in the boom pivot section.

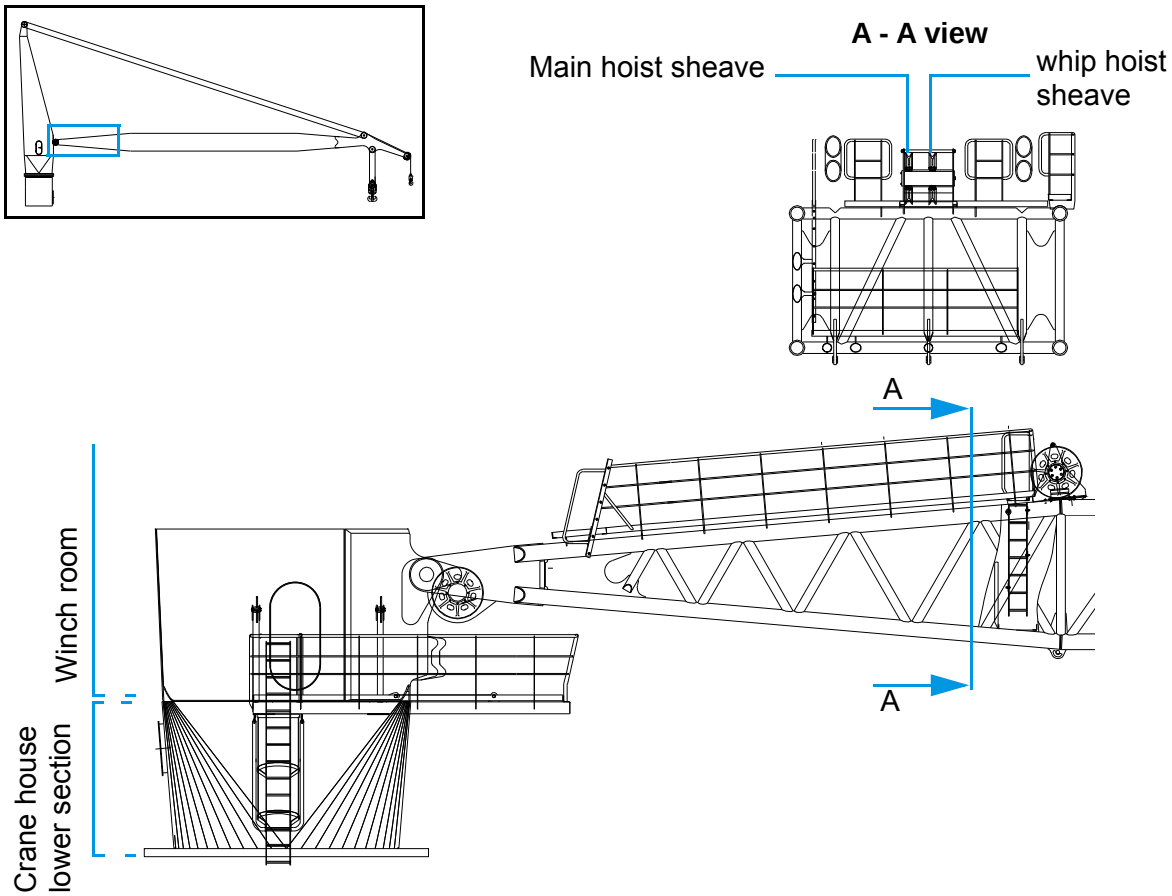


Figure 3-42: Boom stairs and platforms

3.10.2 LIGHTING

The crane is provided with multiple lighting at different locations. Table 3-3 p. 78 gives an overview of different lights mounted on the 300 mt PMC.

Light type	Power [W]	Amount	Location
Floodlight	400	3	Boom
Aircraft Obstruction light	11	1	Crane house upper section
Aircraft Obstruction light	11	1	Jib head
Fluorescent lighting	36	3 set [1]	Winch room
Fluorescent lighting	36	1 set	Crane house lower section
Fluorescent lighting	18	1 set	Crane house lower section
Fluorescent lighting	36	3 set	Crane house upper section
Cabinet lighting	18	1	Power and electronics cabinet (+C12)
Cabin lighting	36	1 set	Control cabin

Table 3-3: Lighting

1. There are two fluorescent lamps in one set.

3.10.2.1 Emergency lighting

The winch room and the operator's cabin have battery powered emergency lighting units (see Table 3-4 p. 79).

Light type	Power [W]	Amount	Location
Emergency lighting	2 x 36	1 set	Winch room
Emergency lighting	2 x 36	1 set	Slew room
Emergency lighting	2 x 36	2 set	Upper section
Cabin lighting	2 x 36	1 set	Control cabin

Table 3-4: Emergency lighting

4 HYDRAULIC SYSTEM

4.1 INTRODUCTION

This chapter is part of the hydraulic documentation belonging to the PMC. The drawings referred to in this chapter are provided in Appendix A: "Reference drawings".

4.1.1 CODING OF HYDRAULIC COMPONENTS

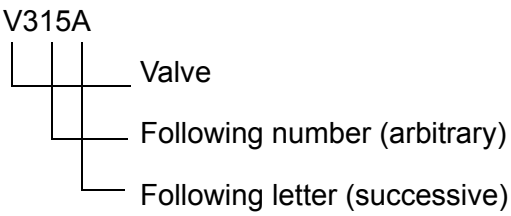
See NEN ISO 1219-1 for an explanation of the coding used on the hydraulic documentation for the hydraulic parts and hoses.

In the description of systems with a large number of components it can be useful to give the system parts a code name as well as their normal name. This code name is chosen in such a way that it is short, but still gives an indication of the type of the component. Hydraulic components are coded by a letter indicating its type, followed by a three-digit number. For identical parts, the number can be followed by a letter, in order to have a unique part number.

The type letters used for the hydraulic system are:

A	Cylinder
D	Motor
F	Filter
H	Hose
M	Manifold
L	Measuring cylinder
P	Pump
S	Sensor/switch
V	Valve
Z	Other component

Example:



The electrical codes (see Appendix A: "Reference drawings") of components in the hydraulic system (solenoids and sensors) are also shown in the hydraulic diagram (see Appendix A: "Reference drawings").

4.2 GENERAL HYDRAULIC SYSTEM DESCRIPTION

Reference drawings:

- A12-48000-80-010: Hydraulic diagram

The main hoist winch, whip hoist winch, tugger winch, boom hoist winch and slewing system are electro hydraulically driven in a (hydraulic) closed-loop circuit. The main hoist and the whip hoist are powered by the same pump and cannot be operated at the same time. The other drives have separate pumps. All pumps have a variable displacement to control the speed and direction of rotation. The main hoist, whip hoist and boom hoist hydro motors have a variable displacement and can be switched in two positions:

- Maximum displacement for maximum load and nominal speed.
- Minimum displacement for high speed: can only be used for loads up to 50% of the maximum Safe Working Load (SWL).

The slewing system and tugger winch have a fixed volume hydro motor.

4.2.1 BASIC WINCH HYDRAULIC SYSTEM

A winch is driven by a two-way hydro motor which is fed by a two-way hydraulic pump which is powered by an E-motor (see Figure 4-43 p.84).

The flow direction of the two-way hydraulic pump, which is controlled by the hydraulic pump direction control circuit, determines the hoisting and lowering movement.

The boost system provides flushing flow and keeps the low pressure side of the system pressurized to prevent cavitation. The brake system pressurizes the hydraulic circuit for brake. The pilot system pressurizes the hydraulic circuit for controlling boom hoist and main/whip hoist pump.

For detailed information on the hydraulic system for the PMC, see the following sections.

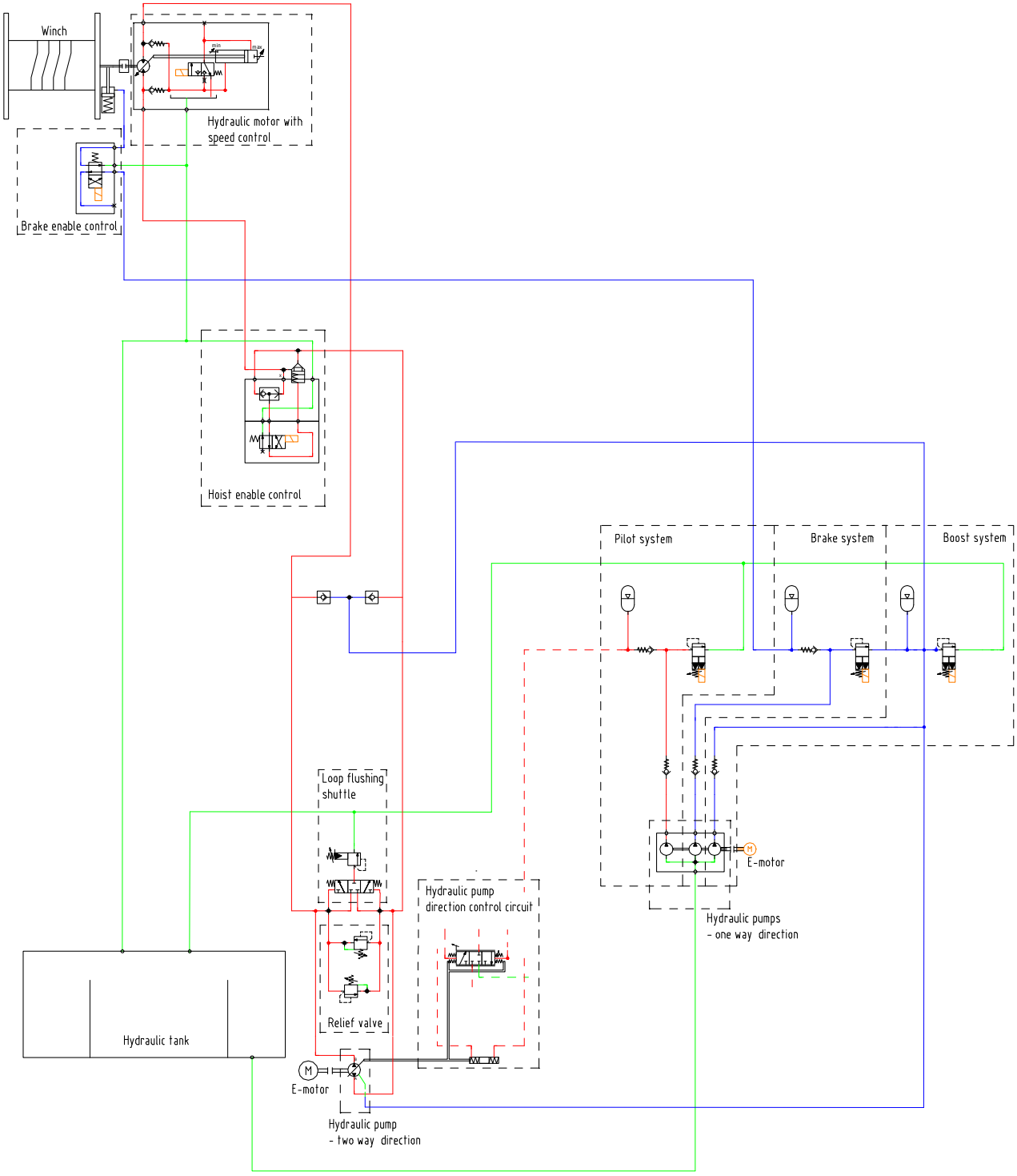


Figure 4-43: Basic winch hydraulic diagram (typical)

4.3 HYDRAULIC POWER SUPPLY

4.3.1 HYDRAULIC POWER UNIT (HPU)

Reference drawing:

- A12-48000-80-010: Hydraulic diagram

4.3.1.1 Drive

Normal operation

All pumps for normal operations are mounted on one electrical motor (811M1) with a shaft on both sides of the motor. On the upper shaft, the main/whip (P101.B) and boom hoist pumps (P101.A) are mounted. The slewing pump (P201.A) and the tugger pump (P201.B) are mounted on the lower shaft (see Figure 4-44 p.85).



1 = Electric motor 500 kW, 60Hz (811M1)
2 = Main & WH winch pump (P101.B)
3 = Boom hoist winch pump (P101.A)
4 = Slew drives pump (P201.A)
5 = Tugger pump (P201.B)

Figure 4-44: Electric motor with pumps (typical)

Emergency operation

The main hoist winch, whip hoist winch, boom hoist winch, and slewing system can be operated (hoist, lower, slew right and left) by means of an emergency HPU when no electrical power is available. It consists of a diesel engine (D070) with an open loop pump. A manually operated directional control valve is used to control either the winches or the slew drives. Hoses can be connected to the manifold and the brake of the winch involved. A counter balance valve is used to protect the drives from load induced movements. In the counter balance valve, a shuttle valve is mounted to control the brake automatically. Procedures for emergency lowering with the hand pump are specified on the emergency operation tags. These are located near the hand pump. They can also be found in reference drawing A17-42000-88-040 in Appendix A: "Reference drawings"

Emergency lowering *without supply of energy* is possible on the main, whip and boom hoist winches. A hand pump is provided to actuate the brake. The lowering speed must be adjusted with a throttle valve. For more information on emergency lowering operation, see 6.10.3 Emergency lowering p.189.

4.3.1.2 Low pressure

The supply of oil for the low-pressure side of the motor is provided by the hydraulic reservoir. The reservoir is located above all hydraulic components to ensure positive hydraulic pressure in the hydro motors.

NOTE	*Verify that ball valves (V052) is open when operating.*

NOTE	*Lock the ball valve (V052) in the open position with the plate under the handle after completion of maintenance and/or repair.*

4.3.1.3 Loop flushing system

In the purging part of the flushing system, the ball valves (V109.A) and (V107.A&B) are placed to be able to replace hoses (H416.302, H416.202 and H416.402).

NOTE	*Verify that ball valves (V109.A and V107.A&B) are in the open position when crane is operational.*

4.3.1.4 Hydraulic reservoir

The hydraulic reservoir (Z030) has a volume of 2000 litres and contains 1600 litres of hydraulic oil. The oil level can be read from level gauge (S031) (see Figure 4-45 p.87). Level gauge (S031) is equipped with 2 level switches (see 4.3.1.9 Sensors p.92).

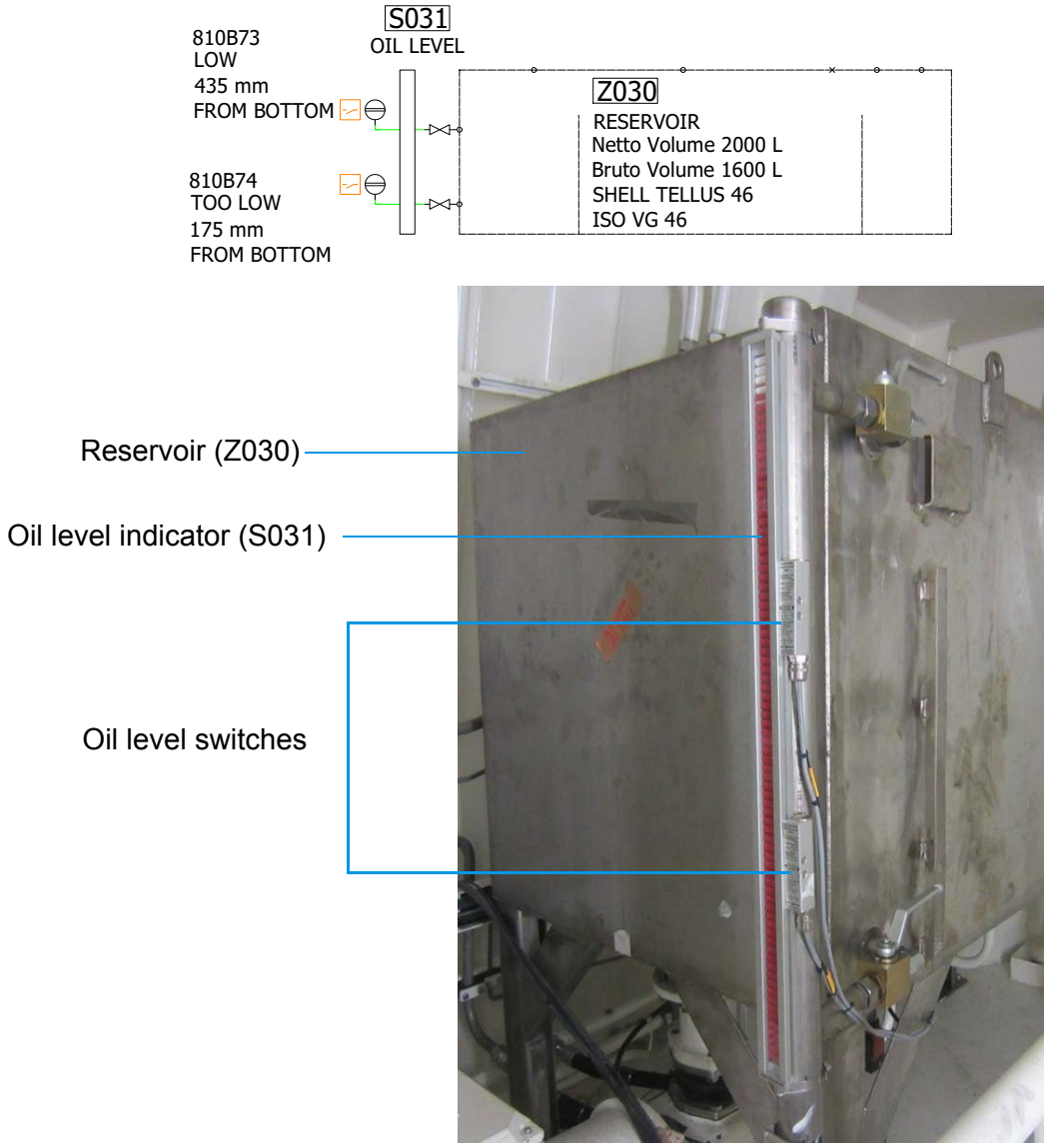


Figure 4-45: Reservoir and level gauges (typical)

4.3.1.5 Heating

Underneath the reservoir, two heaters (Z025) (see Table 4-7) are mounted to keep the hydraulic oil at working temperature in cold environments (see Figure 4-46 p.88).

Position	Symbol code	Symbol description
Z025.A	021E1	Heater 1
Z025.B	021E2	Heater 2

Table 4-5: Heaters

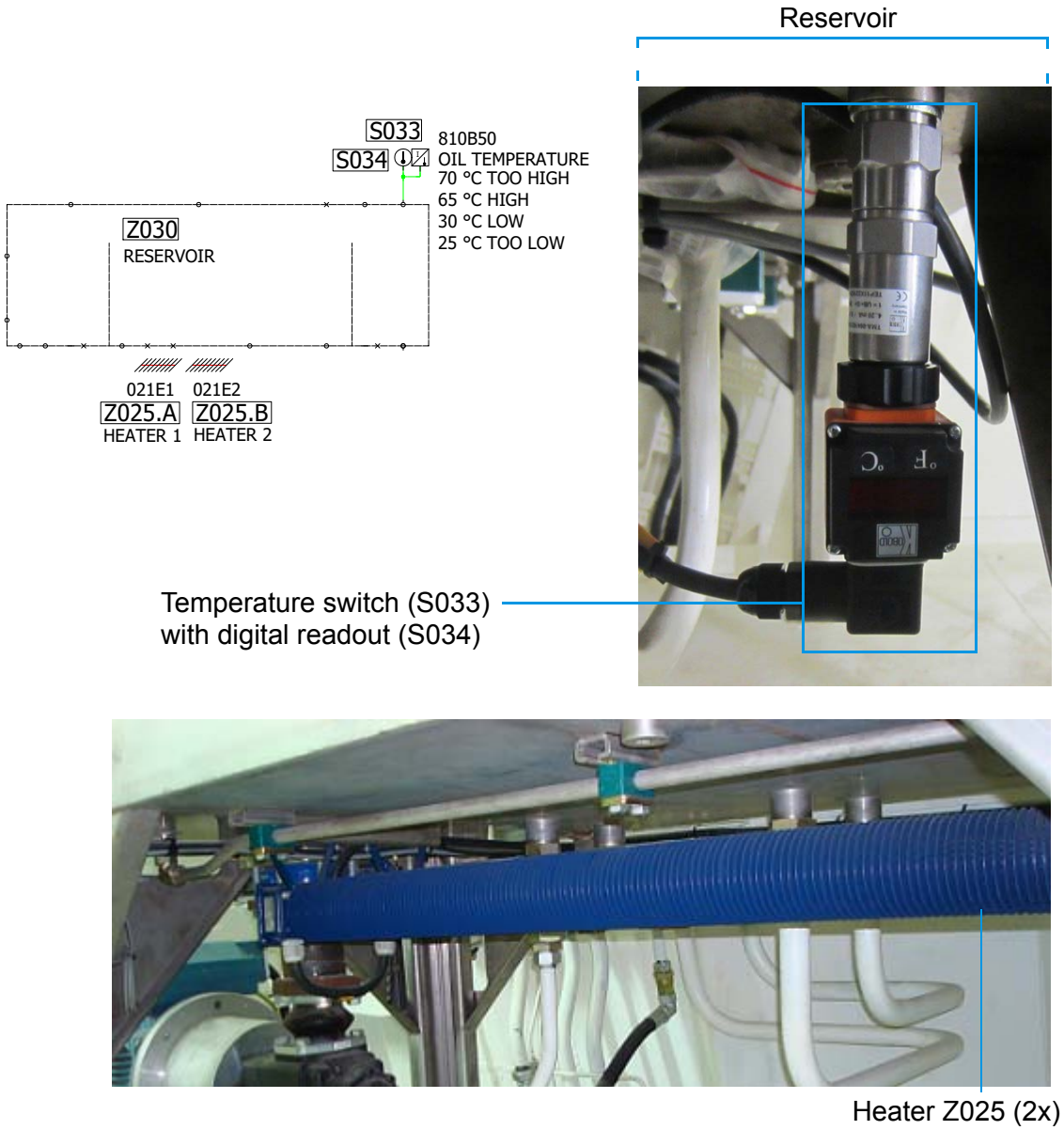


Figure 4-46: Heater and butterfly valve (typical)

The oil temperature is monitored by temperature sensor (S033) (see Figure 4-46 p.88). This temperature sensor has a digital temperature read-out (S034). When the oil temperature is high, too high, low or too low, there is warning/alarm shown on the SCADA screen (see 4.3.1.9 Sensors p.92).

When there is power on the system, the oil heaters are active. In the any of the following circumstances, the heaters are switched off:

1. The oil temperature in the reservoir reaches the 33 ºC setting. After this, the heaters will activate again when the temperature becomes lower than 27 °C
2. System power supply is disconnected.
3. An emergency stop is active.

4.3.1.6 Suction line control

Butterfly valve (V055) can be used to close the suction line to the pumps for maintenance and service operation (see Figure 4-47 p.89). A switch indicates the fully opened position of the valve. When the pumps are running and the switch is de-activated, an alarm “Suction valve failure” is generated. An emergency stop is issued and the pumps will shut down. Restarting the pumps is not possible until the alarm “Suction valve failure” is resolved.

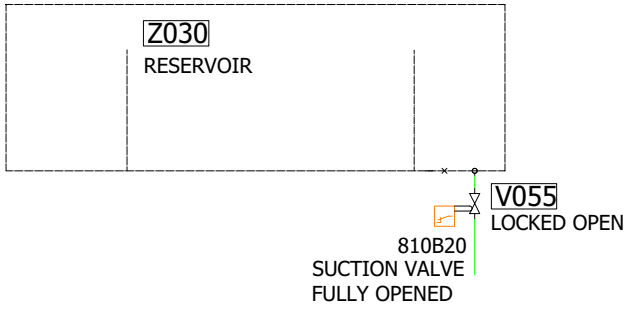


Figure 4-47: Suction line control (typical)

4.3.1.7 Cooling

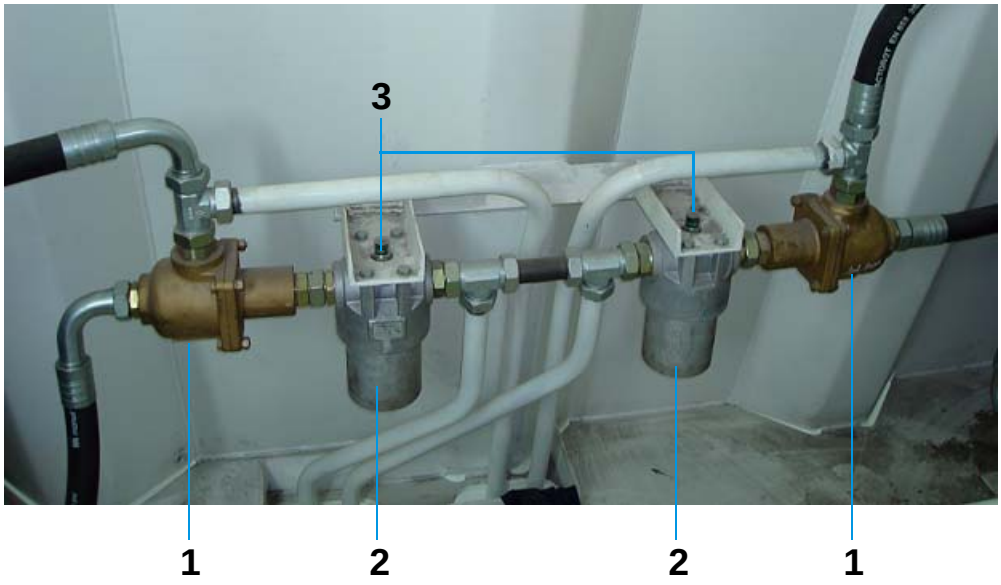
Flushing oil out of the closed loop circuits passes filters (F045). These filters have optical clogging indicators (see Figure 4-48 p.90). Thermostatic valves (V043) by-pass the coolers (Z040) under 43 ºC. Between 43 ºC and 55 ºC the oil is divided over the cooler and the by-pass. Above 55 ºC, all oil flows through the cooler.

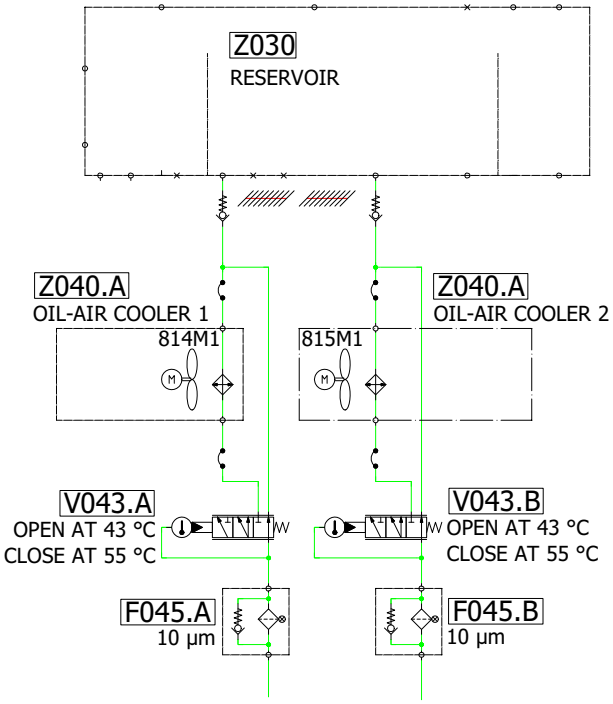
The cooler fans (see Table 4-6) are used both for cooling of the hydraulic oil and ventilation of the crane. The fans are switched on and off according the oil temperature values (see Table 4-7). There is also a thermostat in the pedestal which measures the pedestals ambient temperature which could keep the fans running although the oil temperature has dropped below the set point.

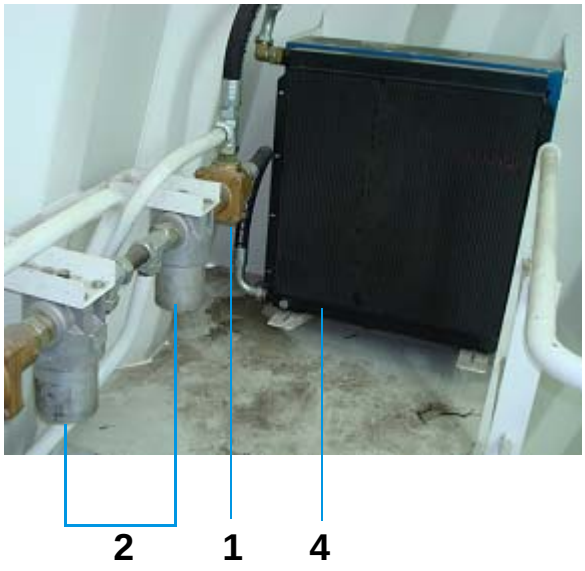
Actual cooling of the oil is dependent on the flow directed to the heat exchanger by the thermostatic valve.

Position	Symbol code	Symbol description
Z040.A	814M1	Cooler fan 1
Z040.B	815M1	Cooler fan 2

Table 4-6: Cooler fans





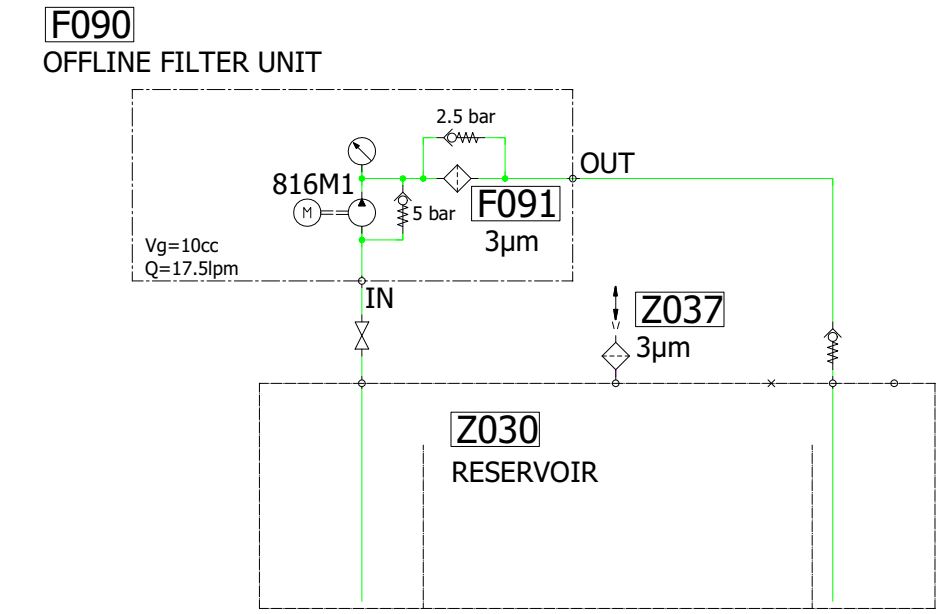


1 = Thermostatic valve 2 = Filter 10 µm 3 = Clogging indicators 4 = Oil-air cooler

Figure 4-48: Cooling (typical)

4.3.1.8 Filtration

The additional filtration of the hydraulic system is realized with off-line filter unit (F090) (see Figure 4-49 p.91). This unit uses a fine-meshed (3 µm) filter element (F091) and a small pump (816M1) for the filtration flow. The unit has an optical clogging indicator. It is not allowed to run the off-line filter when there is a “too low level” alarm.







1 = Filter 3µm (F090)
2 = Clogging indicator
3 = Air breather with silica gel (Z037)

Figure 4-49: Off-line filter unit and air breather (typical)

NOTE	*The off-line filter unit should run continuously, even when the rest of the drive system is shut down.*

Tank breather filter (Z037) (see Figure 4-49 p.91) filters and dries the air that enters the tank. The silica gel changes color when saturated.

4.3.1.9 Sensors

Sensors are used to monitor the oil level and the oil temperature; furthermore, a sensor is used to detect whether the suction valve opens (see Table 4-7).

Position	Symbol code	Description/ measurement	Action
S031 (upper)	810B73	Low level	Alarm
S031 (lower)	810B74	Too low level alarm	Stop pumps, deactivate all valves
S033	810B50	70°C oil temperature Too high	Stop pumps, deactivate all valves
		65°C	Warning
		48°C	Activate coolers
		42°C	De-activate coolers (if pedestal ambient temperature is below thermostat set point e.g. < 35°C)
		33°C	De-activate heaters
		30°C oil temperature Low	Warning
		27°C	Activate heaters
		25°C oil temperature Too low	Unable to start main pumps
S056	810B20	Suction valve opened	When de-activated stop all pumps except offline filter unit

Table 4-7: Temperature, oil level, suction valve sensors

4.3.1.10 Boost and brake system

Pump

For the boost and brake system, a triple vane pump (P001) which consists of 3 separate pump units built into one housing is used (see Figure 4-50 p.93), which has a fixed displacement and is driven by an electrical motor (817M1). The pump contains three outputs: P1, P2 and P3.

Before starting the main motor, the boost/brake -unit must be started (see Figure 4-51 p.94). To prevent overload of the electrical motor, the relief valves(V010, V011 and V012) will be activated only after a delay of 5 seconds. This way, the boost flow is allowed to pass through the filters, thermostatic valve and/or cooler and enter the reservoir with minimal pressure. A small part of the boost flow will to be used to flush the case of the pumps.

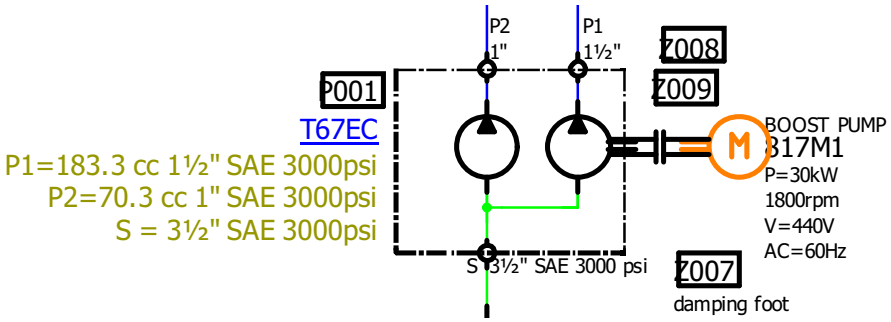


Figure 4-50: Boost pump (typical)

Boost circuit

Output P1 is used for the boost circuit (see Figure 4-51 p.94). The pressure of the boost system is set with pressure relief valve (V011). The boost pressure is monitored by means of pressure transmitter (S005.A). When the boost pressure drops below 16 bar, the sensor will give a signal to the PLC and this PLC will cause an emergency stop. An accumulator (Z020.B) is present, which has a nominal volume of 10 liter, and is pre-filled at 10 bar. The stored oil prevents pressure drops in the boost system. During start-up of the crane, the accumulator is filled.

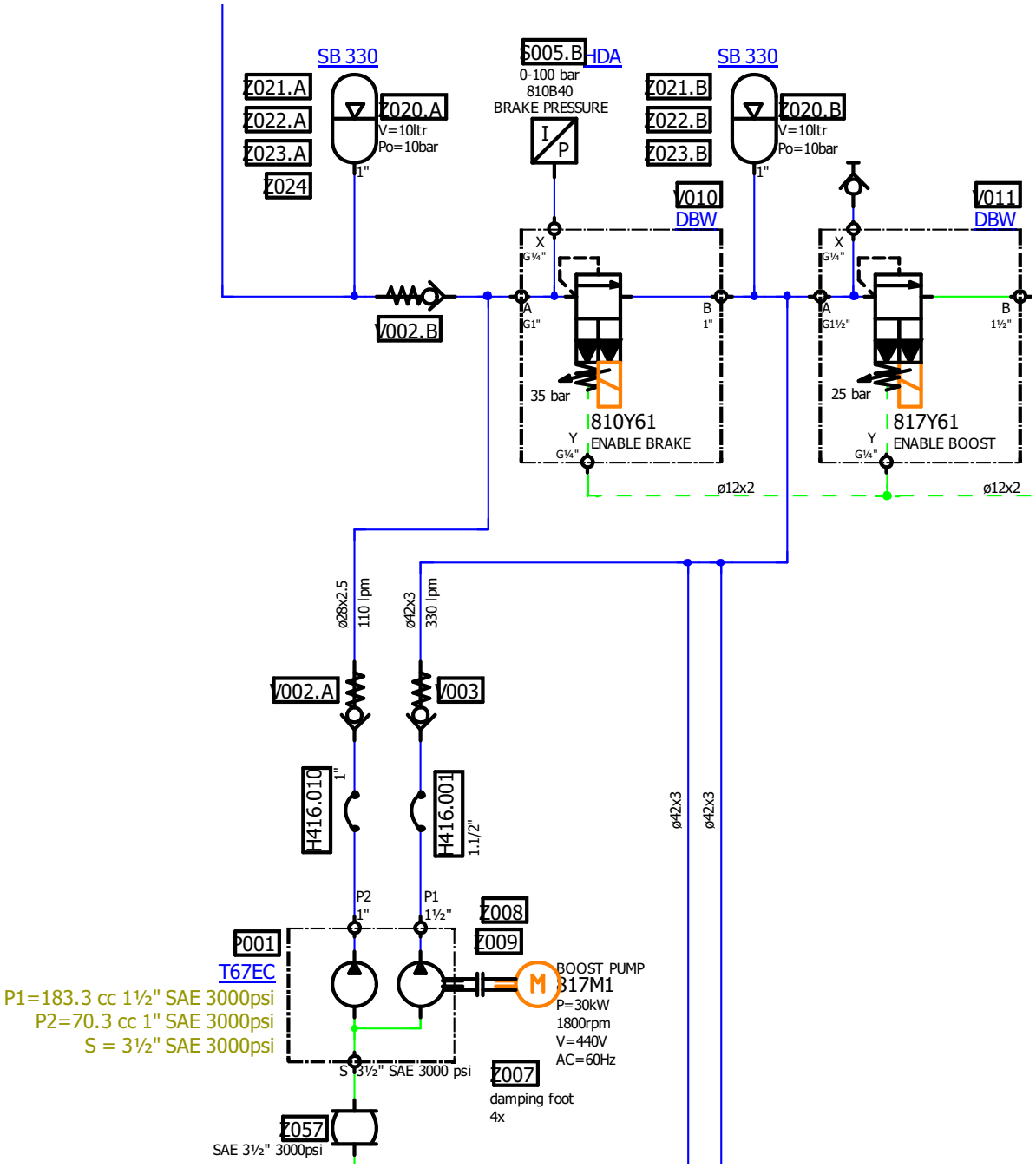


Figure 4-51: Boost, brake and pilot pressure sensors (typical)

Note: The band brake circuit is not shown in Figure 4-51 p.94, for band brake circuit see Figure 4-56 p.105.

Brake circuit

The disc brakes of the winch drives and slewing gear are considered fully lifted at 35 bar (see Figure 4-51 p.94).

Pump unit P2 is used for the brake circuit. The brake pressure is limited by pressure relief valve (V010). When the pressure setting is reached, the excess flow of pump unit P2 will be directed to the boost system. In case the brake pressure drops to below 25 bar, the signal from pressure sensor (S005.B) will cause an emergency stop. All crane movements stop.

An accumulator (Z020.A) is present, which has a nominal volume of 10 liter, and is prefilled at 10 bar. The stored oil prevents pressure drops in the brake system. During start-up of the crane, the accumulator is filled. Check valve (V002.B) prevents oil flow back from the accumulator.

Band brake circuit

The boom hoist winch and the whip hoist winch are equipped with a band brake (see Figure 4-56 p.105).

The band brake acts as the secondary independent brake which is actuated by single acting cylinders. The maximum pressure for the cylinders to be lifted is 120 bar. The band brake circuit is provided with hydraulic power from the normal brake circuit. A pressure intensifying unit (V901) is installed to be able to reach the required working pressure.

The high pressure line from this unit is equipped with an accumulator manifold (M920) with a pressure relief valve (V925) which limits the maximum pressure in the system to 200 bar. Check valve (V921) prevents oil flow back to the pressure intensifier. The flow to the band brake cylinders can be regulated with a needle valve (V923).

An accumulator (Z910) is present which has a nominal volume of 13 liter and is pre-filled at 105 bar. The oil stored is used to back-up the pressure intensifier when this unit cannot provide enough flow. The manifold is equipped with a sequence valve (V922) set at 120 bar to make sure hydraulic power first is provided to the cylinders.

NOTE *The band brake circuit contains oil under high pressure. Before performing service on the band brake circuit, make sure to relief the system by opening valve (V924). After service, make sure to close this valve for the system to be operational.*

Alarms

During the start-up procedures, the alarms caused by the signals from the pressure sensors are delayed for 5 seconds.

If the boost, brake or pilot pressure remains too low for 4 seconds it can be the result of a hose burst. Rupture of a high-pressure hose of a hoist motor is very dangerous. Low boost, brake and pilot pressures are detected by pressure transmitters respectively (S005.A, S005.B and S005.C), upon which the applicable brake is applied, an emergency stop is activated and the corresponding valve closed:

- Main hoist winch: V120.
- Whip hoist winch: V620.
- Boom hoist winch: V320.
- Slewing drives: V220.

Thus, an emergency stop is activated and the HPU is stopped as well.

Position	Symbol code	Action
V010	810Y61	Enable brake pressure

Table 4-8: Actuating devices boost

Position	Symbol code	Action
V011	817Y61	Enable boost pressure

Table 4-8: Actuating devices boost

Position	Symbol code	Description/measurement	Action
S005.A	817B40	Boost pressure < 16 bar	Alarm “Boost pressure failure” & emergency stop
		< 16 bar and t > 4 s	Stop HPU
S005.B	810B40	Brake pressure < 25 bar	Alarm “Brake pressure failure” & emergency stop
		< 25 bar and t > 4 s	Stop HPU

Table 4-9: Measuring devices boost

4.3.2 EMERGENCY SYSTEMS

4.3.2.1 Emergency HPU

In case of a general power failure, the electric motor will not be available to drive the hydraulic components. A small power pack, a diesel driven motor with a hydraulic pump (P075), is installed in the crane, to enable most hydraulic movements (see Figure 4-52 p.97), however, at reduced speed. The maximum pressure is set at 320 bar with the pressure relief valve in valve assembly (V061).

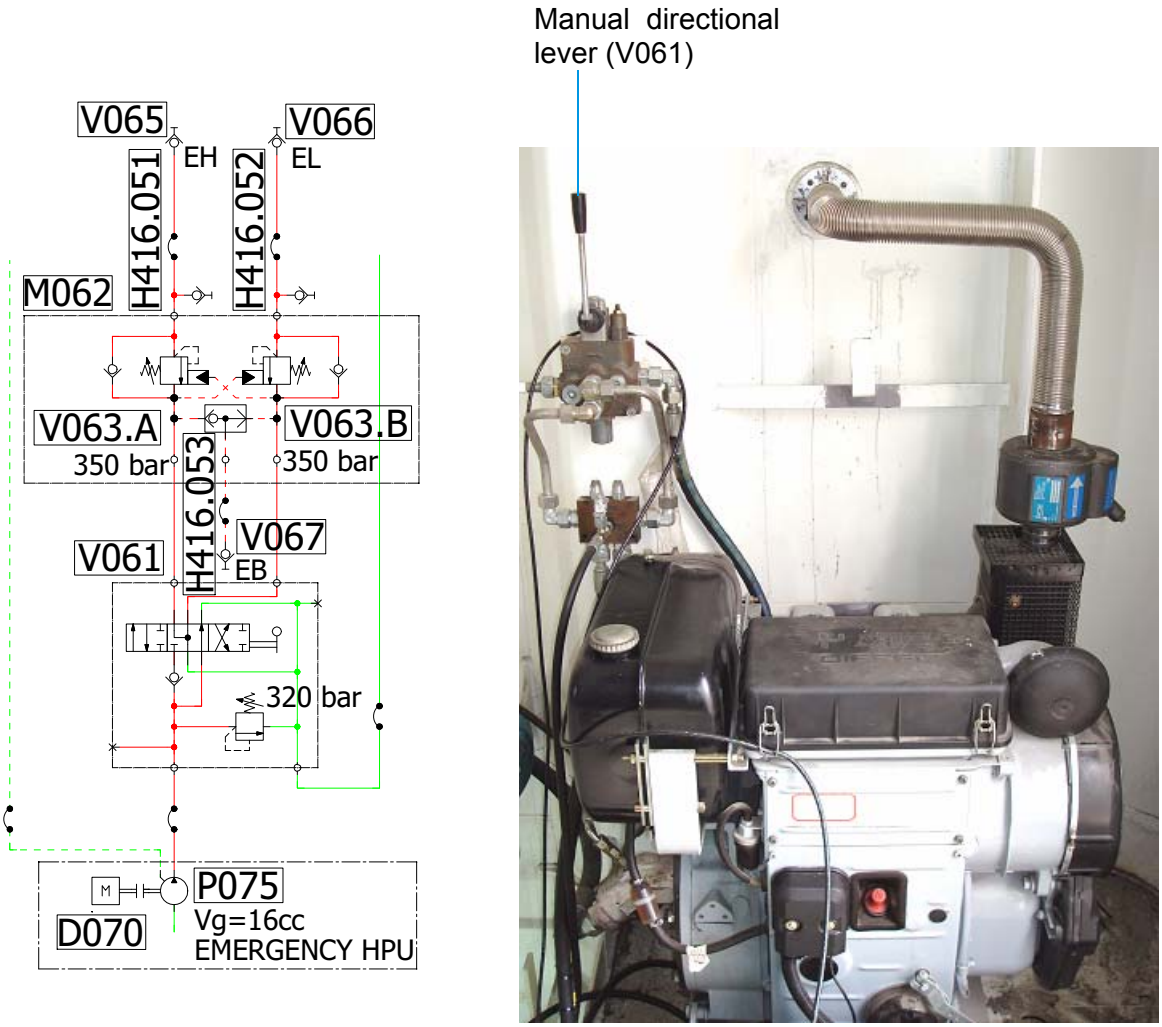


Figure 4-52: Emergency diesel engine for the hydraulic system (typical)

The main, boom hoist and whip hoist winch, as well as the slew system can all be operated by means of the emergency HPU. The diesel engine has its own battery to start up. The battery is always connected to the power supply of the crane by means of a charger. The charger will load continuously with a small current in order to keep the battery in best possible condition.

The direction of the winch or slew drive is controlled with a hand lever (V061). Shuttle valve (V062) will cause the brake to be lifted first when the control lever is moved in either direction. Once the brake is lifted, the flow can be used to control the motor. The diesel engine does not need any external power supply. The battery is only needed to start the engine. All electrical components in the hydraulic system will remain in the usual position when not activated.

The hoses connected to manifold (M062) are equipped with quick connection couplings which can be connected to the quick couplings provided on the drive manifolds and in the brake lines (see Table 4-10).

Hose	Coupling	Main hoist	Whip hoist	Boom hoist	Slewing
H461.051	V065 - EH	V147	V647	V347	V247
H461.052	V066 - EL	V146	V646	V346	V246

Table 4-10: Manifold (M062) hoses coupling information.

Hose	Coupling	Main hoist	Whip hoist	Boom hoist	Slewing
H461.053	V067 - EB	V149	V649.A	V349.A	V249

Table 4-10: Manifold (M062) hoses coupling information. (Continued)

NOTE *The whip and boom hoist are equipped with band brakes which have to be disengaged by means of the hand pump.*

To release the band brake, the hand pump needs to be connected to the quick couplings (see Table 4-11).

Hose	Whip hoist	Boom hoist
H461.058	V649.B	V349.B

Table 4-11: Hose information for band brake.

The operational positions of the valves (see Table 4-12) need to be changed to be able to operate the systems with the emergency HPU.

Main hoist	Whip hoist	Boom hoist	Slewing
V145.A - open	V645.A - open	V345.A - open	V230.A - closed
V145.B - open	V645.B - open	V345.B - open	V230.B - closed
V148 - closed	V648.A - closed	V348.A - closed	V245.A - open
	V648.B - closed	V348.B - closed	V245.B - open
			V248 - closed

Table 4-12: Valves operation positions when operating with emergency HPU.

NOTE *Make sure to set all the ball valves to their original position, as stated on the hydraulic diagram, directly after the emergency operation.*

Procedures for emergency lowering with the hand pump are specified on the emergency operation tags. These are located near the hand pump. They can also be found in reference drawing A17-42000-88-040 in Appendix A: "Reference drawings"

4.3.2.2 Hand pump for emergency lowering

A hand pump (P048) is provided for emergency lowering of the winches (see Figure 4-53 p.99) without use of the diesel HPU The pump can be used to lift the brakes of the following winches:

- Boom hoist winch.
- Whip hoist winch.
- Main hoist winch.

NOTE *In an emergency situation the slew system cannot be used without the standard or the diesel driven HPU.*

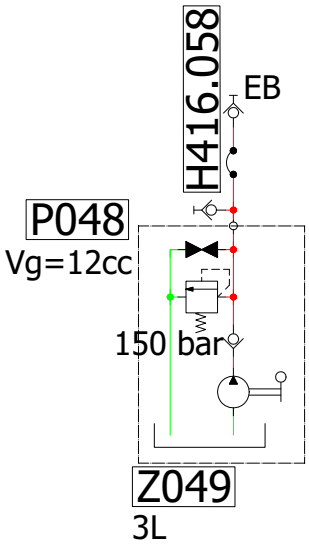


Figure 4-53: Hand pump circuit (typical)

The operational positions of the valves (see Table 4-13) need to be changed to be able to operate the systems with hand pump.

Main hoist	Whip hoist	Boom hoist
V148 - closed	V648.A - closed	V348.A - closed
V130 - open	V648.B - closed	V348.B - closed
V131 - carefully open this throttle valve to adjust the lowering speed.	V630 - open	V330 - open
	V631 - carefully open this throttle valve to adjust the lowering speed.	V331 - carefully open this throttle valve to adjust the lowering speed.

Table 4-13: Valves operation positions when operating with hand pump.

Before connecting the hand pump to the gearbox brakes of the whip or the boom hoist, the band brake cylinders need to be extended with the hand pump. To release the band brake, the hand pump needs to be connected to the quick couplings (see Table 4-14).

Hose	Whip hoist	Boom hoist
H461.058	V649.B	V349.B

Table 4-14: Hose information for band brake when operating with hand pump.

After disconnecting the hand pump from the band brake cylinder, make sure that it stays in position. The hand pump has a built-in oil reservoir containing 3 litres. If required, the tank has to be refilled during operation.

NOTE *Make sure to set all the ball valves and needle valves to their original position, as stated on the hydraulic diagram, directly after the emergency operation.*

For emergency lowering operation procedures, see 6.10.3 Emergency lowering p.189.

4.4 CRANE COMPONENTS

4.4.1 MAIN HOIST

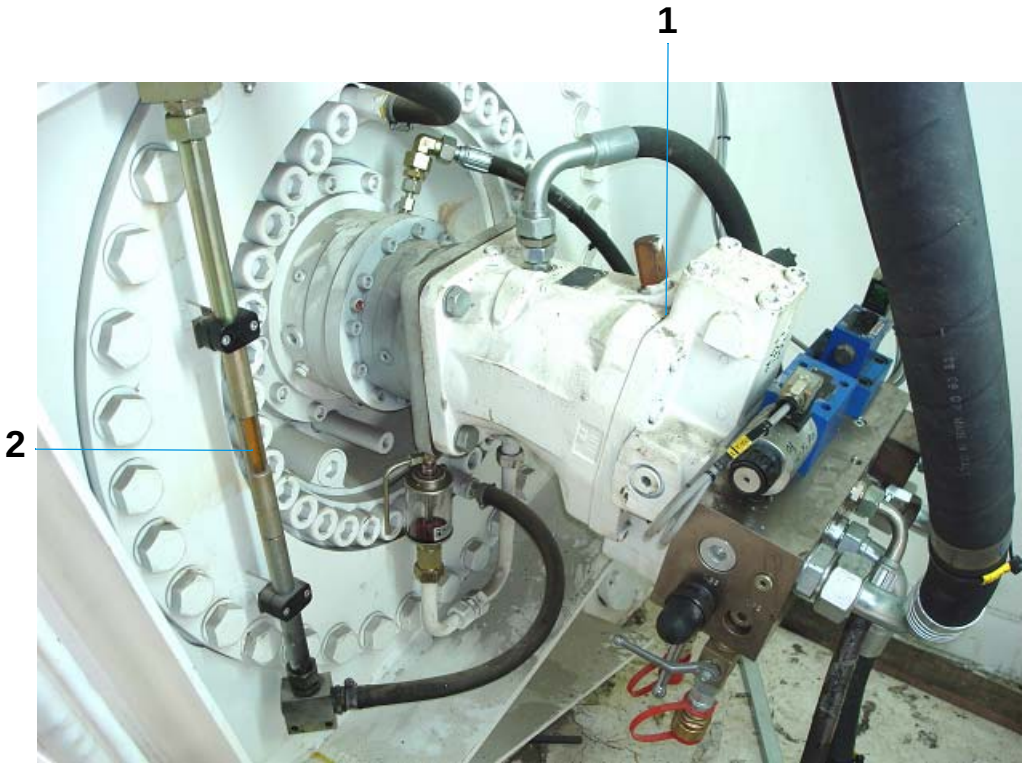
Reference drawings:

- A12-48000-80-010: Hydraulic diagram

4.4.1.1 Operation principle

The main hoist winch and the whip hoist winch are operated by the same pump (P101.B), and it is not allowed to operate the main hoist and the whip hoist at the same time. The operator makes the selection and the control system controls only the valves on the selected winch.

Pump control



1 = hydro motor (D150) 2 = Gearbox oil level gauge

Figure 4-54: Main hoist winch drive (typical)

The pump (P101.B) (see Figure 4-44 p.85) is an axial piston pump with a variable displacement, step less adjustable in two flow directions, and drives a hydro motor (D150) (see Figure 4-54 p.100).

Moving the joystick in the control cabin backwards (hoisting) activates control valve (100Y51-A), and results in a flow to the B-port of the pump. The maximum pressure in the B-port of the pump is set by the pressure relief valve (V164.B) in the B-line of the pump.

Moving the joystick forwards (lowering) activates control valve (100Y51-B), and results in a flow to the A-port of the pump. The maximum pressure in the A-port of the pump is set by the pressure relief valve (V163.B) in the A-line of the pump.

The pump uses the external boost and pilot-unit which has been explained in 4.3.1.10 Boost and brake system p.92.

Pressure in the high pressure line from the pump is measured with pressure sensor (S105.B). During pre-pressurizing, the value measured with this sensor is used to see if the set point is reached.

Drive control

Cartridge valve (V120) is mounted at the high pressure (load-) side on motor manifold (M110) to block the oil flow from and to the motor when no movement is required. A shuttle valve (V121) in a cover plate selects the highest pressure from either the A-port of the motor or the B-port of the pump to keep the cartridge valve closed.

4/2 way directional control valve (V122) is a pilot valve for the cartridge valve. When the control software activates the control valve (V122), the cartridge valve is opened and the hoist motor can be used.

The maximum pressure on the A-port of the motor is limited with the pressure relief valve (V135).

The displacement of the axial piston motor can be switched in two positions. A 3/2 way directional control valve (100Y61) must be activated to switch to the minimum displacement (low torque). De-activating control valve (100Y61) will switch the displacement back to the maximum volume (high torque).

Check valves allow pilot oil from the A- or B-port of the motor to adjust the displacement of the motor.

Sensor

Pressure transmitter (S152) is placed to measure the low pressure side (B side) of the motor (D150), this is to prevent overspeed. The transmitters give a warning when the pressure is lower than the pressure setting on the PLC, and an emergency stop for the hoist drive is initiated.

Check valve (V132) is used to protect the motor against cavitation during an emergency stop or when emergency lowering.

Brake

When the control software activates solenoid (100Y70) the brake will be released. 4/2 directional control valve (V140) is activated, and the multiple disc brake of the winch will be lifted.

4.4.1.2 Hoisting procedure

The operator gives the hoist command by pulling the right-hand joystick backwards. The hydraulic valves will be actuated in the following sequence:

2. The “enable hoist” valve (V122) is activated and the displacement of the pump is set in the hoist direction up to the plussing offset value of the valve controller.

When a pressure of 100 bar is measured by the sensor in the B-side (hoist side, S105B), the brake can be released.

3. After a time delay of about 1 second, the “brake release” valve (V140) is activated.
4. After another time delay of about 0.5 second, the displacement of the pump ramps up to the desired speed.

When the operator sets the joystick in the center position, hoisting is stopped in the following sequence:

1. The displacement of the pump ramps down to the plussing offset value of displacement of the valve controller.
2. The “brake release” valve (V140) is deactivated, and the brake is applied again.
3. About 1 second later, the “enable hoist” valve (V122) is deactivated and the displacement of the pump is set to zero.

4.4.1.3 Lowering procedure

The operator gives the “lower” command by pushing the right-hand joystick forwards. The hydraulic valves will be actuated in the following sequence:

1. The “enable hoist” valve (V122) is activated and the displacement of the pump is set in the hoist direction up to the plussing offset value of the valve controller.

   When a pressure of 100 bar is measured by the sensor in the B-side (hoist side, S105.B), the brake can be released
2. After a time delay of about 1 second, the “brake release” valve (V140) is activated.
3. *After another time delay of about 0.5 second, the displacement of the pump ramps up to the desired speed in lowering direction.*

When the operator sets the joystick in the center position, lowering will be stopped in the following sequence:

1. The displacement of the pump ramps up to the plussing offset value of displacement of the valve controller.
2. The “brake release” valve (V140) is deactivated and the brake is applied again.
3. About 1 second later, the “enable hoist” valve (V122) is deactivated and the displacement of the pump is set to zero.

4.4.1.4 Actuating and measurement devices

Table 4-15 and Table 4-16 show the actuating and measurement devices of main hoist.

Position	Symbol code	Action
P101B	100Y51-A	Pump control - Hoisting
	100Y51-B	Pump control - Lowering
V122	100Y60	Enable hoist
V140	100Y70	Brake release
D150	100Y61	High speed - Low torque

Table 4-15: Actuating main hoist

Position	Symbol code	Description/measurement	Action
S152	100B41	Lowering side pressure < 16 bar	Emergency stop
S105B	100B40	Hoist side pressure	-

Table 4-16: Measuring devices main hoist

4.4.2 WHIP HOIST

Reference drawings:

- A12-48000-80-010: Hydraulic diagram

4.4.2.1 Operation principle

The whip hoist uses the same pump (P101.B) as the main hoist and cannot be operated at the same time. The operator makes the selection and the control system controls only the valves on the selected winch.

Pump control

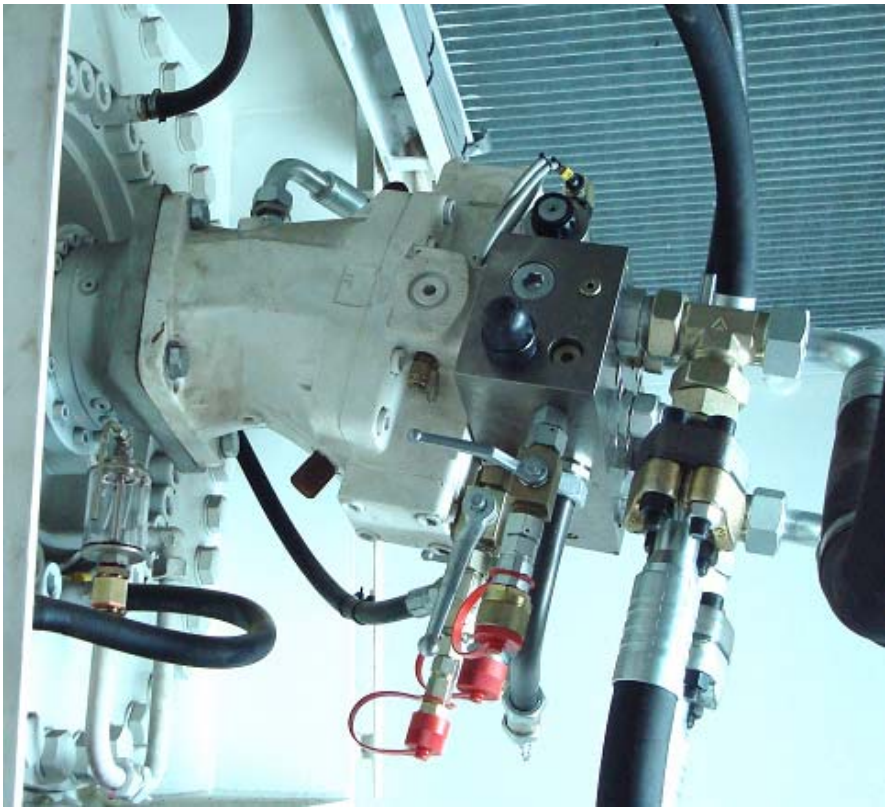


Figure 4-55: Whip hoist winch drive (typical)

The whip hoist uses the same pump (P101.B) (see Figure 4-44 p.85) as the main hoist. The pump control is the same as for the main hoist

The hydraulic closed loop system, the axial piston motor (D650) (see Figure 4-55 p.104), motor manifold (M610) and gearbox are similar to those of the main hoist.

Drive control

Cartridge valve (V620) is mounted at the high pressure (load-) side on motor manifold (M610) to block the oil flow from and to the motor when no movement is required. A shuttle valve in cover plate (V621) selects the highest pressure from either the A-port of the motor or the B-port of the pump to keep the cartridge valve closed.

4/2 way directional control valve (V622) is the pilot valve for the cartridge valve. When the control software activates (V622) the cartridge valve is opened and the hoist motor can be used.

The maximum pressure on the A-port of the motor is limited with pressure relief valve (V635).

The displacement of the axial piston motor can be switched in two positions. A 3/2 way directional control valve must be activated (600Y61) to switch to the minimum displacement (low torque). De-activating (600Y61) will switch the displacement back to the maximum volume (high torque).

Check valves allow pilot oil from the A- or B-port of the motor to adjust the displacement.

Sensor

Pressure transmitter (S652) is placed to measure the low pressure side (B side) of the motor, this is to prevent overspeed. When the measured pressure is lower than the setting on the PLC an emergency stop for the hoist drive is initiated.

Check valve (V632) is used to protect the motor against cavitation during an emergency stop or when emergency lowering.

Brake

When the control software activates 4/2 way directional control valve (V640) the brake in the gearbox will be lifted.

Safety device

A band brake is added on the hoist drum as an extra safety device (see Figure 4-56 p.105). The band brake provides an independent secondary brake acting directly on the drum.

When the crane is in operation and the boom hoist disc brake is released, the band brake cylinder will be activated too, disengaging the brake.

Each time the boom hoist winch is used the band brake will be lifted. Single acting cylinder (A642) with spring return controls the position of the band. Activating 4/2-way directional control valve (V643) disengages the band. This extended position of the cylinder is indicated by proximity switch (S639).

If the extended position is not detected the band is to be considered applied and drum rotation is not allowed, if this occur during movement this needs to be stopped.

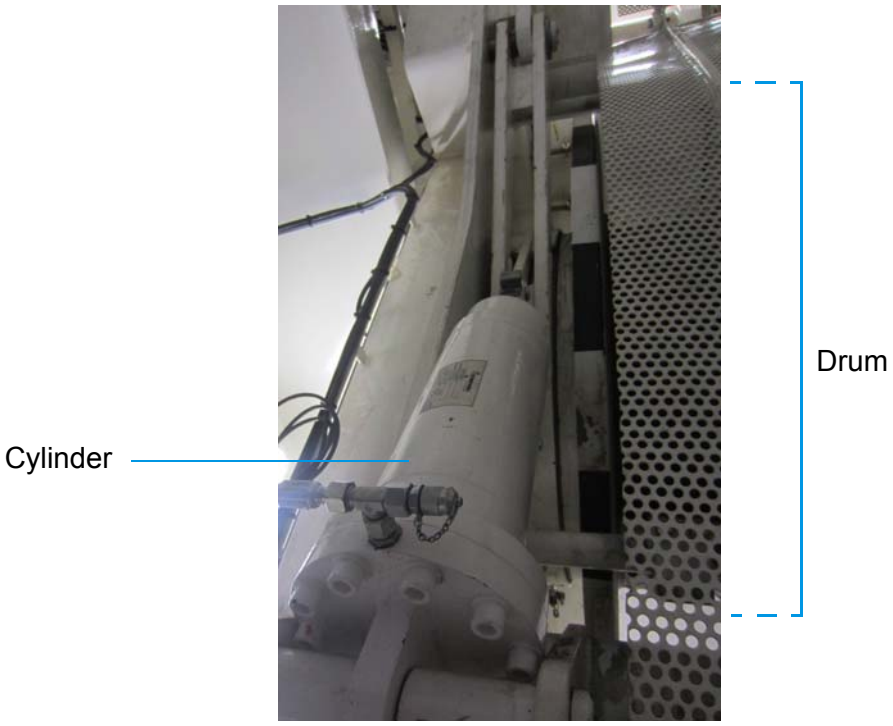


Figure 4-56: Band brake with cylinder (typical)

Constant Torque function

For the whip hoist a Constant Torque (CT) function is available (see Figure 4-57 p.106). This function can be used to hoist loads from a supplier.

NOTE *The load must be between 10 and 12 mt to activate CT mode and cannot be activated when a load is already being lifted.*

The load can be hooked and CT mode requested by pushing the “Whip. CT” button on the joy-stick. When the joystick is moved through the CT set point and the button is pushed again (and held), valve (V661) is activated and the whip hoist will maintain a tight wire.

With valve (V661) activated, the maximum pressure in the pump is set by pressure relief valve (V663). The set point of pressure relief valve (V663) is fixed.

When the whip hoist CT mode is started, the control system fully activates the pump control valve in hoist direction. When the high pressure side reaches the set pressure of valve (V663) displacement is reduced by the hydraulic pump control. The pump and motor pressure will be constant, independent of the direction or the speed of the load.

On the top of a wave, the CT function can be switched over to speed control by releasing the button. The winch will start hoisting for about 1 meter. From this moment the operator needs to take over control and continue hoisting

NOTE *During CT mode, the gearbox brake and the band brake remain lifted.*

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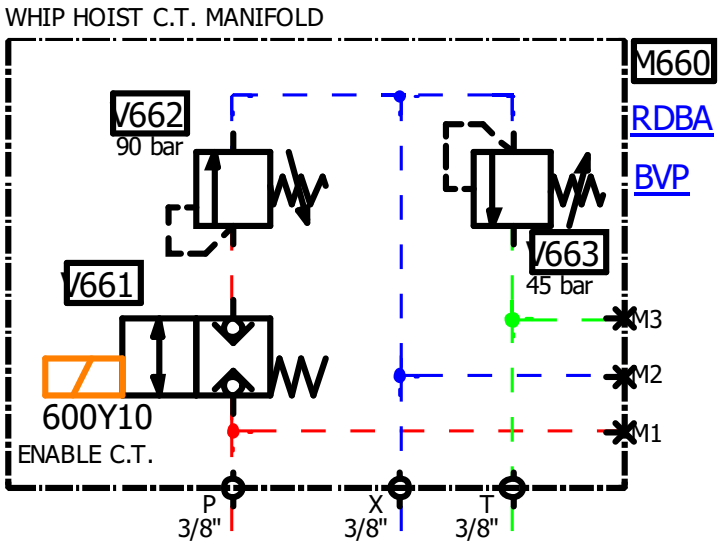


Figure 4-57: Whip hoist CT manifold (typical)

4.4.2.2 Hoisting procedure

The operator gives the “hoist” command by pulling the right-hand joystick backwards. The hydraulic valves will be actuated in the following sequence:

1. The “enable hoist” valve (V622) is activated and the displacement of the pump is set in the hoist direction up to the plussing offset value of the valve controller.

When a pressure of 100 bar is measured by the sensor in the B-side (hoist side, S105.B), the brakes can be released.

2. After a time delay of about 1 second the “brake release” valve (V640) and the “lift band brake” valve (V643) are activated.
3. After another time delay the “band brake lifted” position is verified with proximity switch (Z639). When the “band brake lifted” is confirmed the displacement of the pump ramps up to the desired speed in hoisting direction.

When the operator sets the joystick in the center position, hoisting is stopped in the following sequence:

1. The displacement of the pump ramps down to the plussing offset value of displacement of the valve controller.
2. The “brake release” valve (V640) and the “lift band brake” valve (V634) are deactivated and the brakes are applied again.
3. About 2 seconds later the “enable hoist” valve (V622) is deactivated and the displacement of the pump is set to zero.

4.4.2.3 Lowering Procedure

The operator gives the “lower” command by pushing the right-hand joystick forwards. The hydraulic valves will be actuated in the following sequence:

The “enable hoist” valve (V622) is activated and the displacement of the pump is set in the hoist direction up to the plussing offset value of the valve controller.

1. When a pressure of 100 bar is measured by the sensor in the B-side (hoist side, S105.B), the brakes can be released.
2. After a time delay of about 1 second the “brake release” valve (V640) and the “lift band brake” valve (V643) are activated.
3. After another time delay the “band brake lifted” position is verified with proximity switch (Z639). When the “band brake lifted” is confirmed the displacement of the pump ramps up to the desired speed in lowering direction.

When the operator sets the joystick in the center position, lowering will be stopped in the following sequence:

1. The displacement of the pump ramps up to the plussing offset value of displacement of the valve controller.
2. The “brake release” valve (V640) and the “lift band brake” valve (V634) are deactivated and the brakes are applied again.
3. About 2 seconds later the “enable hoist” valve (V622) is deactivated and the displacement of the pump is set to zero.

4.4.2.4 Actuating and measurement devices

Table 4-17 and Table 4-18 show the actuating and measurement devices of whip hoist.

Position	Symbol code	Action
P101B	100Y51-A	Pump control - hoisting
	100Y51-B	Pump control - lowering
V622	600Y60	Enable hoist
V640	600Y70	Brake release
V643	600Y31	Lift band brake
D650	600Y61	High speed - Low torque
V661	600Y10	Enable CT

Table 4-17: Actuating devices whip hoist

Position	Symbol code	Description/measurement	Action
S652	600B41	Lowering side pressure < 16 bar	Emergency stop
S105B	100B40	Hoist side pressure	
Z639	600B23	Band brake lifted	Hoisting and lowering allowed

Table 4-18: Measuring devices whip hoist

4.4.3 BOOM HOIST

Reference drawings:

- A12-48000-80-010: Hydraulic diagram

4.4.3.1 Operation principle

Pump control

The drive of the boom hoist winch is similar to the drive of the main hoist. The maximum pressure in the B-port of the pump (P101.A) is set by the pressure relief valve (V164.A) in the B-line of the pump. The maximum pressure in the A-port of the pump is set by the pressure relief valve (V163.A) in the A-line of the pump.

Drive control



Figure 4-58: Boom hoist winch drive (typical)

The drive is powered by pump (P101.A) (see Figure 4-44 p.85). The displacement of the axial piston hydro motor (D350) (see Figure 4-58 p.109), can be switched in two positions. A 3/2 way directional control valve (300Y61) must be activated to switch to the minimum displacement. De-activating control valve (300Y61) will switch the displacement back to the maximum volume.

Check valves allow pilot oil from the A- or B-port of the motor to adjust the displacement of the motor.

Sensor

Pressure transmitter (S352) is placed to measure the low pressure side (B side) of the motor, this is to prevent overspeed. When the measured pressure is lower than the setting on the PLC an emergency stop for the hoist drive is initiated.

Safety device

A band brake is added on the hoist drum as an extra safety device (see Figure 4-56 p.105). The band brake provides an independent secondary brake acting directly on the drum.

When the crane is in operation and the boom hoist disc brake is released, the band brake cylinder will be activated too, disengaging the brake.

Each time the boom hoist winch is used the band brake will be lifted. Single acting cylinder (A342) with spring return controls the position of the band. Activating 4/2-way directional control valve (V343) disengages the band. This extended position of the cylinder is indicated by proximity switch (S339).

Deactivation of valve (V343) causes the brake to be applied. The spring retracts the cylinder. Throttle valve (V344) is used to adjust the retracting speed of the cylinder.

4.4.3.2 Hoisting & lowering procedure

The boom hoist function is controlled with the left hand joystick on the operator chair.

The procedures are similar to the procedures for the whip hoist (see Section 4.4.2.2: "Hoisting procedure" and Section 4.4.2.3: "Lowering Procedure").

4.4.3.3 Actuating and measurement devices

Table 4-19 and Table 4-20 show the actuating and measurement devices of boom hoist.

Position	Symbol code	Action
P101.A	300Y51-A	Pump control - Hoisting
	300Y51-B	Pump control - Lowering
V322	300Y60	Enable hoist
V340	300Y70	Brake release
V343	300Y31	Lift band brake
D350	300Y61	High speed -Low torque

Table 4-19: Actuating devices boom hoist

Position	Symbol code	Description/measurement	Action
S352	300B41	Lowering side pressure < 16 bar	Emergency stop
S105.A	300B40	Hoist side pressure	
S339	300B22	Band brake lifted	Hoisting and lowering allowed.

Table 4-20: Measuring devices boom hoist

4.4.4 SLEWING SYSTEM

Reference drawings:

- A12-48000-80-010: Hydraulic diagram

4.4.4.1 Operation principle

Pump control

The pump (P201.A) (see Figure 4-44 p.85) is an axial piston pump with a variable displacement, adjustable in two flow directions. The maximum pressure in both ports of the pump is set by the pressure relief valves in the A- and B-lines of the pump.

The pump uses the external boost-unit, which has been explained in 4.3.1.10 Boost and brake system p.92.

Drive control

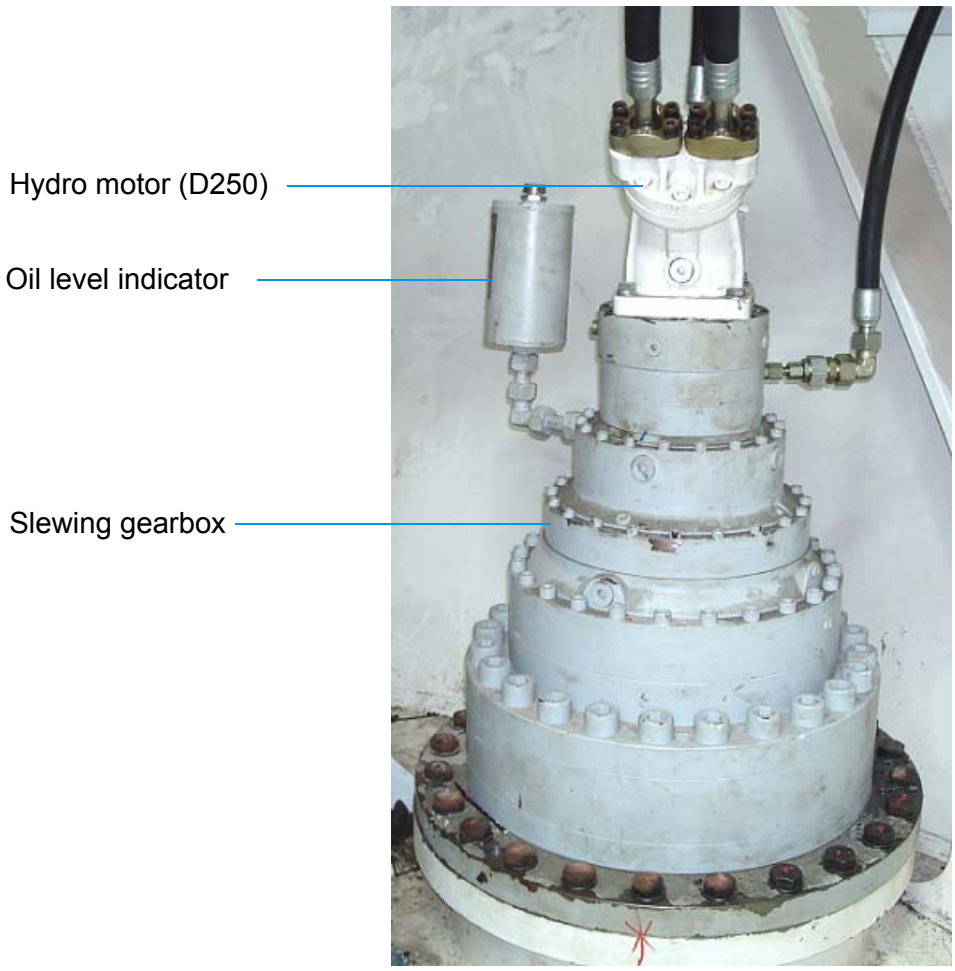


Figure 4-59: Slewing drive (1 of 4) (typical)

The pump drives 4 axial piston motors (D250) (see Figure 4-59 p.111) with a fixed displacement. Each hydro motor is mounted on a slewing gear, which drives the internal gear ring of the crane.

“Slewing enable” valve (V220) on manifold (M210) is mounted in order to be sure that the hydro motors are pressure less during an emergency stop. Pilot valve (V222) is activated to close this valve. A shuttle valve (V221), mounted in the cover plate, selects the pilot pressure from either the A-line or the B-line.

Sensor

Pilot valve (V222) is equipped with a proximity switch detecting the actual position (valve (V220) closed).

4.4.4.2 Slewing procedure

The operator gives the slewing command by pushing the left-hand joystick to the right or left. The hydraulic valves will be actuated in the following sequence:

1. “Enable slewing” valve (V222) is activated. The position must be confirmed by the proximity switch.
2. When the position of the “enable slewing” valve is verified, the 4/2 directional control valves (V240.A and V240.B) are activated simultaneously to release the brakes.
3. After approximately 1 second delay for release of the brakes, the displacement of the pump will ramps up to the desired speed.

When the operator sets the joystick in the center position, slewing is stopped in the following sequence:

1. The displacement of the pump ramps down to zero.
2. Valves (V240.A and V240.B) are deactivated simultaneously to engage the brakes.

NOTE *If one of the two valves does not return to the neutral position when deactivated, the brakes will be applied anyway.*

3. After about 1 second, “enable haul valve (V222) is deactivated. Cartridge valve (V220) opens; thus, equalizing the pressure on the A- and B-ports of the four slewing motors.

4.4.5 ACTUATING AND MEASUREMENT DEVICES

Table 4-21 and Table 4-22 show the actuating and measurement devices of slewing.

Position	Symbol code	Action
P201.A	200Y51-A	Pump control - Slewing CCW
	200Y51-B	Pump control - Slewing CW
V222	200Y60	Enable slewing
V240.A	200Y70	Brake release 1
V240.A	200Y71	Brake release 2

Table 4-21: Actuating devices slewing

Position	Symbol code	Description/measurement
S252.A	200B41	Motor A-side pressure
S252.B	200B42	Motor B-side pressure
V222	200B20	Slewing enabled

Table 4-22: Measuring devices slewing

4.4.6 TUGGER

Reference drawings:

- A12-48000-80-010: Hydraulic diagram

4.4.6.1 Operation principle

Pump and drive control

The tugger winch pump (P201.B) is an axial piston pump with a variable displacement, adjustable in two flow directions. The maximum pressure in both ports of the pump is set by the pressure relief valves in the A- and B-lines on the pump.

The pump drives an axial piston motor (D450) with a fixed displacement. The hydro motor is mounted on a planetary gearbox with a multiple disc brake, built into the drum.

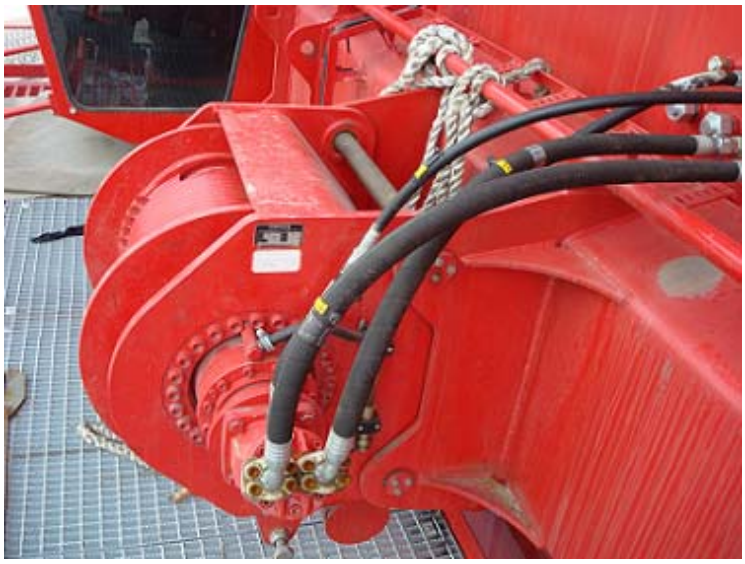


Figure 4-60: Tugger winch (typical)

Constant Torque function

A constant torque (CT) function is available. This function can be used to keep a load from rotating and swaying when suspended in midair.

NOTE	*There are no control measurements on the tugger. The operator must watch the movement of the load, empty drum and nearest position.* *CT mode may only be enabled with the line connected to the load.*

To activate the tugger CT mode the operator has to use the switch on the operator console. The CT mode is then enabled by activating valve (V472). The pump control valve is activated for 100% hoisting.

The high pressure side of the pump is connected to manifold (M470) to the inlet of valve (V475). This is a proportional pressure relief valve. The setting of this valve, and with this the maximum pump pressure, can be adjusted by the operator with the rotational knob in the cabin on the left-hand console and with this, the tension in the line can be adjusted to keep the load as still as possible.

The outlet of this valve is connected to the lowering side of swash plate control piston.

The pressure in this outlet line is limited by valve (V478). This valve has a higher setting than the boost pressure. When valve (V475) opens, oil will first flow to the swash plate control piston forcing this in lowering direction, and opposite direction of the hoist command. This way a constant system pressure is maintained.

In CT mode, the pump and motor pressure will be constant, independent of the direction or the speed of the load.

4.4.6.2 Haul in/pay out Procedure

The haul in and pay out procedures are similar to the hoisting and lowering procedures for the main hoist (see 4.4.1.2 Hoisting procedure p.101 and 4.4.1.3 Lowering procedure p.102).

4.4.6.3 Actuation and measurement

Table 4-23 shows the actuating devices of tugger.

Position	Symbol code	Action
P201.B	930Y51-A	Pump control - haul in
	930Y51-B	Pump control - pay out
V440	930Y70	Brake release
V472	930Y60	Enable CT
V475	930Y52	Set CT pressure

Table 4-23: Actuating devices tugger

5 ELECTRICAL DESCRIPTION

5.1 INTRODUCTION

This chapter provides a general description of the electrical installation of the 300 mt Pedestal Mounted Crane. Next to this chapter, the electrical documentation of the 300 mt PMC contains the electrical diagrams. The reference drawings and the electrical appendices also provide information regarding the electrical system of the 300 mt PMC.

5.1.1 CABLES IDENTITY

Every cable is equipped with a metal tag. The code on the tag correspondents with the electrical diagrams. See Figure 5-61.



Figure 5-61: Metal Cable Tag

In the cabinet, the cables are identified with heat-shrink insulation. These sleeves are only for identification purposes. See Figure 5-62.

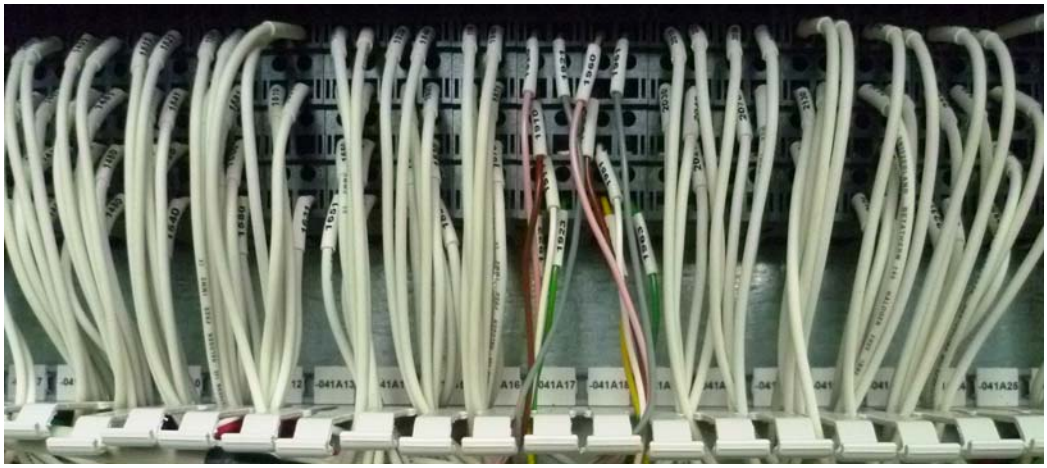


Figure 5-62: Heat shrink insulation

5.1.2 USE OF THE ELECTRICAL DIAGRAMS

This chapter, refers frequently to the electrical diagram. Follow carefully the work instruction regarding the electrical coding, which can be found in the Appendix A: "Reference drawings".

NOTE *When using this electrical chapter, be sure to refer to the electrical diagram supplied*

5.1.3 DESCRIPTION

Reference drawings:

- 10016927A-07-900-01.: Electrical diagrams
- A12-48000-00-401: Sensors arrangement

The electrical system of the PMC performs the following main functions:

- Power distribution
- Control of all movements
- Safety

The electrical diagrams will not be completely described. However, reference is made wherever appropriate.

General safety information is given in Important safety information p.14.

5.1.4 DESIGN CRITERIA

For as far as possible, the electrical system is designed as fail-safe. With a fail-safe design a malfunction or error of a specific sensor, device, circuit or system results in a transition to a safe situation.

5.1.5 FINDING INFORMATION

5.1.5.1 Electrical drawings

The electrical drawings are delivered in pdf format. The electronic version of the pdf drawing has some advantages over the printed version. Using the electronic version it is possible to flip through the pages by following the wiring (arrow heads). When the mouse pointer changes into a pointing finger, it is possible to click with the left mouse button. After the click the page will be opened that connects to the wire that was pointed at. The same applies to most of the relay contacts and relay coils.

The various electrical components can be found in the electrical drawings by using the “find”-function in the pdf-reader. With this function the various location and component codes can be found in the electrical schematics.

5.2 SYSTEM DESCRIPTION

The 300 mt Pedestal Mounted Crane is hydraulically driven. Most of the electrical energy necessary for the PMC, is used to produce hydraulic pressure for the hydraulic motors of the winches and the slewing movement.

The crane is supplied with electrical power from the vessel.

The electrical design of the crane can be divided into 2 parts:

- Main supply distribution for the hydraulic pumps and the heating of the hydraulic fluid and the E-room (Slew room). A control supply is derived from the main supply for the control electronics.
  This part is supplied with 3 x 690 VAC / 60 Hz from the ships main switch board.
- whip supply distribution for the lighting, outlet sockets and air conditioning.
  This part is supplied with 3 x 230 VAC/ 60 Hz from the ships whip switch board.

The winches for main, whip and boom hoist are mounted on a winch frame in the crane house. The crane is fully revolving therefore a slip ring unit is used to transfer the ships power from the fixed part of the crane to the revolving part. In addition, the whip supply and various signals are transferred by the slip ring unit to the crane cabin.

The entire crane is controlled by an advanced PLC system. Through digital and analog input and output units various controls, sensors, relays and actuators are connected to the PLC.

Communication between SCADA and the PLC is by means of an profinet interface. In the SCADA system important data is stored by a data logger to be used for analysis and, when needed, to be sent to Huisman by satellite for the purpose of remote assistance.

Safety is of the highest importance, the crane is therefore provided with a safety system consisting of various emergency stop provisions and emergency stop buttons in strategic areas.

See Figure 2-1 p.24 for an overview of the crane and its components. See Figure 3-6 p.37 for an overview of the crane house.

5.3 POWER SUPPLY AND DISTRIBUTION

Reference drawing:

10016927A-07-900-01 Electrical diagrams

The crane is supplied with electrical power from the vessel. Power is delivered at two voltage levels:

- 400 VAC for the electro-hydraulic power unit and control system,
- 230 VAC for the auxiliary systems such as lighting, cooling and heating.

Power is delivered to the slewing platform via a set of slip rings, see 5.7.2.4 Slip ring unit p.132.

5.3.1 400 VAC

Main power is supplied from the ships main switch board to the power junction box and transferred to POCA ELCA on the slewing platform by the slip ring.

The 400 VAC power is distributed to the various consumers by circuit protection breakers as follows:

- HPU main pump motor -,
- HPU boost pump motor,
- spare,
- HPU cooler 1 motor,
- HPU cooler 2 motor,
- Heating 1 and heating 2 in the hydraulics tank and E-room heating ,
- Control circuit transformer for the 230 VAC power supply to the control circuit.
  The 230 VAC of the control circuit is also used to generate 24 VDC UPS through battery charger and batteries.

5.3.2 230 VAC

Auxiliary power is supplied from the ships main switch board to power junction box and transferred to POCA ELCA on the slewing platform by the slip ring.

The 230 VAC power is distributed to the various consumers by miniature circuit breakers / fuses as follows:

- Power supply to cabin driver cabinet. In the cabin driver cabinet the power is further distributed by miniature circuit breakers as follows:
  - Air conditioning unit,
  - Fluorescent lighting in cabin,
  - Flood lights,
  - Cabin heating,
  - Front window heating,
  - Outlet sockets in the cabin,
  - Spare.
- General lighting. A switch is placed near the lower winch room entrance,

- Back-up lighting. A switch is placed near the lower winch room entrance,
- Aeronautical obstruction lighting crane house and jib head,
- Outlet sockets,
- HPU filter pump motor,
- Stand still heating for HPU main pump and slip ring and cabinet facilities.

5.3.3 24 VDC UPS

The 24 VDC UPS is derived from the 230 VAC supply of the control circuit by Mastervolt battery charger. The battery charger supplies the 24 VDC to the Mastervolt gel batteries and to the 24 VDC distribution bus bar. The supply to the bus bar is guarded by battery watch relay which protects the bus bar against over voltage and protects the batteries against too deep discharge. The 24 VDC is distributed to the various consumers by miniature circuit breakers / fuses as follows:

- 24 VDC supply to cabin driver cabinet. In cabin driver cabinet the power is further distributed by miniature circuit breakers as follows:
  - Window wipers and deck horn,
  - SCADA PC,
  - Driver seat,
  - SCADA touch screen,
- Control circuit,
- Sensor supply,
- Proportional valves supply,
- Valve power module,
- Valve power module,
- Valve power module,
- Data logger supply,
- Etherwan module
- Spare

5.4 ELECTRO-HYDRAULIC DRIVE

The hydraulic part of the electro-hydraulic drive is described in Chapter 4: "Hydraulic system".

Main pumps electric motor

The electric motor of the main pumps is a squirrel cage motor. The motor is started with a star-delta starter to reduce the starting current. After the motor has been started and is running in delta, it can be loaded.

WARNING



Do not cover the air inlet of the motor, due to overheating.

For more information see the documentation of the main pump motor in the suppliers documentation.

Thermistor

The electric motor of the main pump contains thermistors to protect the motor against overheating. The thermistors are connected to the motor overload thermistor relay. The thermistor relay gives a signal to the PLC when the motor temperature becomes too high.

Main pump standstill heating

When the main pump is not used, the standstill heating of the main pump motor and the stand still heating of the slip ring is switched on. The stand still heating protects the electric motor and the slip ring against condensation and thus against corrosion.

5.5 SAFETY DESIGN

Two types of stops can be distinguished:

- controlled
- fast

Usually the controlled stops take place under the following circumstances:

- a limit switch alarm
- overload
- slack rope alarm

Fast stops directly initialize the mechanical brake. A fast stop shortens the life of the mechanical brake system. Fast stops occur during:

- emergency stop
- power failure
- mechanical failure in a winch

Overload protections

Load cells are load measurement devices which monitor the load on shafts or safety pins. See Appendix B: "Reference documentation" for the principle of the load cell. To power the load cells, a 24 VDC power supply is required. Both main and whip hoists use load cells. The output signals of the load cells are fed directly to the PLC.

The electric motors used have current overload protection which protects against sudden high overloads and stalling. Thermistors are built in for backup protection and to protect against long lasting small overloads and the heating effects of frequent starting and stopping.

The current overload protections act directly by switching off the relevant E-motor. This can only be reset in POCA ELCA cabinet. The thermistor overload protection acts through the PLC program. The thermistor relay has a manual reset button.

The overload protection by the load cells acts through the PLC program according to the implemented load curves.

Reverse energy flow

When the direction of the energy flow turns around e.g. by lowering of a load or by slew “down hill”, a part of the energy is delivered to the ship. The other part is absorbed in the HPU tank, the temperature of the oil in the reservoir will increase.

End positions

Geared cam limit switches serve to determine the end positions of hoisting movements, such as last winding, pre-highest and highest position. The geared cam limit switches have several contacts which are monitored by the PLC, see 5.7.3.1 Main hoist winch p.133, 5.7.3.2 Boom hoist winch p.134 and 5.7.3.3 Whip hoist winch p.135.

See supplier documentation (Stromag) for a description of the geared cam limit switch.

Length measuring system

The paid out length of the whip hoist wire is measured by means of a toothed disc in combination with two proximity switches. The toothed disc is attached to the whip hoist sheave on the crane top (see Figure 5-63). The presence of two proximity switches results in two pulse signals, which enable calculation of both direction and speed of the sheave. The actual length of the paid out wire is displayed at SCADA.

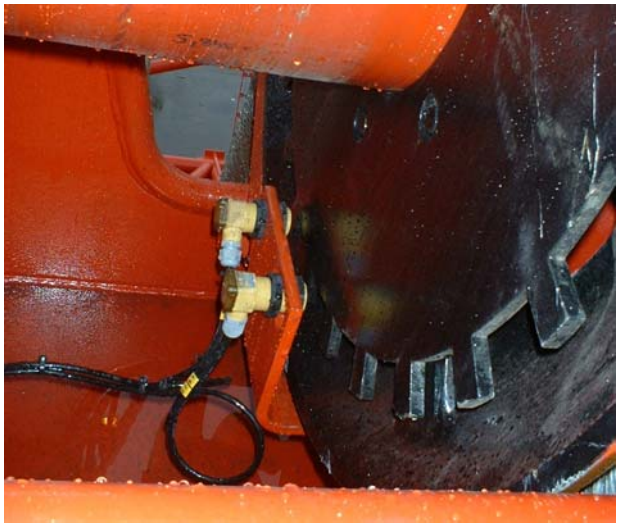


Figure 5-63: Length measuring system (typical)

Highest position

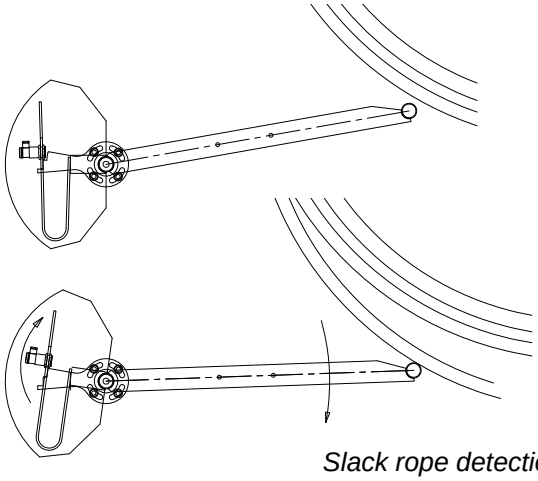
Besides the geared cam limit switches used for the detection of various hoisting positions, a special spring blade switch is used for detection of the highest position of the boom.



Figure 5-64: Highest position switch

Slack rope

Each of the slack rope devices, for main, whip and boom hoist winches, consist of a bar, mounted underneath the drum. A slack rope makes contact with the bar and causes it to fall down. The proximity switch is then deactivated. The applicable winch stops consequently. When a slack rope has occurred, first check the rope leading, sheaves and other items that could have caused the slack, and do not reset until the cause of the slack has been removed. The bar must be reset manually into the original position.





Slack rope detection bar (under winch drum)



Proximity switch normal position



Proximity switch slack rope position

Figure 5-65: Slack rope switch (typical)

Emergency stop circuit

Safety switches (i.e. emergency-stop buttons, limit switches) are regarded as being normally closed contacts where possible. Failing of the switch or discontinuity of the cable will therefore result in a stop. The emergency stop system is hardwired with double contact emergency relays.

The PMC system is equipped with an emergency stop circuit. The emergency stop circuit consists of a master relay and several slave relays. The emergency stop circuit consists of a channel 1 and channel 2 circuit and a reset circuit. The emergency stop push buttons each have a third contact which is connected with the PLC, so each stop push button is monitored by the PLC.

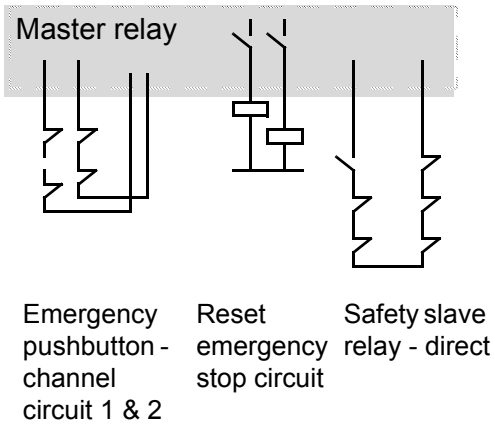


Figure 5-66: Emergency stop circuit

Several auxiliary or slave relays are used to enable the switch off of all pump motors and all electrically operated valves. The emergency stop circuits channel 1 and channel 2 consist of normally closed contacts and are therefor normally active. The circuit is deactivated by emergency stop push buttons, placed on all locations where the PMC system can be controlled. The PLC/SCADA can tell which button is pushed. The PLC will also stop the system if it detects a pushed button.

The emergency stop circuit is also deactivated if the PLC is no longer working. This is detected by a watchdog. If the watchdog is not activated by the PLC within a certain period of time, the main emergency relay is de-activated.

If the emergency relays are deactivated, all contacts are deactivated. The position of the load in the crane is maintained. The brakes will hold the winches in their position.

5.6 CRANE MOVEMENTS

Hoisting and lowering

In Chapter 4: "Hydraulic system", the main and whip winches are described.

Both whip winch and tugger are equipped with Constant Tension (CT) control. The torque is measured by pressure. The CT is fixed for the whip winch, a hydraulic value has been entered. When, for example, 5 mt is requested and CT is active, it will control the drum on this 5 mt level, meaning that it will start paying out when the torque is increasing and hauling in when the torque is decreasing. See for more information Section 6.3.3.1: "Whip Constant Tension hoist".

Boom hoist

See 4.4.3 Boom hoist p.108 for an explanation.

Slewing movement

The hydraulic motors for the slewing movement contain no electric sensors. The motors are controlled from the manifold near the motors. This manifold contains the sensors and actuators mentioned below.

For a description of the slewing movement, see 4.4.4 Slewing system p.110.

5.7 DESCRIPTION OF ELECTRICAL CABINETS

In the sections below components are described according to their actual position in the crane. From an electrical point of view the crane is split up into the following areas:

- Pedestal
- Crane house lower section in the electrical schematics also called Slew room or E-room.
- Winch room
- Crane top
- Boom
- Crane cabin

The electrical components in these areas are described in detail in the following paragraphs. See Figure 2-1 p.24 for an overview of the crane and its components. See Figure 3-6 p.37 for an overview of the crane house.

5.7.1 PEDESTAL

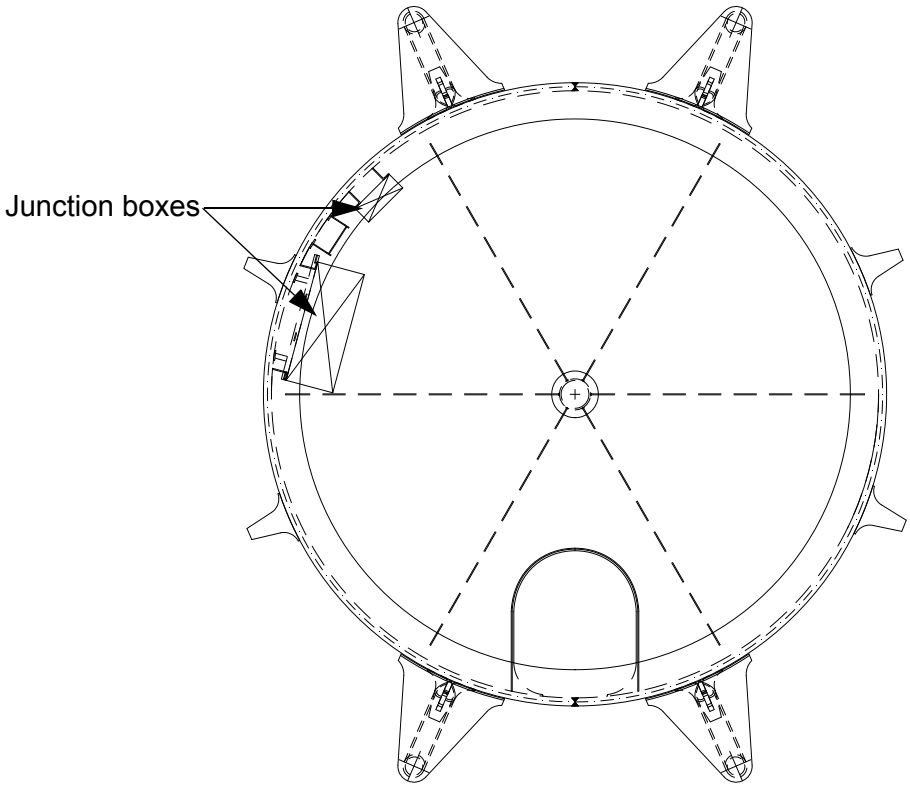


Figure 5-67: Junction boxes

Inside the pedestal, two junction boxes are installed. A junction box for the connection of the power from the ships switch boards to the crane and a control junction box for the connection of the signal cables from the ship to the crane.

5.7.2 CRANE HOUSE LOWER SECTION (E-ROOM)

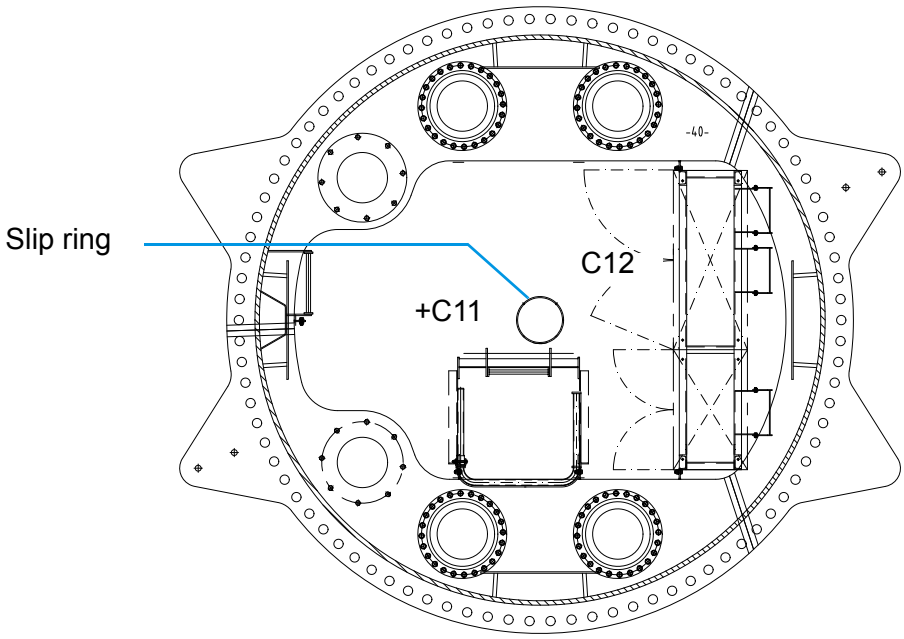


Figure 5-68: Crane house lower section or slew room

The slewing room contains the power and electronics cabinet and the slip ring unit. These items are described in the sections below.

5.7.2.1 Power and Electronics Cabinet

The POCA ELCA consists of two panels, each with two doors. The left hand panel is mainly the power cabinet and the right hand panel the electronics cabinet.

The doors of the cabinet contain the following controls and indicators:

- Main switch for the 400 VAC main supply from the ships switch board.
  When the main switch is on, the cabinet door is locked; the door can only be opened when the main switch is in the ‘off’ position.
  The following components are switched by the main switch:
  - Main pumps electric motor,
  - Oil cooler fans and filter pumps,
  - Tank heating,
  - 220 VAC in the power cabinet,
  - 24 VDC supply to the battery charger,
- Main switch for the 230 VAC whip supply from the ships switch board.
  The following components are switched by this main switch:
  - Fluorescent lighting,
  - Aeronautical obstruction lighting,
  - Socket outlets,
  - Cabinet facilities,
- Current indicator; HPU motor current,
- Voltage indicator with voltage selector switch to indicate the main 400 VAC supply voltage,

- HPU hour counter to indicate the number of hours that the HPU has been active,
- Red HPU failure indication light,
- Red filter pump failure indication light,
- Green HPU start push button with build-in indication light,
- Green filter pump start push button with build-in indication light,
- Red HPU stop push button,
- Red filter pump stop push button,
- Blue heating on indication light to indicate the stand still heating of the HPU pump motor and slip ring is switched on,
- Emergency stop push button.

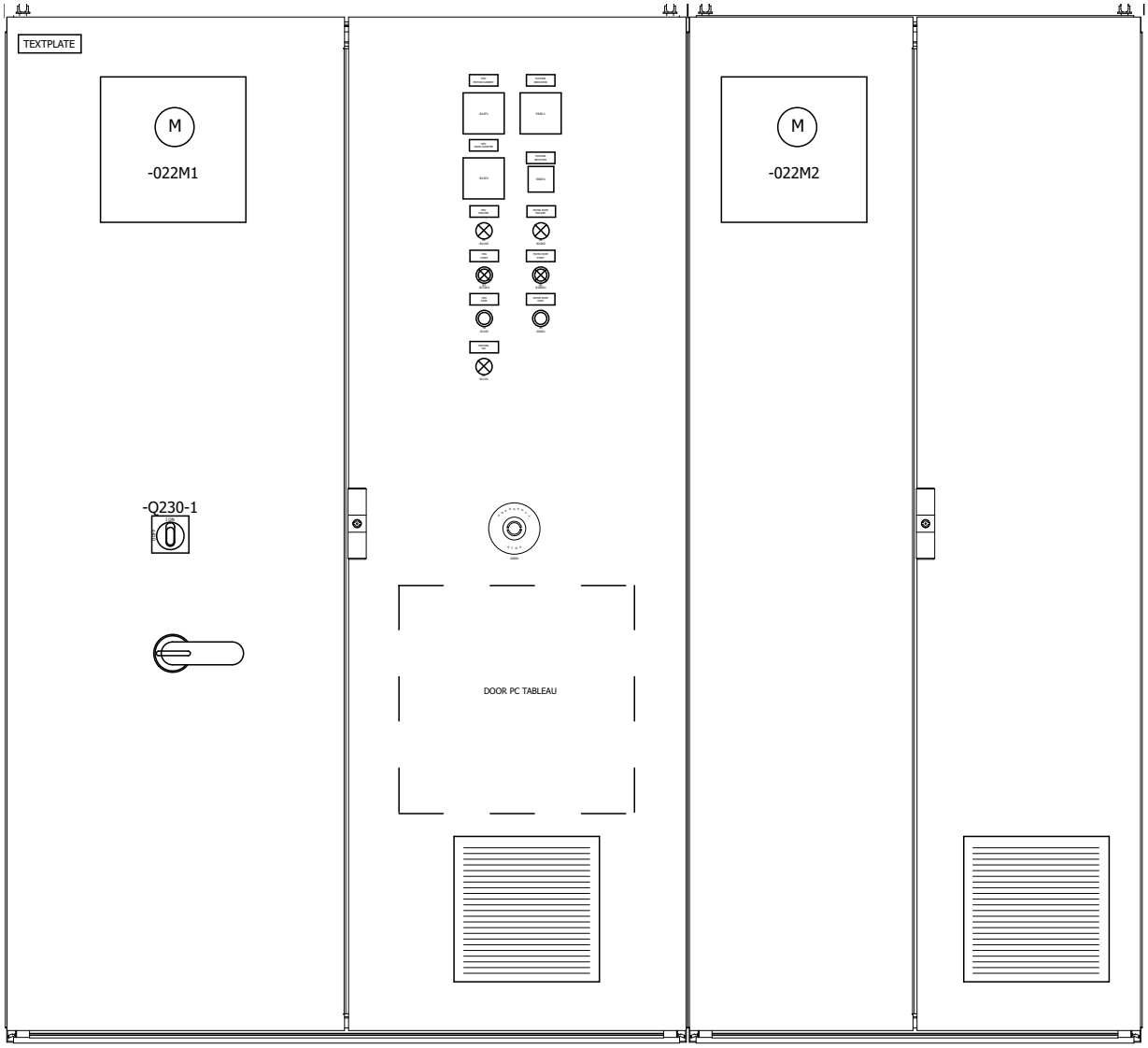


Figure 5-69: POCA ELCA +C12 front

5.7.2.2 Emergency stop relay / circuit

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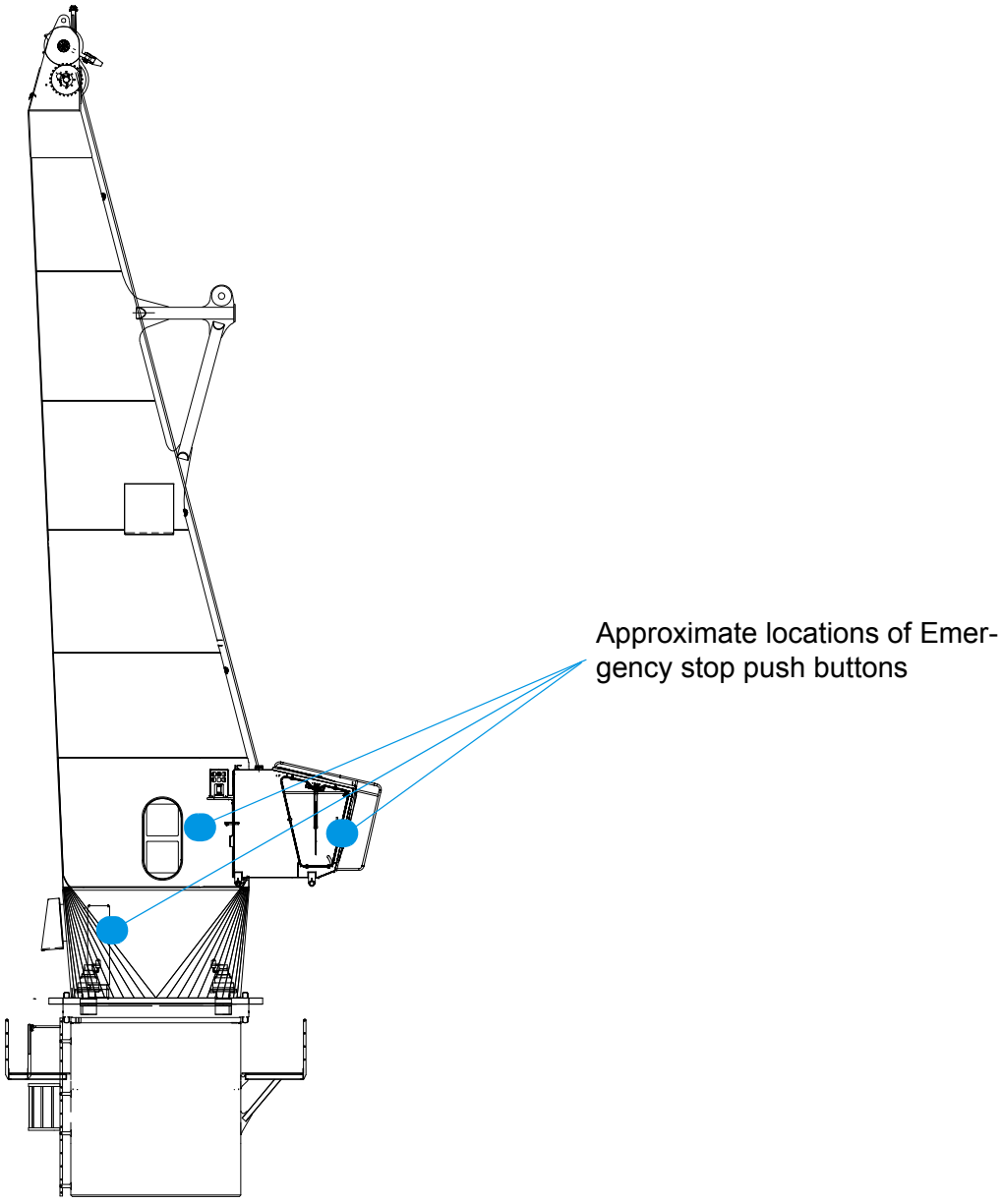


Figure 5-70: Emergency stop locations

The following components are part of the emergency stop circuit loop:

Description	Location
PLC watchdog	In electronics cabinet
E-stop on cabinet door	On door of cabinet
E-stop on crane drivers chair	On left-hand console of chair
E-stop in winch room	In lower part of winch room
E-stop in winch room	In upper part of winch room

Table 5-24: Emergency stop circuit

When one of the above-mentioned switches opens, the whole system stops. The following components stop immediately:

- Main pumps
- Oil cooler fan 1
- Oil cooler fan 2
- Filter pump
- Boost pump
- Main hoist high Speed
- Whip hoist high speed
- Boom hoist high speed
- Enable Main hoist
- Enable Boom hoist
- Enable Whip hoist
- Enable Slewing
- Boost pressure enable

The tank heating is not switched off when an emergency stop occurs.

When the emergency stop is activated, the complete emergency stop reset circuit has to be closed before the emergency stop can be reset. (A reset of the emergency stop is possible from the operator chair in the crane cabin).

5.7.2.3 PLC

This section of the manual describes the hardware of the Programmable Logic Controller (PLC). More information can be found in the appendices. The PLC actually controls the power pack and the main pumps of the crane. All inputs with respect to the main pumps, oil tank and oil coolers (e.g. push buttons and sensors) are connected to this computer system. According to the program, outputs will be activated or not. The safety diagram gives much information about the PLC program, see safety diagram in Appendix B: "Reference documentation".

More information about Siemens PLC' s can be found in the suppliers documentation.

PLC basics

The PLC is a computer system that is mostly applied in an industrial environment, to control a process or a machine. All necessary data from the system or machine is transferred to the PLC. For example digital pressure switches, push buttons, limit switches, and contacts of relays and switches etc.

Depending on the state of the process or machine, indicated by the signals of the sensors that are connected to the inputs, the PLC controls its outputs according to the loaded program. The outputs can be either digital, for example to a valve or a relay, or analog, for example to a panel meter, a proportional valve or an input for another controller.

Remote I/O module

The remote I/O station is the interface between the analog and discrete signals at one side and the PLC at the other side.

For more information, see Siemens Supplier documentation.

Watchdog Interface Print (WIP)

The Watchdog Interface Print (WIP) monitors the constant pulsetrain from the PLC. When the PLC is working correctly, every cycle the PLC generates a pulse. This output is connected to the WIP. When the PLC program cycle stops, the pulse is no longer generated. When the WIP does not detect a pulse anymore, the internal relay opens, activating an emergency stop.

5.7.2.4 Slip ring unit

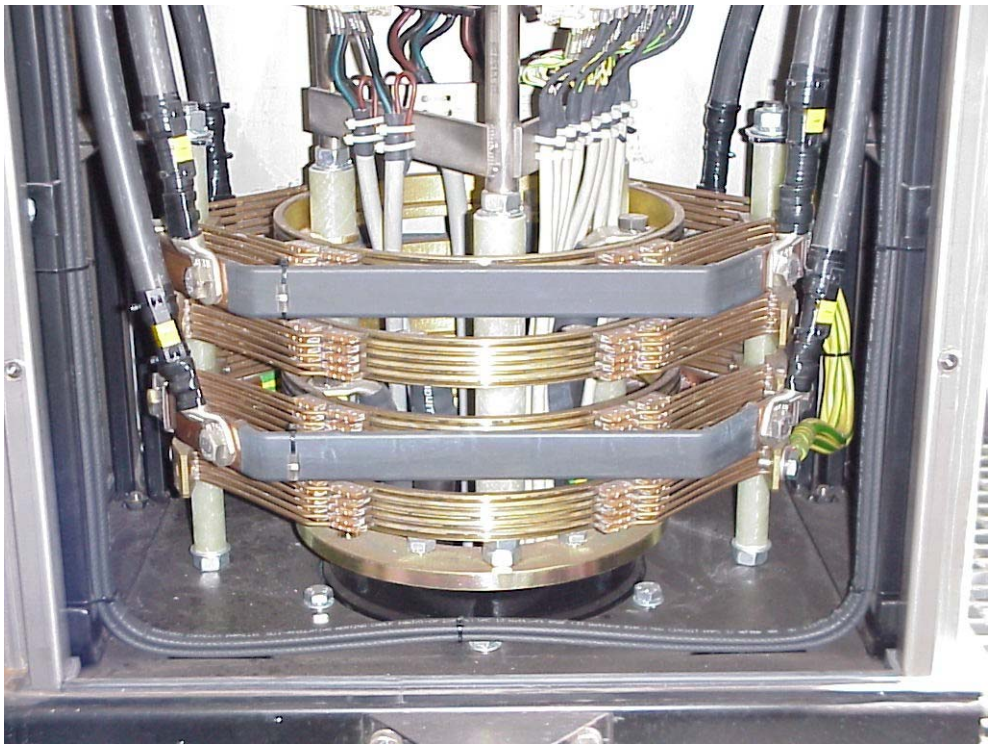


Figure 5-71: Power rings of a slip ring (typical)

The slip ring transfers the electrical power from the ship's distribution board to the crane. For this purpose 3 rings are placed in the slip ring unit, one for each of the 3 phases. Each ring is rated at 600 A continuous. There is also a ring for an earth connection. For the 230 V supply (for lighting etc.), the unit contains 3 rings of 25 A. Twelve silver plated rings with a rating of 12 A handle the signals between crane and ship. For more information, see the suppliers' documentation (Cavotec).

5.7.2.5 Slew drive

Sensor and valves

When valve -200-Y60 is activated, slewing is possible. When it is inactive, it is not possible to use the motors, because they are short-circuited. When -200-Y60 is activated, pressure sensor -200-B20 will detect the pressure for slewing, and will enable the slewing movement. Slewing is then controlled with valves -200-Y51-A and -200-Y51-B through valve controller -200-A51. When there is an emergency stop, or a broken wire (either from -200-Y60 or -200-B20), -200-Y70 and -200-Y71 will be de-activated which will apply the brakes, and the motors are short-circuited. This achieves a safe stop of the slewing movement.

The valves -200-Y70 and -200-Y71 lift the brakes on the slew motors. More information can be found in the hydraulic description, see Chapter 4: "Hydraulic system".

5.7.3 WINCH ROOM

Introduction

The winch room contains most of the main parts of the crane. Two emergency stop buttons are located in the winch room. Pushing an emergency stop button will stop the crane immediately. The emergency stop circuit is described in 5.7.2.1 Power and Electronics Cabinet p.128.

The winch frame, main pumps, oil coolers and the emergency diesel pump are situated in the winch room. The winch room components are discussed below.

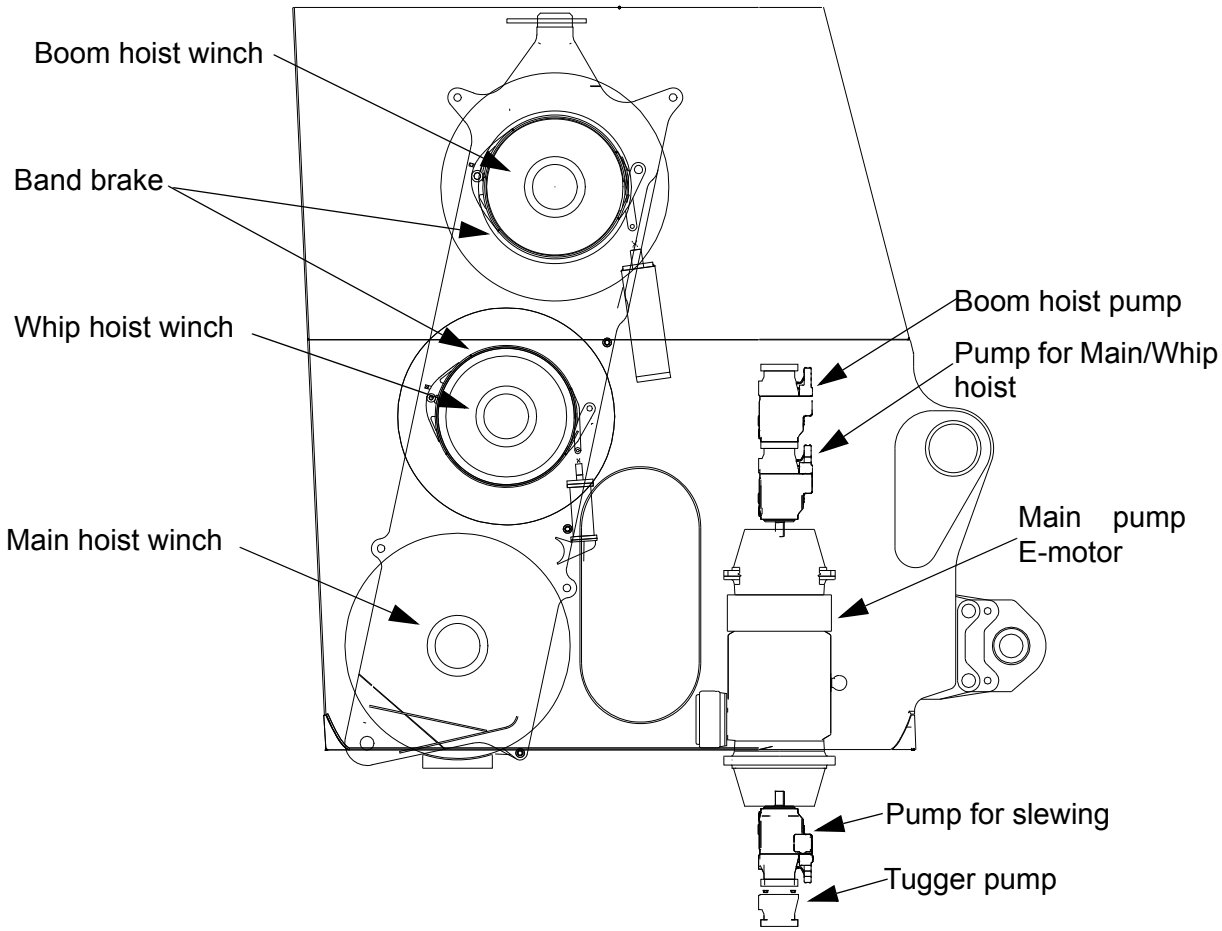


Figure 5-72: +C30 winch room

5.7.3.1 Main hoist winch

Motor:

Valve -100-Y60 enables the main hoist motor. When valve -100-Y61 is activated, the motor is set into high speed mode. When brakes are enabled by valve -810-Y61, the brake can be lifted by means of valve -100-Y70.

Slack rope detection

A description of the slack rope detection device is given in Section 5.5: "Safety design".

Geared can limit switch

For the main hoist switch, six contacts are installed:

- Empty drum main hoist. This switch is adjusted in such a way that the drum will stop in lowering direction when 5 windings are left at the drum.
- Pre empty drum.
- Spare.
- Highest position 4 falls. This switch is adjusted in such a way, that the drum will stop in hoisting direction when the main hoist hook is in its highest position in case of 4 falls reeving.
- Highest position 8 falls. This switch is adjusted in such a way, that the drum will stop in hoisting direction when the main hoist hook is in its highest position in case of 8 falls reeving.
- Spare

See supplier documentation for detailed information on the geared cam limit switch.

5.7.3.2 Boom hoist winch

Motor: -300-Y60, -300-Y61, -300-Y70, and -300-Y31

Valve -300-Y60 enables the boom hoist motor. When valve -300-Y61 is activated, the motor is set into high speed mode. When brakes are enabled by valve -810-Y61, the brake can be lifted by means of valve -300-Y70 and the band brake by valve -300-Y31.

Slack rope detection

A description of the slack rope detection device is given in the previous section.

Band brake

Activating 4/2-way directional control valve [V343] disengages the band. This extended position of the cylinder is indicated by proximity switch [S339].

Deactivation of valve [V343] causes the brake to be applied. The spring retracts the cylinder. Throttle valve [V344] is used to adjust the retracting speed of the cylinder.

Switch

For the boom hoist system switch -300-GS1, four contacts are installed:

- Parking position. This switch is adjusted in such a way, that the drum will stop in lowering direction when the boom is in the boom rest.
- Lowest working position. This switch is adjusted in such a way that the drum will stop in lowering direction when the boom angle is 0º. Lowering is then only possible when the button ‘boom parking position’ is pressed, and only at low speed. The slewing speed is also limited.
- Pre lowest working position. This switch is adjusted in such a way that the drum will go to low speed in lowering direction when the boom angle is about 7º.
- Pre highest position boom hoist. This switch is adjusted in such a way that the drum will switch to low speed in hoisting direction when the boom angle is about 80º.

Highest position switch

In order to prevent the boom from being hoisted through its maximum angle and causing damage, a highest position safety mechanism is mounted in the crane house. See Section 5.5: "Safety design" for detailed information.

5.7.3.3 Whip hoist winch

Motor: -600Y60, -600Y61 and -600Y70

Valve -600-Y60 enables the whip hoist motor. When valve -600-Y61 is activated, the motor is set into high speed mode. When brakes are enabled by valve -810-Y61, the brake can be lifted by means of valve -600-Y70 and the band brake by valve -600-Y31.

Slack rope detection

A description of the slack rope detection device is given in Section 5.5: "Safety design".

Band brake

Activating 4/2-way directional control valve [V643] disengages the band. This extended position of the cylinder is indicated by proximity switch [S639].

If the extended position is not detected the band is to be considered applied and drum rotation is not allowed, if this occurs during movement this needs to be stopped.

CT function

Switch

For the whip hoist switch -600-GS1, four contacts are installed:

- Empty drum whip hoist. This switch is adjusted in such a way, that the drum will stop in lowering direction when 5 windings are left at the drum.
- Pre-empty drum. This switch is adjusted in such a way, that the drum will only lower at low speed when the whip hoist hook is between its pre-empty drum and empty drum position.
- Pre-highest position whip hoist (1 FALL). This switch is adjusted in such a way, that the drum will only hoist at low speed when the whip hoist hook is between its pre-highest and highest position. Pre-highest position is about 2.5 meter wire traveling from the highest position.
- Highest position whip hoist (1 FALL). This switch is adjusted in such a way, that the drum will stop in hoisting direction when the whip hoist hook is in its highest position, about 2.3 meter under the sheave in the fly jib.
- Spare.
- Spare.

Length measuring system

The whip hoist is provided with a system to measure the paid out wire length. See ’5.7.5 Boom p.137 for details.

5.7.3.4 Emergency diesel pump

Diesel engine

The main, whip and boom hoist, as well as slewing system can be operated (hoist, lower, slew right and left) with an emergency HPU when no electrical power is available. This emergency HPU consists of a diesel engine with an open loop pump.

The diesel engine contains no electrical interfaces engineered by Huisman. All information with respect to mechanical or hydraulic issues can be found in the appendices and in Chapter 4: "Hydraulic system".

Battery and charger

The start battery for the emergency diesel is a standard automotive battery with a capacity of 70 Ah. The voltage is 12 V. The charger is an automatic 3-step Mastervolt charger. Leave the charger always on, and also leave the battery connected to ensure that the emergency diesel is always ready for use. For more information, see appendices: Mastervolt Battery Charger.

5.7.4 CRANE HOUSE

5.7.4.1 Oil tank

Oil coolers

The oil coolers are located in the upper section of the crane. They are controlled by the PLC. The motors of the oil coolers are not equipped with any sensors for overheating, but are protected by the motor protection switches in cabinet C12. Besides cooling the hydraulic oil, the oil coolers also provide ventilation of the crane house.

Oil temperature sensor

The oil temperature sensor detects the oil temperature and returns it to the PLC. The temperature is converted to an analog (4…20 mA) value. The actual temperature is displayed on the sensor itself.

Oil level detection.

Description	Contact
HPU tank level low	NC (Closed when level is not low)
HPU tank level too low	NC (Closed when level is not too low)

Table 5-25: Oil level detection contacts

5.7.4.2 FL Lights with / without battery backup

See suppliers documentation (Chalmit).

5.7.5 BOOM

5.7.5.1 Boomhoist inclino sensor

The location of this sensor is on the boom, between the pivots.

This sensor generates a 4…20 mA current signal corresponding with -15°…90° boom angle. With this information the PLC is able to calculate the exact main hoist radius, thus guarding the maximum allowable load curve.

5.7.5.2 Load cells main hoist

These sensors are located in the sheave in the crane head section.

The load cells measure the actual load, by means of strain-gauges, at the main hoist hook (see also 3.9.3 Load Measuring Pin p.72 and Appendix B: "Reference documentation").

5.7.5.3 Load cell whip hoist

This sensor is located in the sheave in the crane head section.

This is the load cell that measures the actual load, by means of strain-gauges, at the hook.)

5.7.5.4 Length measurements

The whip hoist of the crane is equipped with a length measurement. The length measurement of the whip hoist is placed at the sheave above the cabin.

5.7.5.5 Floodlights boom

Six 400 W floodlights are present four at the boom and two at the jib. They are directly switched from the cabin driver cabinet in the crane cabin.

5.7.5.6 Aircraft obstruction lights

One red aeronautical obstruction light is placed on the jib head and one on the crane house head. They can only be switched on and off with circuit breaker in the power and electronics cabinet in the E-room.

NOTE	*It is strongly advised to leave these lights always on!*

5.7.6 CRANE CABIN

Introduction

In normal operation, the 300 mt PMC can only be controlled from the crane cabin. The operator chair and a cabin driver cabinet are located inside the crane cabin. At the operator chair, two joysticks are located. One joystick operates the slewing and boom hoist movement, the other one operates the tugger and either the whip hoist or the main hoist; a selection between these two movements can be made by a switch on the console.

The cabin is equipped with air conditioning and heating, which is thermostat controlled. All components in the cabin are fed from the power and electronics cabinet in the slew room. The power from POCA ELCA is supplies the cabin driver cabinet and distributed from this cabinet to the various consumers.

The crane is equipped with a camera system, to enable the crane driver to monitor the winches (except the tugger winch) while he is operating the crane. The system consists of a camera above the winch frame in the winch room, and a monitor in the crane cabin.

The overload alarm sounder under the cabin is activated when the crane is in an overload situation.

A slewing alarm warning beacon (sound and flashing light) is mounted under the cabin and is activated by the PLC through relay in cabin driver cabinet during slewing.

For a complete overview of the control cabinet and all its consoles, see Section 6.2: "Control system".

All switches, joysticks, lights and other actuators which are placed on the operator chair are connected to remote I/O modules that are mounted inside the operator chair consoles. These remote I/O modules are connected to the PLC in POCA ELCA.

5.7.6.1 Cabin driver cabinet +D11

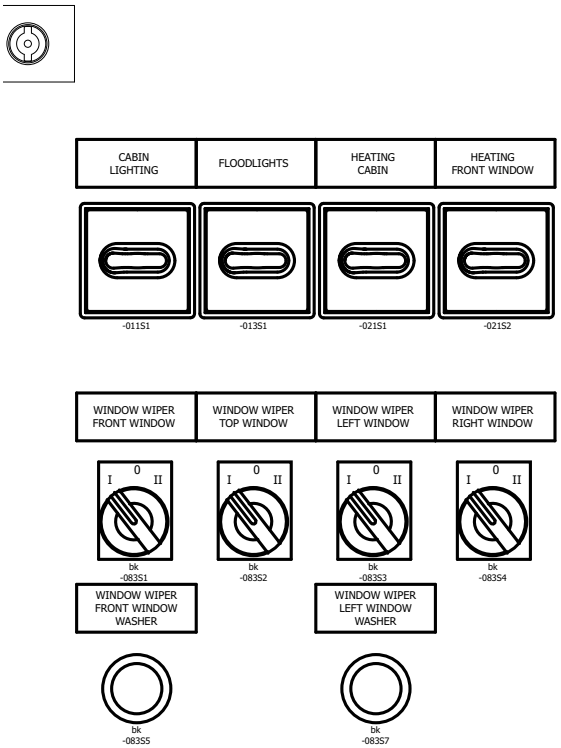


Figure 5-73: Cabin driver cabinet +D11 front

The cabin driver cabinet has the following controls and indicators on the front:

- Cabin lighting switch for control of the fluorescent lighting in the cabin,
- Flood lights switch for control of the flood lights on the boom and fly jib,
- Cabin heating switch for on / off control of the cabin heating. Once turned on the heating is controlled by thermostat placed in the cabin.
- Front window heating switch for on / off control of the front window heating.
- Window wiper control switches:

6 OPERATION

6.1 INTRODUCTION

This chapter describes the operation of the 300 mt Pedestal Mounted Crane following its functionality:

- Section 6.2: "Control system"
- Section 6.3: "Control location"
- Section 6.4: "Operating modes"
- Section 6.5: "Operation speed"
- Section 6.6: "SCADA"
- Section 6.7: "Operating procedures"
- Section 6.8: "System operations"
- Section 6.9: "General procedures"
- Section 6.10: "Emergency procedures"
- Section 6.11: "Troubleshooting"

It provides a general description of the control system and furthermore describes the procedures for operating the PMC.

6.2 CONTROL SYSTEM

All controls to operate the crane are located in the control cabin. The control cabin is accessible via the slew platform, and rotates along with the crane in the slewing movement.

The control system consists of the following parts:

- PLC including remote I/O units.
- Monitor system, gathers information from PLC and load protection system.
- Sensors and operator switches.

The control system performs the following tasks:

- Control of automatic functions, such as ventilation.
- Interlock of all limit switches, pressure switches, etc.
- Safeguarding the load conditions of the crane.
- Providing information to the crane operator regarding load conditions.
- Handling control signals from operator and transfer these to the different sub-systems.

6.3 CONTROL LOCATION

The PMC is operated through a number of switches, buttons and joysticks. The PMC is controlled primarily from the control cabin. All equipment for monitoring and operating the PMC is located in the control cabin.

The following control location and equipment is available:

- Main control panels in the control cabin.

The main control panels are the left- and right-hand operator console.



Figure 6-74: Operator chair with consoles and monitoring displays (typical)

SCADA is used for control of the subsystems, i.e. main hoist, whip hoist, boom hoist and tugger, to enter or change system parameters and perform maintenance/service activities. Sensors can be overruled or calibrated on the parameters page by persons with proper privileges. For a general explanation on the SCADA system. Specific SCADA screens are discussed in Section 6.3.4: "Operator display/SCADA interface" and SCADA user manual in Appendix B: "Reference documentation".

The layout and functionality of the main control panel in the control cabin is described in Section 6.3.2: "Left-hand console" and Section 6.3.3: "Right-hand console".

6.3.1 OPERATOR CHAIR

The crane operator chair is designed to provide an ergonomic seat. Therefore, the following adjustments can be made:

- **Weight adjustment:** The spring under the chair can be adjusted with a handle on the front side. Adjust this spring in such a way that the displayed weight is equal to the weight of the crane operator.
- **Horizontal adjustment chair:** The chair can be adjusted horizontally with respect to the consoles. Use the upper handle at the right side under the chair for this purpose.
- **Horizontal adjustment consoles**: The consoles can be adjusted with the lower handle at the right side under the chair.
- **Tilting lower part of seat:** This can be done with the button on the front side of the chair itself.
- **Adjustment back rest:** The angle of the back rest can be adjusted with the handle at the left side of the chair, near to the backrest.
- **Turning the chair:** To let the chair turn, push the handle at the front side of the chair by foot.

CAUTION



Do not adjust the pre-adjusted turn-angle, because this can lead to damage of the cables in the chair.

The operator chair is provided with controls to adjust the back-rest, the seat and the arm rests The two operating consoles are built into the arm rests and will be discussed in the sections below.

6.3.2 LEFT-HAND CONSOLE

The left-hand console contains the following controls:

- Emergency stop/reset
- System on/off
- Deck speaker
- Alarm buzzer
- Slewing/boom hoist joystick
- Alarm acknowledge (on joystick)
- Slewing/boom hoist high speed request (on joystick)

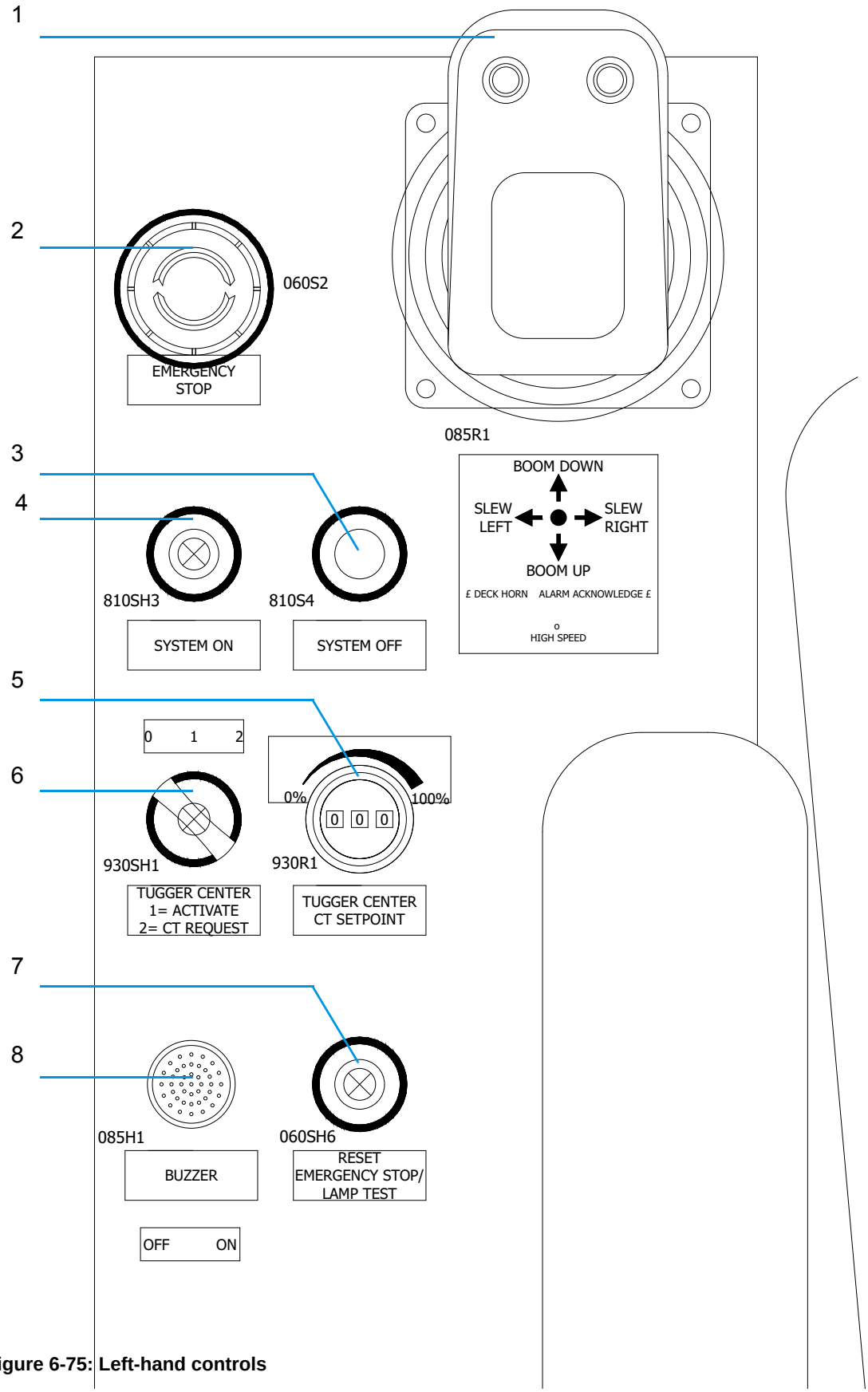


Figure 6-75: Left-hand controls

The left-hand console contains the following control parts :

#	Part name	Part description
1.	Left joystick	- X-axis: slew left/right. Push to the left to slew the crane Counter-Clock-Wise (CCW). Push to the right to slew the crane Clock-Wise (CW). - Y-axis: boom up/down. Push forward to boom down. Pull backward to boom up.

Table 6-26: Control parts of left-hand console

NOTE *The joysticks are proportional i.e. a small movement of the joystick results in a slow movement of the PMC and greater movement of the joystick will result in a faster movement.*

1	Left joystick buttons	On top of the joystick 2 spring return push buttons are: - Left = Deck Speaker. - Right = Alarm acknowledge. - Center = Requests high speed. High speed on each movement is only released if the load is below a fixed level, measured by the load cells. This procedure works automatically. As soon as the load level rises above the limits set in the software, the speed will be automatically reduced to nominal. Refer to the safety diagrams in Appendix B: "Reference documentation" for the load limits and the associated preset speed values for each PMC movement.
2	Emergency stop push buttons	One emergency stop push button is located on the left-hand operator console. This emergency stop button must only be used to stop the crane in case a dangerous situation occurs. The start-up procedure (Section 6.7.2: "Start-up procedure") will have to be carried out to restart the crane.
3	System Off	The control system will only react to a “System off” command when all joysticks are in neutral position and all brakes are applied.
4	System on	The operator must press the “System On” push-button and the start-up sequence begins. When the system has been started up correctly, the “System On” indicator light inside the push button lights up. The following sequence appears on the operator screen: - Yellow flashing -> starting. - Yellow continuously -> standby. - Green continuously -> operational. - Red flashing -> stopping.
5	Tugger Center Setpoint	Tugger center constant torque setpoint dial [0 -100%]
6	Tugger Center	This switch determines the operation mode of the tugger winch. - Position 0: Tugger not active (both speed mode and CT mode are not active). - Position 1: Tugger in speed mode. - Position 2: Tugger in Constant Torque (CT) request.

NOTE *The main pump can also be started from the electronics cabinet in the slew room. This can be useful for e.g. service or maintenance purposes.*
If the crane is started from the E-room, the system will get in standby mode, the “system on” button in the cabin has to be pressed, to make the controls operational

7	Reset emergency stop/ lamp test	Resets the emergency stop circuit and tests all lit-indicators inside the cabin, also the buzzer is activated. First unlock the emergency push stop button by turning, until it changes back into the neutral position. After reset, the system has to be restarted.
8	Buzzer	The buzzer will be activated every time a new message is being generated, such as an operator failure or system failure. For more information on buzzer activating situation, see SCADA user manual in Appendix B: "Reference documentation".

6.3.3 RIGHT-HAND CONSOLE

The right-hand console contains the following controls:

- Main hoist/whip hoist selection switch.
- Boom parking mode selection button.
- Constant tension whip hoist disable/enable
- Deck horn button (on joystick)
- Whip activate CT button (on joystick).
- Main hoist/ whip hoist high speed request (on joystick).

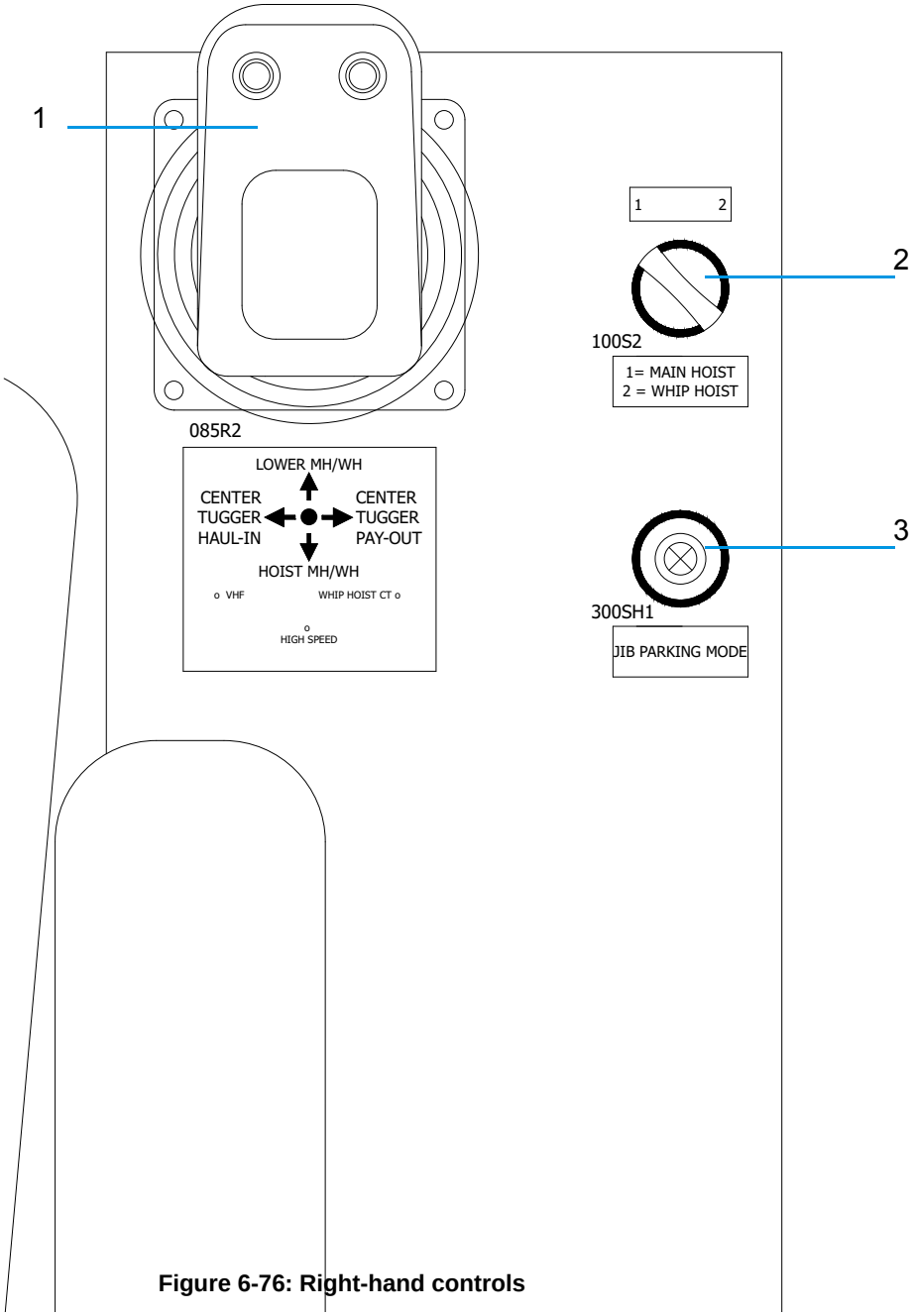


Figure 6-76: Right-hand controls

The right-hand console contains the following control parts:

#	Part name	Part description
1	Right joystick	- X-axis: tugger haul-in/pay-out. Push to the left to haul-in the tugger. Push to the right to pay-out the tugger. - Y-axis: hoisting/lowering. Push forward to lower main hoist/whip hoist. Pull backward to hoist main hoist/whip hoist. Proportional joystick that controls either the main or whip hoist according to the position selected in the “Main/whip. control switch”.

Table 6-27: Control parts of right-hand console

NOTE *The joysticks are proportional i.e. a small movement of the joystick results in a slow movement of the PMC and greater movement of the joystick will result in a faster movement.*

1	Right joystick buttons	On top of the joystick three spring return push buttons are provided: - Top right = Activate CT hoist on whip hoist (see Section 6.3.3.1: "Whip Constant Tension hoist"). - Top left = This activates the VHF and allows the operator to use the VHF without removing his hands from the joystick. - Center = Requests high speed for main hoist/whip hoist. High speed on each movement is only released if the load is below a fixed level, measured by the load cells. This procedure works automatically. As soon as the load level rises above the limits set in the software, the speed will be automatically reduced to nominal. Refer to the safety diagrams in Appendix B: "Reference documentation" for the load limits and the associated preset speed values for each PMC movement.
2	Main hoist/ whip hoist	Switch on the console to select main or whip hoist on the joystick control. Selecting another hoist can only be done if the joystick is at neutral position without input and all brakes are applied. Not following this sequence will result in an invalid command and the previous selection will stay active.
3	JIB Parking mode	Push this button to activate boom parking mode. For more information on parking mode, see Section 6.8.4.4: "Boom hoist".

6.3.3.1 Whip Constant Tension hoist

Constant Tension (CT) is used to hold a constant tension on the hoist wire, in order to pre-tension the wire prior to lifting the load. This is very useful when lifting the load from another moving object such as a supply boat or barge, or from the seabed. Without constant tension, it is very difficult to prevent the load from bumping back onto the supply boat during the next wave after the load has been lifted.

The following conditions apply to CT:

- On the whip hoist, the load must be at least 10 mt and not more than 12 mt in order to activate CT.
- The CT has a fixed setting equivalent to 100 bar at the hoist side (equivalent to 10 mt).

To prevent accidents, CT cannot be applied when the load is already being lifted.

Whip hoist winch (CT request)

On this crane, CT mode is implemented on the whip hoist. The whip hoist will go into CT request mode when the whip hoist is selected and the button “whip hoist CT”, left on the main hoist/whip hoist joystick is pushed. The whip hoist CT system has a fixed set point. SCADA will, by means of instructions, guide the operator to the proper set point. The CT mode is not activated until the joystick is moved through the CT set point. The status of the CT mode is indicated on SCADA.

NOTE *CT can only be activated if the load is between 10 and 12 mt and the pressure on the hoist side crosses the fixed CT pressure set point. The CT has a fixed setting equivalent to 100 bar at the hoist side (equivalent to 10 mt).*

The maximum pressure will then be reduced to a fixed value which cannot be adjusted by the operator. When the “Whip hoist CT” button is pushed, and activated the winch will start hoisting, until the maximum CT value is reached. If the load increases due to movements of the boom or vessel, the winch will start paying out. As soon as the button is released again, the winch will start hoisting in high speed for about 1 meter. From that moment onwards, it will be directly under control of the joystick (speed control). This means that a direct changeover from CT to speed control is possible. The correct moment to do this is when the actual speed is approximately the same as the desired speed.

6.3.3.2 Pedals

One pedal is available for the crane operator, see Figure 6-77. Table 6-28 gives an overview of the pedal functions.

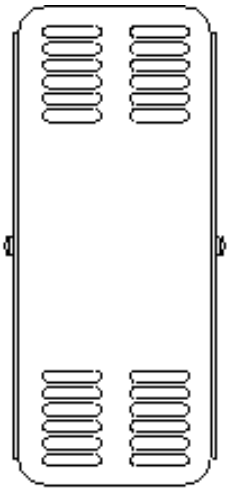


Figure 6-77: Foot pedal

Pedal	Function
---	Haul in /pay out load tugger

Table 6-28: Pedal function

6.3.4 OPERATOR DISPLAY/SCADA INTERFACE

A computer panel with a SCADA application (Supervisory Control And Data Acquisition) is located near the operator chair. With SCADA is possible to visualize data, statuses, measurements and alarms. This enables the operator to monitor actual loads, etc., and better coordinate his actions to control the PMC. For more information, see Section 6.6: "SCADA".

6.3.5 REMOTE CONTROL

If a problem can not be solved by the maintenance staff on board of the vessel, Huisman engineers can assist in troubleshooting by remote access to the PLC system of the crane. Once the maintenance staff has connected the PLC by means of a modem to a satellite phone line, a Huisman engineer is able to connect the PLC of the PMC to a diagnostic computer system. If required, the engineer may overrule the failure cause temporarily in expectation of a lasting solution by downloading a special software version into the PLC. In case assistance by one of our service-engineers might be required, the service engineer can be instructed about corrective actions to be taken in advance.

NOTE *Satellite telephone equipment is not supplied by Huisman.*

6.3.6 OTHER FACILITIES

6.3.6.1 Window wipers control panel

Control panel for the window wipers of the control cabin. See Exalto supplier documentation for more information.

6.3.6.2 Deck alarm

The deck horn is meant to warn personnel on deck. It is activated by means of the upper red button on the front of the right joystick.

6.3.6.3 Cabin light

There is a switch control on and off of the light inside the cabin.

6.3.6.4 Thermostat cabin heater and cabin fans

There are switches control on and off of the cabin heating and fans. The fans are located behind the heating element and provide a hot airflow to the front window in order to keep it free of condensate.

6.3.6.5 Cabin air conditioner

For instructions on how to operate the air conditioning unit inside the cabin, see supplier documentation.

6.3.6.6 Camera system

The camera serves to provide the operator with a view on the winches while operating the crane. The camera system is not provided with any supplemental operating options (e.g. pan, tilt, zoom). The camera has its own power supply in the cabin. For detailed information on the camera, see Teleconnect supplier documentation.

6.3.6.7 Boom floodlights

The floodlights along the boom section are connected to the switch on the control cabin cabinet.

6.3.6.8 Aircraft obstruction lights

The aircraft obstruction lights at the boom head and on the crane house can only be switched on and off with circuit breaker in the power and electronics cabinet (+C12).

NOTE	*It is strongly advised to leave these lights always on!*

6.4 OPERATING MODES

The cane can only be operated in manual mode. In manual mode, each piece of equipment is controlled individually and all safety interlocks are active. The operator moves the equipment with the joysticks in the operator chair.

6.5 OPERATION SPEED

The crane movement speeds are automatically limited depending on hook load, operating mode, position limits and other variables.

The maximum speed for a movement is determined by the PLC depending on the current SWL and hook load. The operator can vary the actual speed with the joystick. For the maximum speeds for each movement, refer to 2.4 Technical Specification p.26 .

6.5.1 REDUCED SPEED

Reduced speed is automatically selected by the control system. Reduced speed varies per movement and is less than nominal. A safe speed before the end position is guaranteed by the automatic reduced speed selection. Reduced speed is applicable in pre-conditions like pre-highest position, pre-empty drum and more.

6.5.2 NOMINAL SPEED

At nominal speed the applicable movement can perform at maximum torque. Nominal speed varies per movement and is between reduced and high speed. Nominal speed mainly depends on the motor characteristics. The control system will select nominal speed based on measured hook-load or position related interlocks.

6.5.3 HIGH SPEED

High speed is above nominal speed. At this speed the applicable movement can not perform at maximum torque. The available torque is decreased with a decreased stroke volume of the hydro motor. The hydro motor with a decreased stroke volume can rotate faster with the same hydraulic force provided by the pump.

If one or more of the conditions, required for activation of high speed mode no longer apply (e.g. if the maximum allowed load is exceeded), the control system will switch back to nominal speed mode automatically.

High speed is only allowed when the following conditions are met:

- No pressure failures are active.
- Main motor from HPU has no failure.
- The crane’s overload protection system is not overruled.
- The load from the movement is below the high speed load limit.

6.5.4 PARKING SPEED

Parking speed is the speed in which the crane can be lowered into the boom rest. To activate the parking speed, the “Parking mode” button on the right-hand console needs to be pressed.

6.6 SCADA

SCADA (Supervisory Control And Data Acquisition) is a control system to monitor and coordinate the actions to be taken to control the crane. The SCADA system is used to enter parameters and commands. It provides logging and trending capability to store process values over a period in time. SCADA includes operational and maintenance pages for all subsystems, as well as various alarm pages and general pages. The status of the control system can also be shown.

See Appendix B: "Reference documentation" for information about SCADA.

SCADA starts automatically when the respective PC is started and can only be shut down (utilities menu) by users with administrator access level.

The operational pages are discussed per subsystem. In this section, the following screens will be described:

- Section 6.6.1: "Operations screen"
- Section 6.6.2: "Detail screen"
- Section 6.6.3: "Additional screens"

NOTE *The values in the displayed SCADA screens are examples.*

6.6.1 OPERATIONS SCREEN

To access the operations screen (see Figure 6-78), push the “OPERATIONS” button.

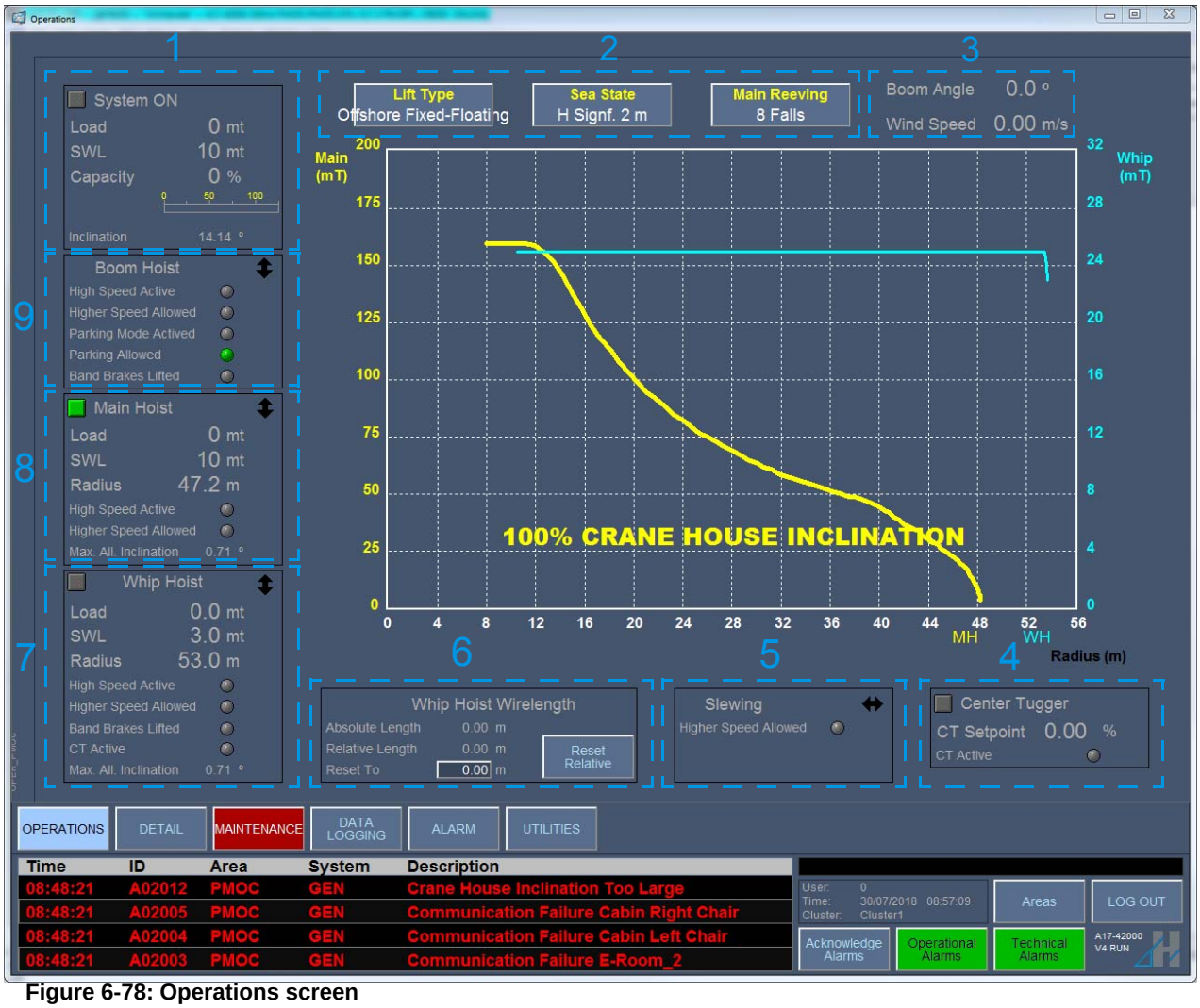


Figure 6-78: Operations screen

6.6.1.1 Information

The operations screen shows the following information;

Nr.	Field	Options
1.	Crane	Information displayed on crane: - System ON [indicator [1]] - Load [mt] - SWL - Capacity [%] - Inclination [°]
2.	PMC setup	Options for: - Selecting lift type (offshore/ fixed/ floating) - Selecting the sea state for Significant wave height (Hsig)[2] - Selecting reeving selection, the number of falls

Table 6-29: Operations screen

Nr.	Field	Options
3.	Boom angle	Information displayed on: - Boom angle[°] - Wind speed [m/s]
4.	Center tugger	For the tugger, the following information is displayed: - Center tugger active [indicator [1]] - CT set point [%] - CT active [indicator]
5.	Slewing	Indicators show: - Movement, CCW and CW slewing allowed [arrow[4] indicator] - Higher speed allowed
6.	Whip hoist wire length	Information displayed on: - Absolute length [m]. - Relative length [m]. - Reset to [field for new value, m] Button: - Reset relative wire length. - See Section 6.6.2: "Detail screen" for more information
7.	Whip hoist	Information displayed on: - Whip hoist active [indicator [1]] - Movement [arrow[4] indicator] hoist/ lower - Load [mt] - SWL [mt] - Radius [m] - High speed active [indicator] - Higher speed allowed [indicator] - Band brake lifted status [indicator] - Drum speed [rpm] - CT active [indicator - Maximum allowed inclination [°]
8.	Main hoist	Information displayed on: - Main hoist active [indicator [1]] - Movement [arrow indicator] hoist/ lower - Load [mt] - SWL [mt] - Radius [m] - High speed active [indicator] - Higher speed allowed [indicator] - Maximum allowed inclination [°]
9.	Boom hoist	Indicators show: - Movement [arrow indicator] up/ down - High speed active - Higher speed allowed - Parking mode active - Parking allowed - Band brake lifted

Table 6-29: Operations screen

4When an indicator is lit, the state of the status is true, e.g. when system on indicator is lit, the system is on. When the indicator is not lit, the state of the status is not true, e.g. when band brakes lifted indicator is not lit, the band brake is not lifted but applied.

5Selecting the sea state, i.e. 0.5 m (1.7 ft), 1 m (3.3 ft), 1.5 m (5.0 ft), 2 m (6.7 ft).

6Boom is also called jib.

7When the arrow is lit green, moving with nominal speed is allowed. When the arrow is lit yellow, moving with reduced speed is allowed.

Capacities

For movements without a load curve the actual used load capacity is displayed by means of a numeric relative value in [%] and a bar graph under the load curve. The load capacity is shortly called the capacity.

The load capacity = the actual load / SWL* 100%.

Load curves

For some movements the current Safe Working Load (SWL) depends on the current radius of the hoist. The relation between the radius and the SWL is visualized in a load curve. See for more information the load charts and load curves in Appendix B: "Reference documentation".

6.6.1.2 Touch buttons - PMC setup

The touch buttons are for the PMC setup which are provided in the operation screen. After a restart, the correct setup of the PMC and the hoist conditions must be re-selected.

At the top of the screen the correct setup of the PMC and the hoist conditions must be selected .

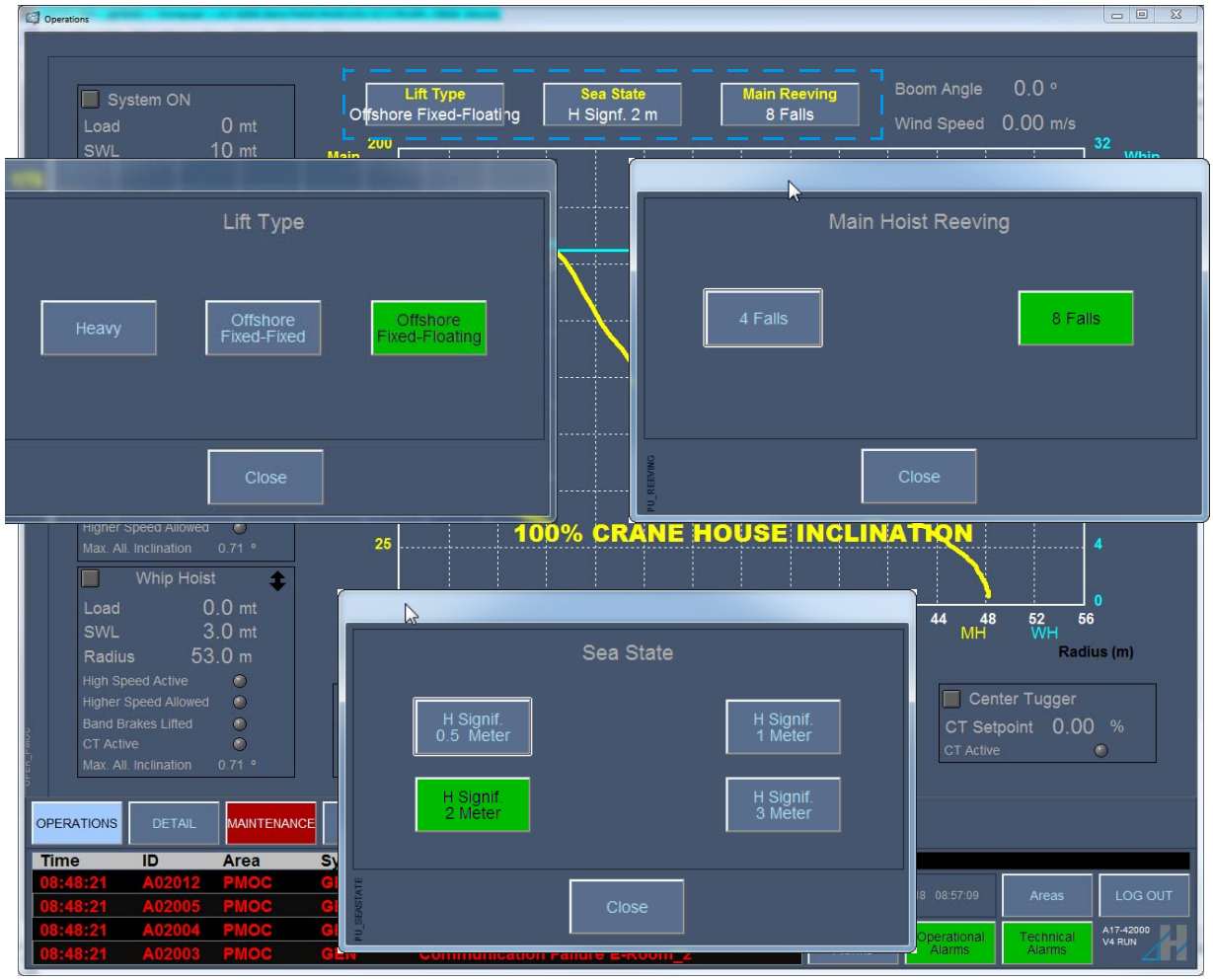


Figure 6-79: PMC setup

Lift types

Three lift types are possible for this PMC:

Heavy lift:	A lift in sheltered waters without vessel motion due to waves, significant wave height is ignored.
Offshore Fixed-Fixed	A lift to or from the fixed vessel to a fixed object .
Offshore Fixed-Floating	A lift to or from the fixed vessel to a floating object

NOTE *If a lift type is not allowed to set, the button is not disabled.*

Sea state

Sea conditions are set and displayed in sea state categories, quantified in significant wave height (Hsig). If a sea state is not allowed to set, the button is not displayed. A button will be green when that mode is selected. Selecting an other mode will de-select the former selection.

NOTE *Inclination too large alarm will influence movements.*

Reeving

The main hoist can be reeved in 4 or 8 falls. In this pop up screen the operator indicates a reeving preference. The SWL curve of the main hoist depends on the reeving of the main hoist lower block.

CAUTION



Set the reeving configuration correctly on SCADA, otherwise, the system might be damaged, i.e. due to the incorrect highest position geared cam limit *switch selection or an incorrect SWL.*

6.6.2 DETAIL SCREEN

To access the detail screen, press the “Detail” button on the operations screen see Figure 6-78 p.157.

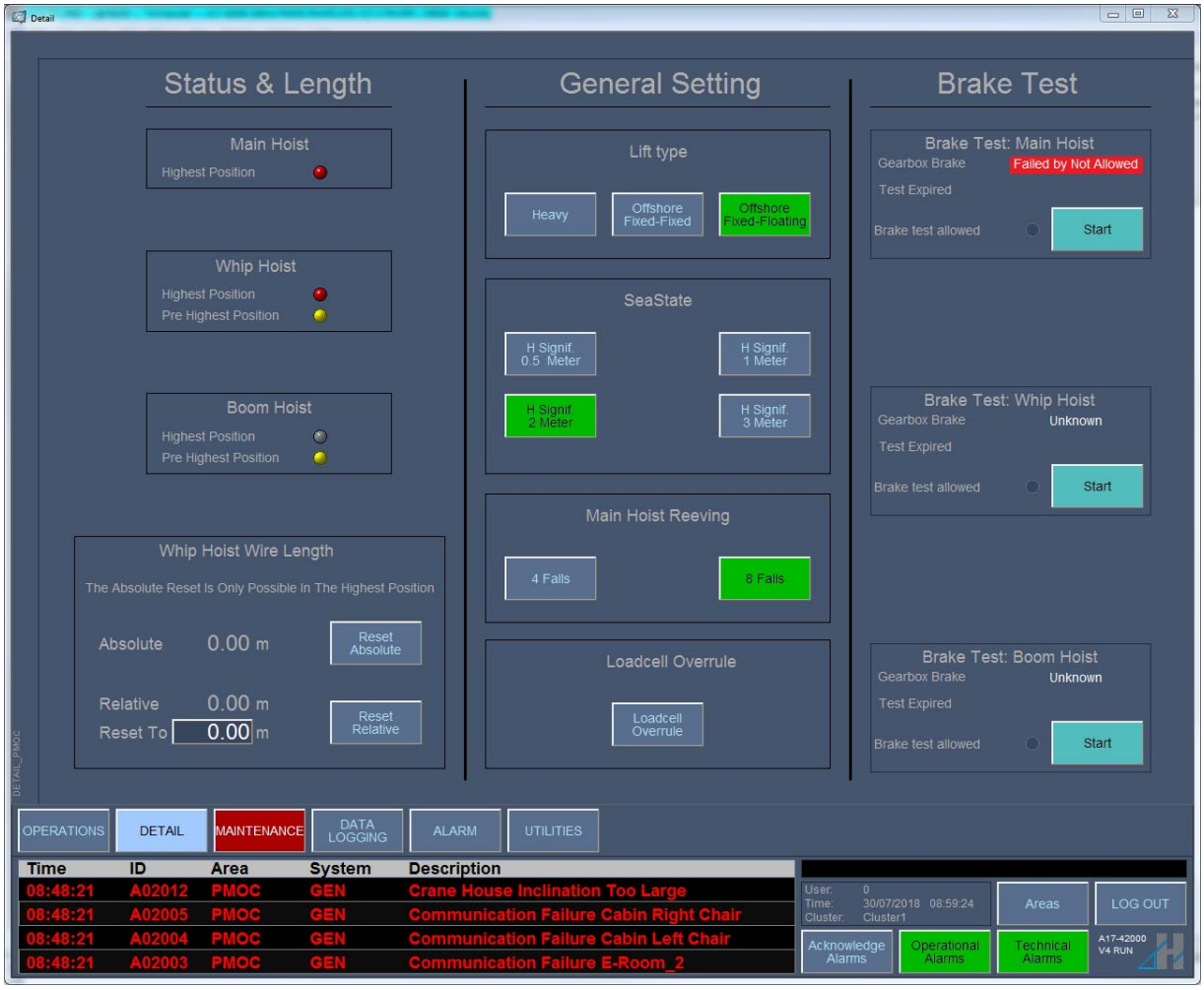


Figure 6-80: Detail screen

6.6.2.1 Information

The detail screen shows the following information:

Fields	Information	Description
Status & Length	Information displayed on: - Main hoist: • Highest position [indicator] - Whip hoist: • Highest position [indicator] • Pre highest position [indicator] - Boom hoist: • Highest position [indicator] • Pre highest position [indicator - Whip hoist wire length: • Absolute [m] • Relative [m] • Reset to [dialogue box] • Reset absolute [button] • Reset relative [button]	- When highest position indicator is lit red, hoisting movement is stopped. - When pre highest position indicator is lit yellow, hoisting movement limited to a reduced speed. - The whip hoist absolute wire length reset is only possible in the highest position and only to zero. - The whip hoist relative wire length reset can be done at any hoisting range. The value can be set to the length typed in the “reset to” dialogue box.
General settings	Buttons: - Lift type: • Heavy • Offshore Fixed-Fixed • Offshore Fixed-Floating - Sea state selection: • 0.5 [m] (1.7 ft) • 1 [m] (3.3 ft) • 2 [m] (6.7 ft) • 3 [m] (10 ft) - Main hoist reeving: • 4 falls • 8 falls - Loadcell overrule • Loadcell overrule [button]	
Brake test	Information displayed on: - Brake test main hoist: • Gearbox brake status [display] • Test expired [display - day] or Holding brake remain [second] • Brake test allowed [indicator] • Start [button] - Brake test whip hoist: • Gearbox brake status [display] • Test expired [display - day] or Holding brake remain [second] • Brake test allowed [indicator] • Start [button] - Brake test boom hoist: • Gearbox brake status [display] • Test expired [display - day] or Holding brake remain [second] • Brake test allowed [indicator] • Start [button]	- The gearbox brakes have to be tested once in one month. The days remaining before the next brake test is shown in the test expired display. - Brake status: unknown (the initial state), test in progress (brake test has started), hold brake (brake test in progress), wait for confirmation (wait for user to confirm whether brake is holding or slipping), brake test failed, brake test passed. For the brake test procedure please see 6.7.5 Brake test p.166.

Table 6-30: Detail screen

6.6.3 ADDITIONAL SCREENS

For the following screens see the huisman SCADA manual in Appendix B: "Reference documentation":

- Maintenance screen.
- Alarm screen.
- Data logging screen.
- Utilities screen.

6.7 OPERATING PROCEDURES

CAUTION



Before taking the crane into operation, verify that the gearboxes are filled with oil!

The PMC is operational when the following conditions are met:

- The E-room remote I/O unit is OK.
- Emergency stop relay is OK.
- Crane configuration is confirmed.

6.7.1 PRE-START CHECKS

To start up the crane, the HPU has to be started first. This can be done in either the e-room or the cabin. During its start procedure, the “system on” indicator in the cabin and the “HPU running” indicator (local cabinet) starts blinking. If the HPU is running, the indicator on the local cabinet light up continuously.

The “system on” indicator in SCADA blinks yellow when the HPU is starting, and lights up continuously (green) if the HPU is running and the crane is operational. If the HPU is not started from the cabin, the “system on” indicator on SCADA remains yellow. To activate the controls, it is necessary to press the “system on” button on the chair.

When the HPU stops, both the “system on” indicator and “HPU start” indicator turned off. The “system on” indicator on SCADA flashes red, until the HPU has fully stopped.

Before start-up, make sure that:

- The oil level in gearboxes is OK.
- No one is present in the immediate vicinity of the winches and the crane.
- The drums can rotate freely (without obstruction).
- The slewing gears are free of foreign objects and well greased.
- The crane can slew without obstruction.
- The hooks can be lifted freely (check before every lifting operation).
- The ventilation grids in the crane house and pedestal are open.
- The rain protection cover used to cover the hole for the boom hoist position switch is removed.
- 400 VAC, 230 VAC, 24 VDC and 24 VDC UPS are available.
- All emergency stops are deactivated.
- The joysticks are in neutral position.
- “Load cell overrule mode” is not activated.
- All operating settings are as required, especially the selections for wave height and reeving.
- All alarms and invalid commands are cleared.

6.7.2 START-UP PROCEDURE

The PMC is starting allowed when the following conditions are met:

- The PMC is operational.
- No command is active.
- No load curve parameter failure active.
- All brakes are applied.

The start-up procedure is as the following:

1. Check the monitor for alarms and status of the system.
2. Pull out emergency stop button(s) (see Figure 5-70 p.130 for locations).
3. If the screen displays “Emergency stop active”, push the “Reset emergency stop” button.
4. Push “System on” button.
5. Wait a few seconds, to enable the system to start-up (yellow indicator is blinking).
6. Push “Alarm acknowledge” button if the display shows non-acknowledged faults.

   At this point the crane is ready for operation. The green “System on” indicator is lit continuously to indicate that the system is ready and the start-up sequence has been completed. The system is on when the HPU is running (see 6.8.3 HPU operation p.170).

6.7.3 EMERGENCY STOP PROCEDURE

Applying one of the emergency stop buttons will cause immediate braking and shutdown of the crane and HPU. In case of a dangerous situation anywhere in or around the crane, or if the operator is no longer able to control the crane, the crane has to be stopped as soon as possible. The procedure is:

1. Push the emergency stop button.

This will cause an immediate braking and shutdown of the crane.

6.7.4 SHUT-DOWN PROCEDURE

The PMC can be switched off if any of the following condition is met:

- All brakes are applied.
- HPU is not running.
- Emergency stop is active.
- No movements are active.

The shut-down procedure is as the following:

1. Bring the crane into a safe position, e.g. boom rest.
2. Stop all movements.
3. Press the “System off” button (Figure 6-75 p.146).

6.7.5 BRAKE TEST

The brakes need to be tested once a month or after executing emergency stop.

If the brake test has expired a warning is given on SCADA and before the next lifting operation the brakes are to be tested. After an emergency stop a warning is given and the load is to be lowered into a safe position after which a successful brake test is to be performed before operations can continue.

The following requirements need to be met before the brake test for the specific gearbox brake:

- **Main hoist gearbox brake:**
  The hook is below pre-highest position.
- **Whip hoist gearbox brake:**
  The hook is below pre-highest position.
- **Boom hoist gearbox brake:**
  Boom angle is between 40^{o} and 50^{o}. Main hoist hook and whip hoist hook are in the air.

NOTE *The brake test ends automatically if pre-empty drum situation occurs.*

Procedures

1. Push the “Start” button in the specific gearbox brake test field on “Detail” SCADA screen when the brake test is allowed.
2. Select if the brake is holding/slipping in the step 1/2 popup window and confirm the selection by pressing the “Confirm” button (see Figure 6-81 p.167).

   The employee placed near the specific drum has to inform the employ in the control cabin if the drum is moving: not moving: brake holding, moving: brake slipping.
3. If brake is holding confirmed, the corresponding hoist is actuated in hoisting direction for about 20 seconds.
4. Select if the brake is holding/slipping in the step 2/2 popup window and confirm the selection by pressing the “Confirm” button (see Figure 6-82 p.167).

In case of movement of the drum:

- The brake test is to be considered as failed.
- The employee detecting movement needs to actuate an emergency stop button. After which, the brakes are re-applied, The pump displacement is set to zero, and the pumps are stopped.
- Check with a pressure gauge at measuring point (MGB) for residual pressure in the gearbox brake cylinder what might cause the brake to be partially lifted.
- Consult the supplier documentation for detailed maintenance information.

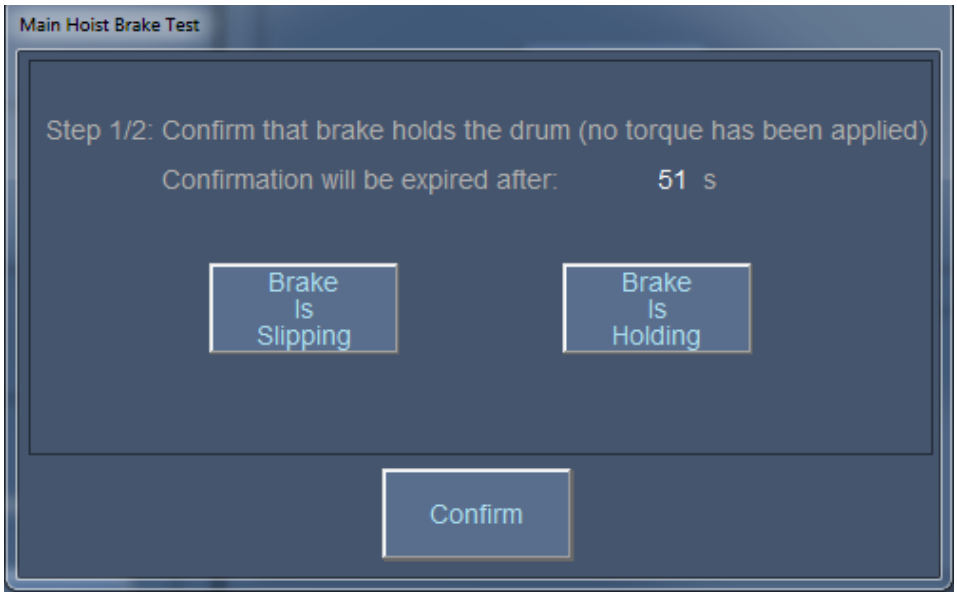


Figure 6-81: Brake test 1/2 popup windon

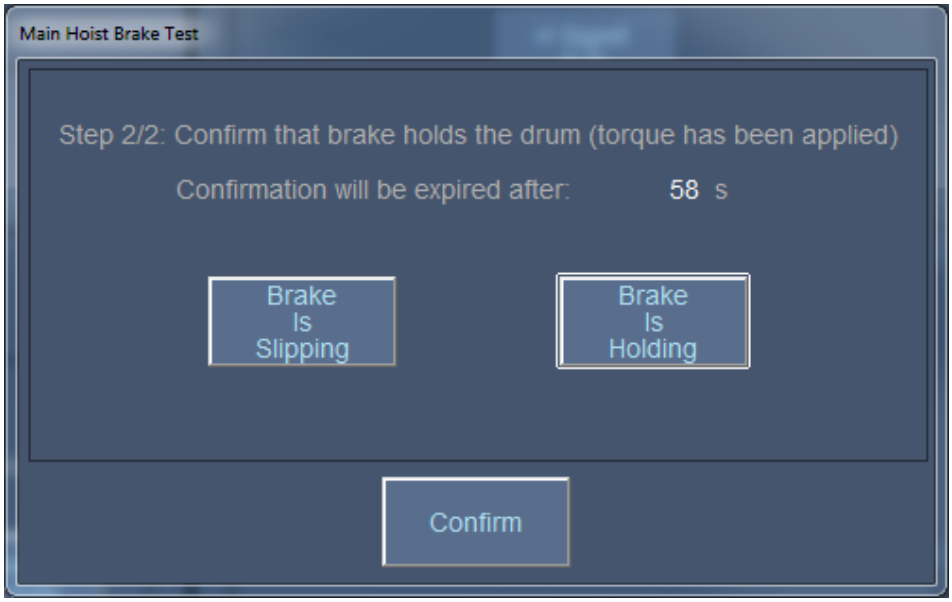


Figure 6-82: Brake test 2/2 popup window

6.8 SYSTEM OPERATIONS

6.8.1 NORMAL OPERATION

When the crane has been taken into use, it is best to leave the main switch on the power cabinet (slew room) always in the ON position because the oil tank heating is connected to it. The crane can be controlled entirely from the crane cabin. The start/stop buttons for the main pump inside the crane house lower section can be used during testing, maintenance or repair.

WARNING



Emergency stop button use
Do NOT use the emergency stop button to deactivate the crane in regular use!
The filter pump, heating and cooling will be deactivated.
After resetting the emergency stop; startup HPU or HPU filter pump, the cooling and heating functions will be activated.

6.8.2 OVERLOAD PROTECTION SYSTEM

For each setup of the crane, a specific load curve is applicable and visible on the SCADA screen. The load curves shown are based on the values for Hsig. The current value for Hsig must be entered in the main SCADA screen by the operator.

The overload protection system prevents the PMC from being loaded beyond the maximum capacity. The overload protection system incorporates the main hoist LMPs, whip hoist LMP, inclinometer and PLC. The LMPs measure the load acting on the hoist wire. The inclinometer measures the boom angle relative to the horizontal. The combined data of these measuring devices are used to calculate the Safe Working Load (SWL) of the PMC. See Table 6-31.

Overload situation MH	Lift type	Motions					SCADA display	Continuous audible and visible alarm
		Slewing	Boom lifting	Boom lowering	Hoist lifting	Hoist lowering		
$F_{average}$ = 90% SWL	Heavy Lift	Allow					90% SWL	in cabin
	Offshore lift Fixed – Fixed & Fixed – Floating	Allow						
$F_{average}$ = 110% SWL	Heavy Lift	Stop				Allow	110% SWL	in cabin and on deck
	Offshore lift Fixed – Fixed & Fixed – Floating	Stop				Allow		
F = 90% DWL	Offshore lift Fixed – Fixed & Fixed – Floating	Allow					90% DWL	in cabin
F = 110% DWL	Offshore lift Fixed – Fixed & Fixed – Floating	Allow					110% DWL	in cabin and on deck

Table 6-31: Main hoist overload protection table

Overload situation WH	Lift type	Motions					SCADA display	Continuous audible and visible alarm
		Slewing	Boom lifting	Boom lowering	Hoist lifting	Hoist lowering		
$F_{average}$ = 90% SWL	Offshore lift Fixed – Floating	Allow					90% SWL	in cabin
$F_{average}$ = 110% SWL	Offshore lift Fixed – Floating	Stop				Allow	110% SWL	in cabin and on deck
F = 90% DWL	Offshore lift Fixed – Floating	Allow					90% DWL	in cabin
F = 110% DWL	Offshore lift Fixed – Floating	Allow					110% DWL	in cabin and on deck

Table 6-32: Whip hoist overload protection table

Where:

- F :is the measured hook load of the equipment [mt]
- $F_{average}$:Average load during 5 [sec]. The introduction of $F_{average}$ avoids superfluous alarms. $F_{average}$; it is just a delay;
- SWL safe: Working Load [mt] of the equipment
- DWL: Dynamic Working Limit [t] is the factored design load of the equipment. DWL= SWL x F_{dyn}.

WARNING



"Do not use the "disable overload protection" unless absolutely necessary. Do so only with full knowledge of the possible consequences!

The crane's overload protection system can be temporarily overruled by the switch "Overload protection" on the left-hand console, see 6.3.2 Left-hand console p.145.

Load limits

The overload warnings and alarms are described in 6.3 Control location p.144.

Situation	Actions
Load is over 110% SWL	An overload alarm is activated. For main hoist and whip hoist, hoisting is not allowed while lowering is still possible. The boom hoist movement up or down is stopped by an overload alarm.

Table 6-33: Load limits

For a detailed description of the Load Measuring Pins, refer to Appendix B: "Reference documentation".

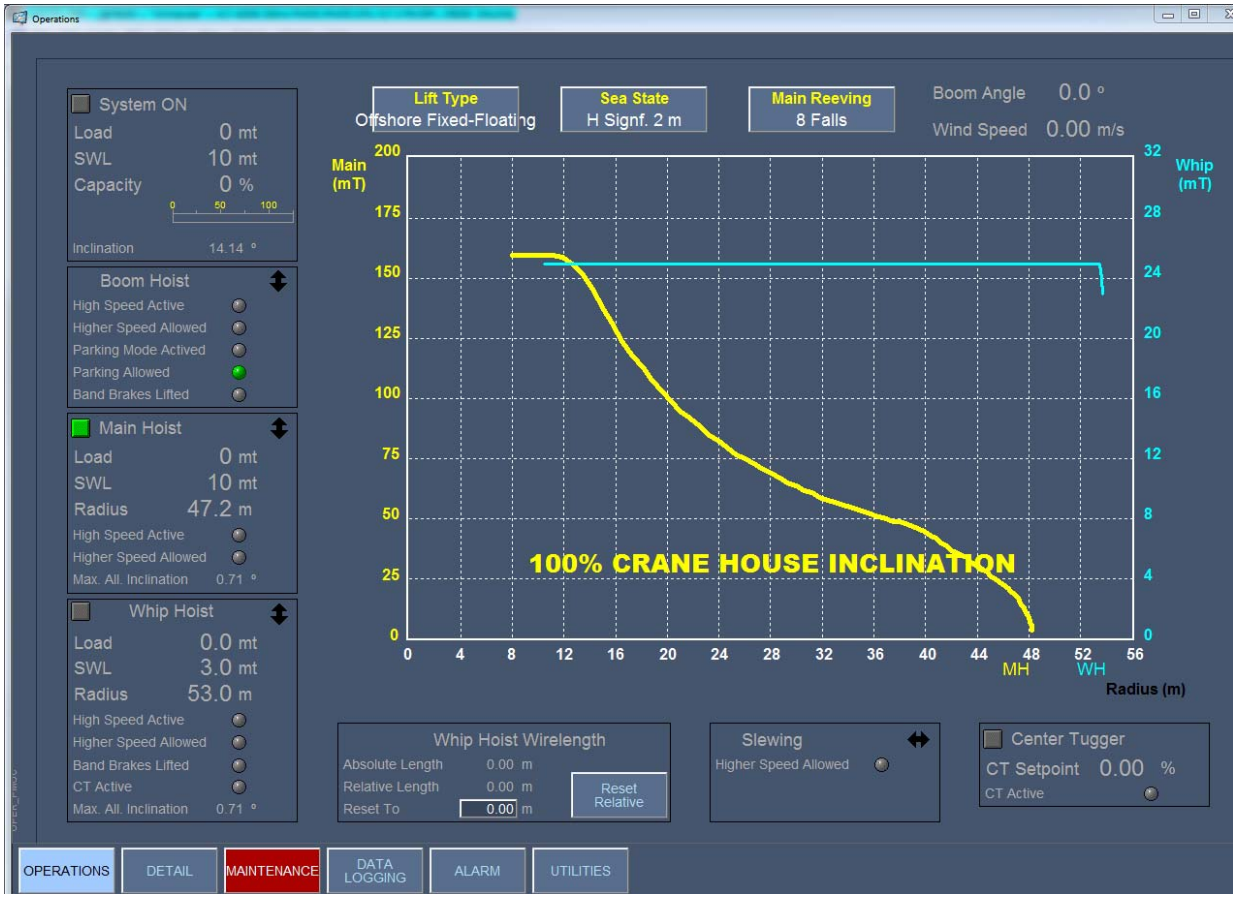


Figure 6-83: Load curve as displayed in SCADA.

6.8.3 HPU OPERATION

All winches of the crane are hydraulically powered. The HPU consists of a filter pump, boost pump and main motor. The electric motor driving the boost pump also drives the brake pressure pump. The main motor powers the main/ whip hoist pump, boom hoist pump, slew pump and tugger pump.

Running the HPU is only allowed when the following conditions are met:

- The PMC is operational.
- Suction valve must be open.
- No brake pressure sensor failures are active.
- No boost pressure sensor failures are active.
- No pilot pressure sensor failure are active.
- No main motor breaker trip alarm active.
- No boost pump failures (start or run failure) are active.
- No main pump failures (start or run failure) are active.
- No oil temperature alarms (low, high and sensor).

NOTE *If during a movement that the HPU is not detected running, all movements are direct stopped.*

6.8.3.1 HPU start sequence

HPU start sequence starts when the following conditions are met:

- Running HPU is allowed.
- PMC system on is allowed.
- System on button in cabin or “Start HPU” button in E-room is pressed.

Starting the HPU starts the boost pump and main motor in a sequence:

1. Boost pump starts.

   If boost pump is detect running in the start sequence, pilot pressure, brake enable, and boost enable valves are activated.

2. The main motor starts when the following conditions are met:

The main motor will be started via the start sequence when:

- Boost pressure > Low boost pressure limit (parameter between 16 and 22 bar. This parameter will be determined during commissioning.)
- Brake pressure > Low brake pressure limit (parameter between 27 and 30 bar. This parameter will be determined during commissioning.)
- Pilot pressure > Low pilot pressure limit (parameter between 45 and 70 bar. This parameter will be determined during commissioning.)

3. HPU is declared “running” after main motor is running 7 seconds.

6.8.3.2 HPU stop sequence

HPU stop sequence starts when any of the following conditions is met:

- PMC is stopping allowed.
- “System off” button in cabin or “Stop HPU” button in E-room is pressed.
- Main pump running is not allowed.
- Main pump is not running.
- Oil temperature becomes too low or too high.
- Oil temperature has a sensor failure.

Stopping the HPU stops the main motor and boost pump in a sequence.

1. HPU “running” indication is disappeared when stop sequence is started.
2. Main motor stops.

   If main motor and boost pump are no longer detected running in the stop sequence, pilot enable, brake enable and boost enable valve are deactivated.

NOTE	*If the oil temperature has a sensor failure, the HPU stops with its stop sequence. The boost pump keeps running if the oil temperature becomes too high.*

6.8.3.3 Filter pump

The filter pump is started with the “System on” button in the cabin or “Start HPU” button in the E-room, or individually by the “Start filter pump” button in the E-room.

The filter pump can only be started/running when the following condition is met:

- Running the HPU is allowed
- Oil level is not too low
- The breaker for the filter pump is not tripped

The filter pump will not be stopped on stopping the HPU. An alarm is generated if the filter pomp is not running during 15 minutes. Filter pump can be stopped by a push button in the E-room.

6.8.3.4 Boost pump

The boost pump can only be started by the HPU start sequence.

The boost pump can only be started/running when the following conditions are met:

- Running the HPU is allowed.
- Oil level is not too low.
- The suction valve is opened.
- The circuit breaker for the boost pump is not tripped.

The boost pump can only be stopped by the HPU stop sequence or when running is not allowed.

6.8.3.5 Main pump

The main motor can only be started by the HPU start sequence.

The main motor can only be stopped via the stop sequence or if any of the following occurs:

- Boost pump is not running.
- The breaker for the main motor is tripped.
- The main motor is overheated.

6.8.3.6 Cooling

The cooler fans should be started as soon as the HPU is running. The cooler fans will be stopped when:

- PMC is not operational.
- Oil temperature sensor failure occurs.
- System off, oil temperature below de-active cooler level and slew room temperature not high.

When the HPU is starting, stopping or running, the cooling must be:

- Switched on when the oil temperature is > 48°C.
- Switched off when the oil temperature is < 42°C.

If the HPU is stopped, the oil coolers will stop directly, except when:

- The oil temperature is high (> 65°C) or too high (> 70°C).
- E-room temperature exceeds a pre-defined value (value to be set on thermostat).

If the HPU is stopped and but the cooler fans are still running, the cooler fans will be turned off automatically after 5 minutes.

6.8.3.7 Heating

The HPU oil heating should be switched on when the oil temperature is low. The heating is stopped if:

- PMC not operational.
- Tank temperature sensor failure occurs.

The HPU oil heating will be started/stopped on temperature limits when HPU or filter pump is started:

- Heating is switched on when temperature is below 35°(parameter between 22 and 47°C, determined during commissioning).
- Heating is switched off when temperature is above 41°(parameter between 28 and 53°C, determined during commissioning).

6.8.4 HOIST SYSTEM OPERATIONS

The Winch is operational when all of the following conditions are met:

- The PMC is operational.
- HPU is running.
- Winch is selected (not applicable for boom hoist).

6.8.4.1 Main hoist and whip hoist

The main and whip hoists are both powered by the same pump and, therefore, cannot be used at the same time.

Load Measuring Pins (LMPs) measure the working load. Depending on the sea state, reeving and lift type, different load curves can be active. The SWL is represented by these load curves.

For information on the load curves, see Appendix B: "Reference documentation". The load curves are shown on the SCADA screen.

Switching

Switching between main and whip hoist is only allowed if the brakes of both systems have been applied for a predefined time (default: 3 sec).

If the selection switch is used when switching is not allowed, the hoist that was selected stays active, and an invalid command will appear. When allowed, it switches automatically.

The main hoist winch is operational when the following conditions are met:

- The E-room remote I/O unit is OK.
- Emergency stop relay is OK.
- Crane configuration is confirmed.
- HPU is running.
- Winch is selected.

When all conditions are ok and the speed set point ≠ 0, the PLC will enable the lifting of the brake.

Hoisting and lowering

When an interlock which prevented movement is reset, for instance a slack rope alarm, the joystick must have been in its neutral position after the reset and before a hoist of lower movement can start again.

To hoist/lower, use the right-hand joystick (see Figure 6-76 p.149).

Movement is not allowed in any of the following cases:

- System not operational.
- Joystick failure.
- Hydraulic system is not running.
- Corresponding hoist not selected.
- Corresponding hoist slack rope.
- Corresponding hoist slack rope sensor failure.
- Boom hoist slack rope.
- Boom hoist slack rope sensor failure.
- Winch pressure too low.
- Corresponding hoist s-curve parameter failure.
- Corresponding hoist pulsing failure.
- Corresponding hoist brake lift failure.
- Pressure sensor failure on hoist side.
- Power management system feedback not allowed to start..

Lowering is not allowed on an empty drum alarm. Lowering is possible with reduced speed on a pre-empty drum.

Hoisting is not allowed when the highest position of the selected hoist is detected.

Position limits

Activated switch	Message	Action
Empty drum	Alarm	Lowering movement stopped.
Pre-empty drum		Lowering movement limited to a reduced speed.
Highest position	Displayed on main screen	Hoisting movement is stopped. When operator gives a new move command, invalid command message appears.
Pre-highest position[1]	Displayed on main screen	Hoisting movement limited to a reduced speed.

Table 6-34: Position limits

[1] Not available for main hoist.

Speed modes

The main hoist and whip hoist feature three different speed modes:

- Reduced speed.
- Nominal speed.
- High speed.

The hydro motor powering the winch has a variable swash plate allowing a normal displacement and high displacement (higher rotation speed, less torque). High speed may be used when the following conditions are met:

- Normal operating pressures for all subsystems (lower than 350 bar).
- No pre-overload or overload in the selected hoist or LMP overrule active.
- Load under the SWL for high speed: default <80/<150 mt for 4/8 falls in the main hoist and <15 mt for the whip hoist.
- No main motor pre-overload.
- No boom hoist pressure sensor failure on hoisting side.

High speed mode can be selected with the high speed request button on the right-hand joystick if the higher speed available indicator is lit. If the high speed is active, the indicator on SCADA is lit (see Figure 6-84 p.175). High speed can be deactivated by pressing the high speed request button again.

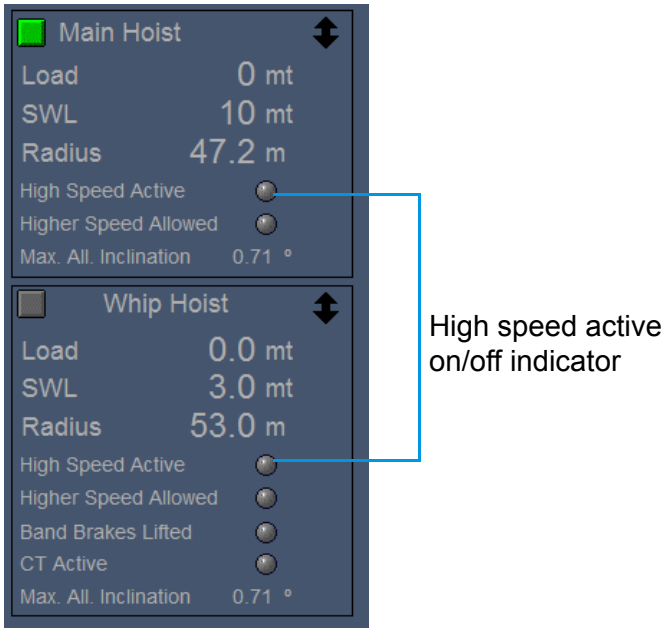


Figure 6-84: The high speed indicators

Reduced speed mode is automatically activated if the hoist is nearing its end position, which is the pre-empty drum or pre-highest position. The reduced speed of the winch is limited to 30% of the nominal speed.

If a reduced speed interlock falls away, the higher speed available indicator lights up. Nominal speed can than be activated with a high speed request. Nominal speed is automatically activated when the joystick is lower than, or moved to lower than the reduced speed limit. This to prevent the winch from suddenly speeding up when resetting an alarm.

6.8.4.2 Main hoist

Hoisting and lowering

- Check if the selection switch is in the “Main hoist” position (also visible on screen).
- Select the right number of falls, the right wave height (Hsig) and the right lift type (see Figure 6-79 p.159). If the combination of these parameters is not chosen correctly, an error message will be displayed over the load curve.

WARNING



The inclination values for the various lift types are to be observed! The maximum values are indicated in the general crane section on the SCADA main page. However, no actions being taken if these values are exceeded. It is therefore the operator’s responsibility to make sure the maximum values will not be exceeded.

- To lower the main hoist hook, push the right-hand joystick forwards.
- To hoist the main hoist hook, pull the right-hand joystick backwards.
- To activate “high speed”, push the center button on the right-hand joystick. Whether high speed is allowed, not allowed or already activated, they are displayed on the screen. High speed will be active until stopped by the control system. High speed can also be disabled by pushing the button again if more precise speed control is needed.
- The hoisting movement will be stopped when the hook reaches its highest position; only lowering is then possible. This is indicated as “Main hoist highest position” on the screen.
- The lowering movement will be stopped when there are only 5 windings left on the drum. This is indicated as “empty drum”.

6.8.4.3 Whip hoist

Hoisting and lowering

- Check if the selection switch is in the “whip hoist” position.
- Check if the right wave height (Hsig) and the right lift type are selected.
- To lower the whip hoist hook, push the right-hand joystick forwards.
- To hoist the whip hoist hook, push the right-hand joystick backwards.
- To activate “high speed”, push the button in center of front side of the joysticks. Whether high speed is allowed, not allowed or already activated is displayed in the screen; High speed will be active until stopped by the control system because of too much load.
- To activate CT, push the left button on the right-hand joystick.
- The hoisting movement will go into reduced speed when the hook reaches its pre-highest position, this is indicated as “whip hoist pre-highest position” on the screen.
- The hoisting movement will be stopped when the hook reaches its highest position, only lowering is then possible, this is indicated as “whip hoist highest position” on the screen.
- The lowering movement will be stopped when there are only 5 windings left on the drum, this is indicated as “empty drum”.

Whip hoist Constant Tension

CT can only activated if the load is between 10 and 12 mt, and the pressure on the hoist side crosses the fixed CT pressure set point.

CT is only allowed when:

- Movement allowed.
- Whip hoist LMP sensor is functioning.
- Normal hoisting and lowering is allowed.

Activation:

1. When CT is allowed and a CT request is given by pressing the left button on the right-hand joystick, the indicator on SCADA starts to blink (see Figure 6-85).

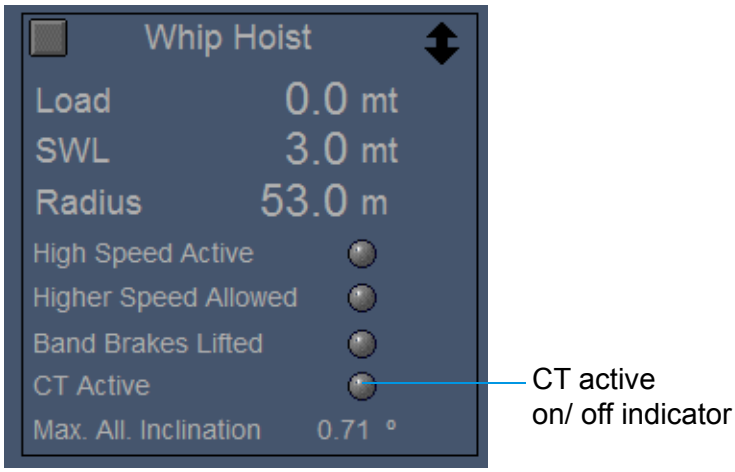


Figure 6-85: CT indicator operation screen

2. To activate CT, the joystick has to be moved to the CT set point.

If the actual pressure is too low, the pressure should be increased, by starting hoisting, this is indicated on SCADA by the message “GO UP”.

If the pressure is too high, the operator should lower the load, indicated by “GO DOWN”. If the CT set point is exceeded, CT mode automatically becomes active, and the indicator lights up green.

3. If CT is active, the joystick is ignored until the CT mode is disabled.

- Deactivation:

1. CT-mode can be deactivated at all times by the operator by pressing the “Whip hoist CT” the left button on right-hand joystick (Figure 6-76 p.149).

After disabling CT mode, the joystick set point becomes directly active. This means, that disabling the CT while the joystick is pulled backward, will hoist the load.

If CT mode is disabled by an interlock, the joystick must have been in its rest position to start the movement again.

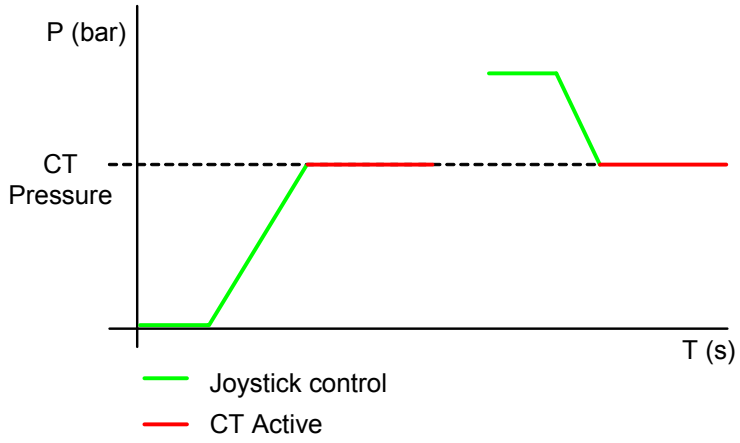


Figure 6-86: Whip hoist constant tension

Whip hoist wire length

The wire length of the whip hoist is measured. The wire length consists of two values: an absolute length and a relative length.

The absolute length is the length measured from its highest position, this position has to be calibrated regularly, as small deviations may occur. The absolute wire length can only be reset while the whip hoist is in its highest position. Whip hoist wire length calibration is started by pushing the button "whip hoist wire length calibration" on the detail page in SCADA 6.6.2 Detail screen p.161.

The relative wire length can be reset at any point between highest position and empty drum. The relative length can be reset both at the main and detail page.

Resetting the absolute wire length will also reset the relative wire length.

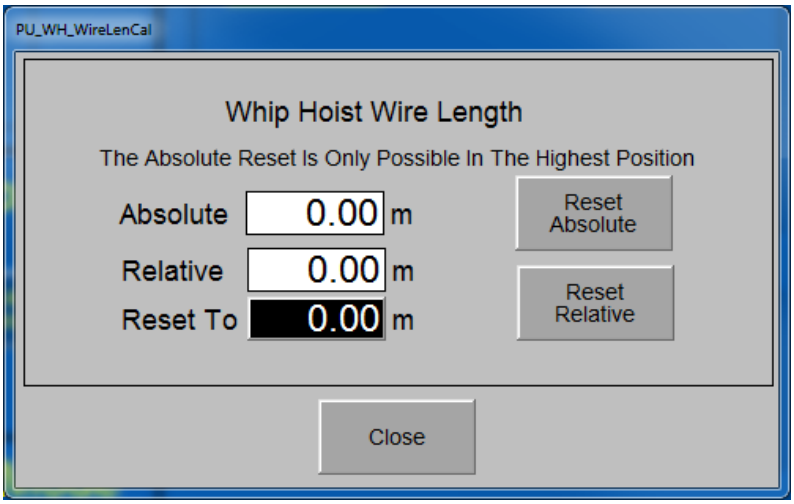


Figure 6-87: Wire length calibration popup

6.8.4.4 Boom hoist

The boom hoist drive is similar to that of the main/whip hoist; for safety, a band brake is added. Both the band brake and the normal brake keep the boom in place when the crane is deactivated, or when the boom is not moving for a definable time.

The boom hoist winch is operational when the following conditions are met:

- The E-room remote I/O unit is OK.
- No emergency stop active.
- Crane configuration is confirmed.
- HPU is running.

Hoisting and lowering

To hoist/lower use the left-hand joystick.

- Check if the right wave height (Hsig) and the right lift type are selected.
- To lower the boom: push the left-hand joystick forwards.
- To hoist the boom: pull the left-hand joystick backwards.
- To activate “high speed”, push the center button on the left-hand joystick. The screen displays whether high speed is allowed, not allowed, or already activated.
- The hoisting movement will go into reduced speed when the boom reaches its pre-highest position. This is indicated as “boom pre-highest position” on the screen.
- The hoisting movement will stop when the boom reaches its highest position, only lowering is then possible. This is indicated as “boom highest position” on the screen.
- The lowering movement will be stopped when the boom angle is 0º. This is indicated as “Boom lowest working position” on the screen.
- To lower the boom in the boom rest, push the “Jib parking mode” button. This button is located on the right-hand console. The boom will lower in reduced speed.
- When the boom is in the boom rest, lowering is no longer possible.

Position limits

Activated switch	Message	Action
Lowest working position	Alarm	Lowering movement stopped.
Pre-low working position		Lowering movement limited to a maximum of 30% speed.
Highest position	Displayed on main screen	Hoisting movement is stopped. When operator gives a new move command, invalid command message appears.
Pre-highest position	Displayed on main screen	Hoisting movement limited to a maximum of 30% speed.

Table 6-35: Position limits

Speed limits

The boom hoist features three different speed modes:

- Reduced speed.
- Nominal speed.
- High speed.

The hydraulic motor powering the winch has a variable swash plate, allowing either a normal displacement or a high displacement (higher rotation speed, less torque). High speed can be used if the following conditions are met:

- No pre-overload on main hoist and whip hoist.
- No high pressure on main, boom and whip hoists.
- No pressure sensor failure on the high pressure side of main/whip and boom hoist.

High speed mode can be selected by pushing the high speed request button on the left joystick if the “higher speed available” indicator is lit. If high speed is active, the indicator on SCADA lights up. High speed can be deactivated by pressing the high speed request button again.

The reduced speed mode is automatically activated if the hoist is nearing its end position; pre-empty drum and pre-highest position. During reduced speed the speed of the winch is limited to 30% of the nominal speed.

If a reduced speed interlock falls away, the “higher speed available” indicator lights up, too. Nominal speed can than be activated with a high speed request. Nominal speed is automatically activated when the joystick is either below the reduced speed limit, or moved to below the reduced speed limit. This to prevent the winch from suddenly speeding up when resetting an alarm or a warning.

Boom parking mode

Activate the boom parking mode when parking the boom into the boom rest. Boom parking mode is only allowed when:

- No load is detected on main hoist.
- No loadis detected on whip hoist.

To activate boom parking mode, press the “parking mode” on the right-hand console.

6.8.4.5 Tugger

To control the suspended loads the crane is equipped with one tugger with a capacity of 10 mt. The tugger is controlled with the right-hand joystick.

There is one tugger winch:

- One drum, the drum has one hydro motor. The motor is controlled by one pump.
- Constant Torque (CT) mode.
- Capability of handling 10 mt.

The tugger is operational when the following conditions are met:

- Crane system operational.
- HPU is running.
- Joystick is selected.
- Joystick no failure.
- No s-curve parameter failure from tugger.
- Power system OK.

Nominal speed mode

Only one speed mode is available.

Pulling/paying out

To pull/pay out, use the right joystick (Figure 6-76 p.149).

Tugger Constant Torque mode

The tugger is equipped with Constant Torque

(CT) mode. CT mode enables the operator to control a load automatically with a constant line pull, called the CT set point. The CT set point can be set between 0...62% with the “CT set point” dial (Figure 6-75 p.146).

NOTE *The tugger Constant Torque (CT) can be set up to 62% of the maximum allowed hoist side working pressure (350 bar).*

- Activation:

  CT mode is activated in manually or by auto take-over.

  Activate CT mode **manually** by the following sequence:

  1. Set CT set point with the “CT set point” dial (Figure 6-75 p.146).
  2. Haul in or pay out the winch by hand until load is about the CT set point.
  3. Turn the “CT mode” switch to 2. The drive will then control the winch to maintain the tension of the CT set point. The CT-mode is active when the indicator light is on continuously.

  Activate CT mode with **auto take-over** by the following sequence:

  1. Set CT set point with the “CT set point” dial.

2. Turn the “CT mode” switch to 2.
   The indicator will start flashing, this means CT mode is not active yet.
3. Operate the tugger using the right-hand joystick (see Figure 6-76 p.149), when the tension is close to the CT set point the tugger will automatically switch to CT mode, then the indicator is on continuously.

- Deactivation:

  CT-mode or CT-request can be deactivated at all times by the operator by turning the “CT mode” switch Figure 6-75 p.146 to 0.

NOTE *When turning the tugger winch off, be aware that the winch will come to a sudden stop.*

CT-mode has to be deactivated if the actual tension becomes out of limits. The operator has to keep an eye on the tugger load when operating. CT-mode is not allowed and will be stopped when the application is not allowed to move, a CT-request time out alarm occurs or if the potentiometer is out of limits.

- SCADA:

  SCADA will show:

  - The CT-set point in %.
  - CT-mode status.

6.8.4.6 Slewing

Speed modes

The slew system features two different speed modes:

- Reduced speed.
- Nominal speed.

Reduced speed mode is automatically activated if the boom hoist is at its lowest working position or has a empty drum alarm, or if the parking mode is set active. During reduced speed, the slewing speed is limited to 30% of the nominal speed in all speed.

If a reduced speed interlock falls away, the “higher speed available” indicator will also light up. Nominal speed can than be activated with a high speed request. After the high speed has been requested, nominal speed mode is automatically activated when the joystick is under or moved under the reduced speed limit of the nominal speed mode.

Slewing

- Check if the right wave height (Hsig) and the right lift type are selected.
- To slew right, push the left-hand joystick to the right.
- To slew left, push the left-hand joystick to the left.

NOTE *The PMC can fully revolve.*

6.9 GENERAL PROCEDURES

6.9.1 WIRE CHANGE OUT PROCEDURE

6.9.1.1 Tools needed for change out of the wires

- Reel with messenger wire with sufficient length and strength, depending on the wire that has to be changed.
- Spooling device that can handle the weight and length of the hoisting wire.
- Empty reel with sufficient storage capacity.
- Tugger winch for controlling messenger wire.
- Chain blocks and slings for temporarily securing wires and moveable parts.
- Reel with new wire.

6.9.1.2 Guidelines for change out procedures

- All wires have to be equipped with welded links on both dead ends. Chinese fingers are not recommended.
- Place the boom in the optimum position for changing the wire.
- To avoid dangerous situations make sure that all moveable parts are correctly secured to the crane structure before wires are disconnected.
- Before disconnecting the wires, make sure that the wire is temporarily secured to the crane structure near the point of disconnection. The connection has to be strong enough to hold the weight of the wire so it cannot slip or fall.
- When changing a wire, use a messenger wire (wire with smaller diameter) to safely guide the old wire out of the crane and the new wire into the crane.This messenger wire can be spooled on the hoist winch or on a tugger winch. Make sure the messenger wire has sufficient length and strength.

NOTE *Set clear safety parameters around the crane with red/white band.*

CAUTION



Changing out wire is a complicated and dangerous procedure. It should only be done by reeving experts with extensive knowledge and experience.

CAUTION



Reeving a new wire must be done in service mode.
Service mode is not be used in normal operating situations because operating with a slack rope can result in rope failure or insufficient lifting capacity!

6.9.1.3 Main hoist fall changing procedure

The main hoist can be reeved in 4 and 8 falls. To change the reeving configuration, proceed as followings:

1. Lower the boom onto the boom rest.
2. Lower the main hoist lower block onto a support or cradle. Support the block such that it remains upright. Preferably, the hook must be in horizontal position so as to provide

enough free space for the socket to be pulled through under the sheave block (see Figure 6-88 p.184). Secure the block before continuing.

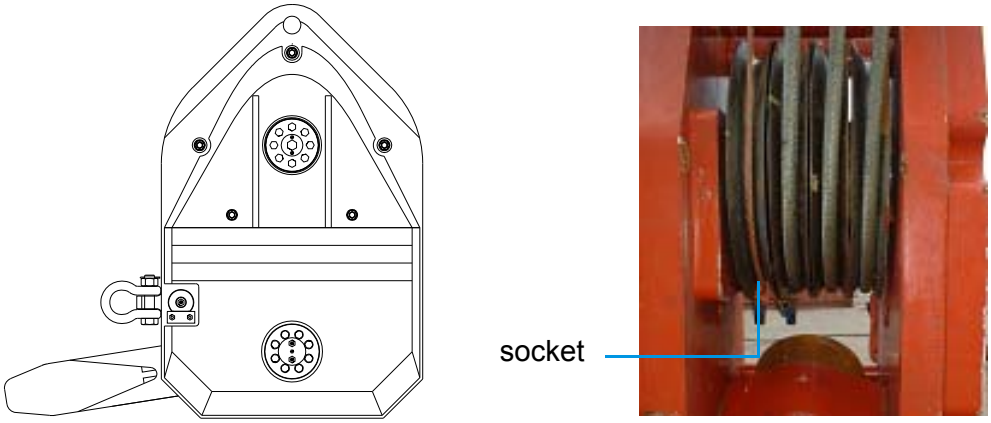


Figure 6-88: Main hoist block position (typical)

3. Remove bolts and the wire retaining rods around the sheave block (see Figure 6-89 p.184)..

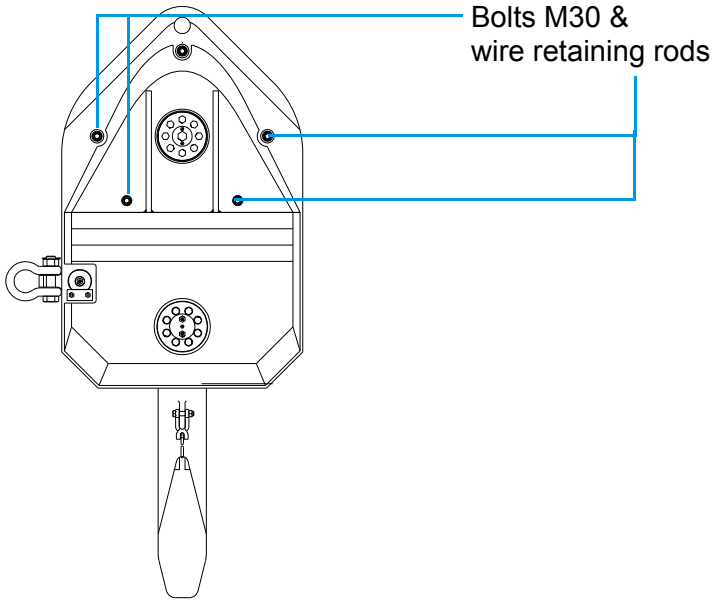


Figure 6-89: Main hoist block covers

4. Remove the safety clips and the wire retaining rods in the boom head (see Figure 6-90 p.185).

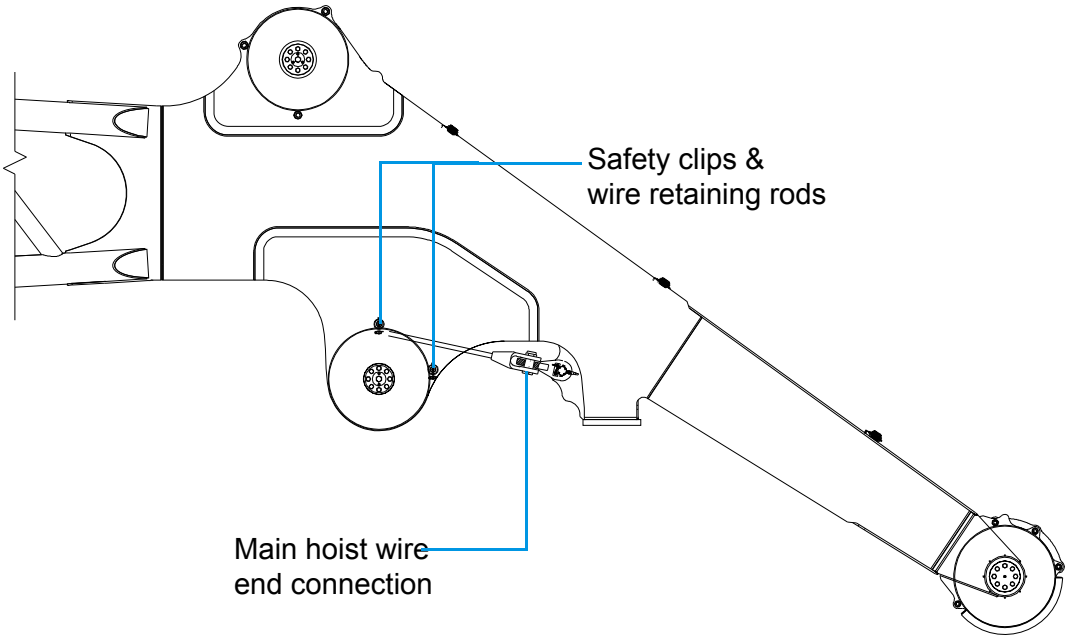


Figure 6-90: Boom head

5. Loosen the bolts of the wire end connection at the boom head and pull out the shaft. The socket needs not to be removed. It can be pulled through the system.
6. Attach a whip wire to the tugger winch (see Figure 6-91 p.185).

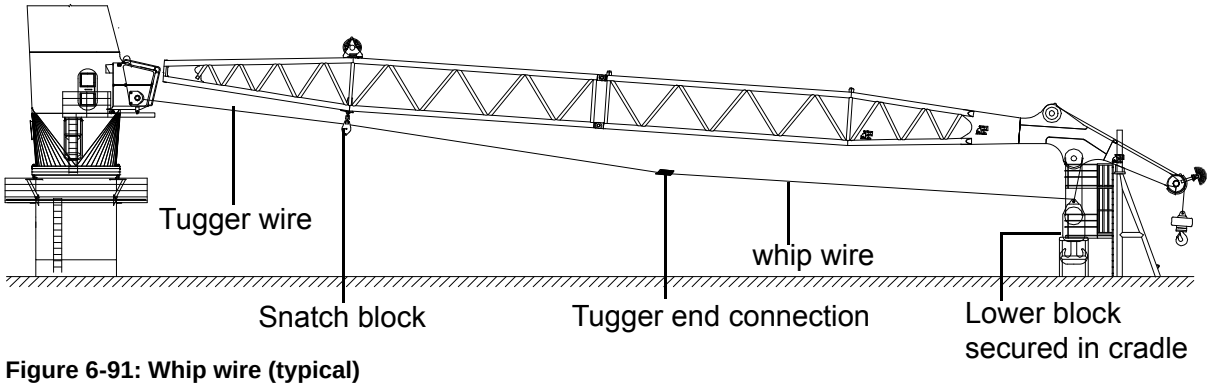


Figure 6-91: Whip wire (typical)

7. Attach a snatch block to the eye on top of the lower block by means of a shackle (see Figure 6-92 p.186).

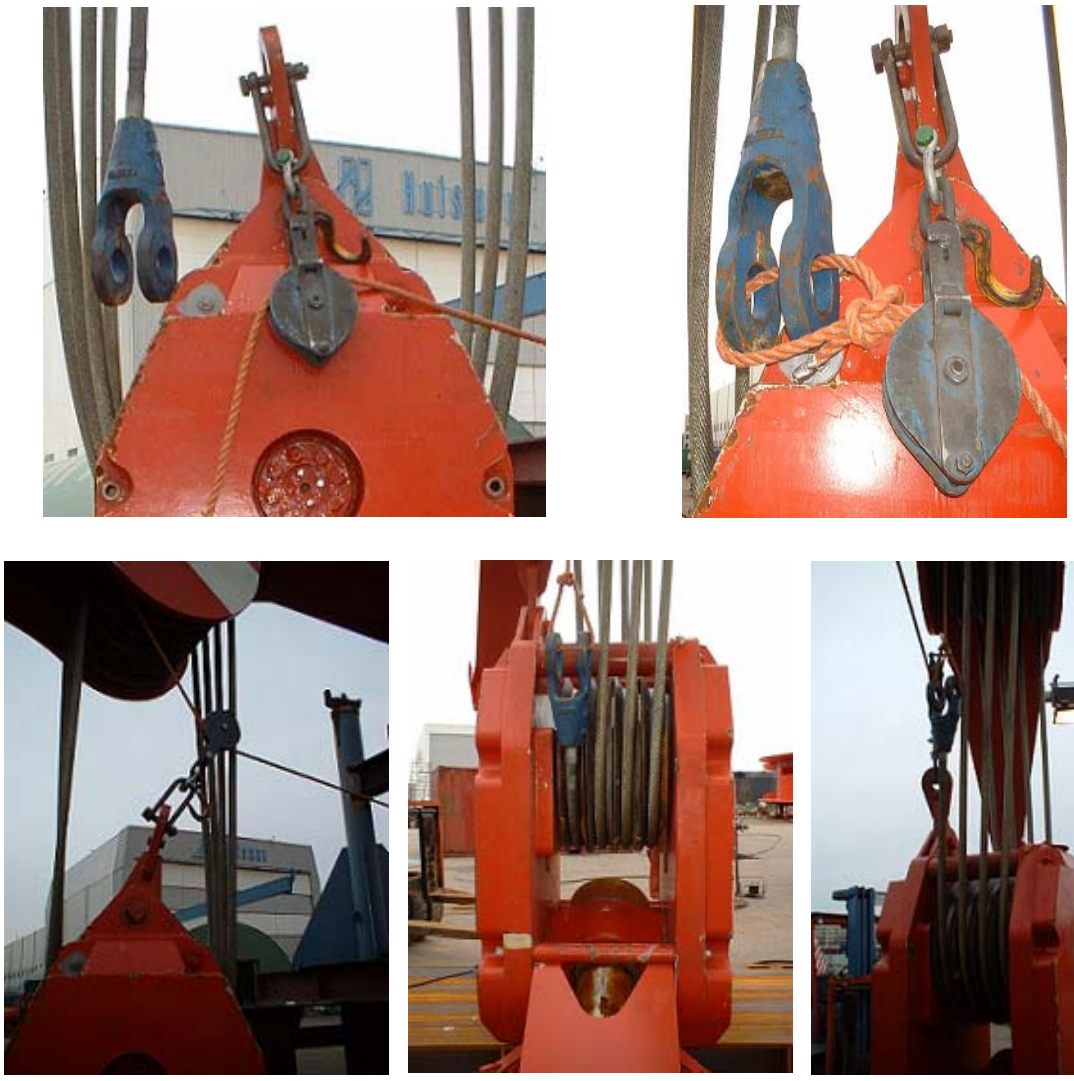


Figure 6-92: Attachment of a snatch block (typical)

8. Attach the whip wire to the socket and lead the wire over the sheaves according to the desired reeving configuration using the tugger winch. Figure 6-93 p.187 shows which sheaves to use for each number of falls.

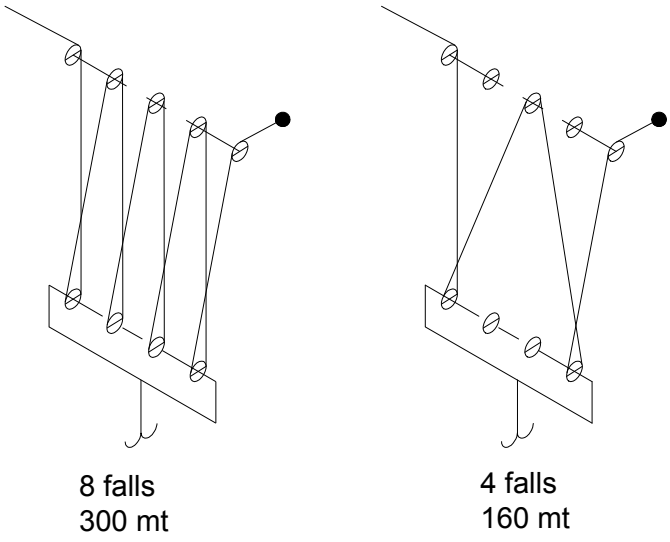


Figure 6-93: Reeving

NOTE *When changing to a higher number of falls, it can be considered to manually move the hoist wire into the required sheaves before loosening the end connection at the sheave block in order to save time. In this way, the wire does not need to be removed from all the sheaves and reeved from start.*

9. While pulling the socket through the boom head, take care to properly lead the socket over the sheaves to prevent it from getting stuck. Ideally, the cheeks of the socket should be in vertical position, and each fall should be more and less into the groove of a sheave (see Figure 6-94 p.187).

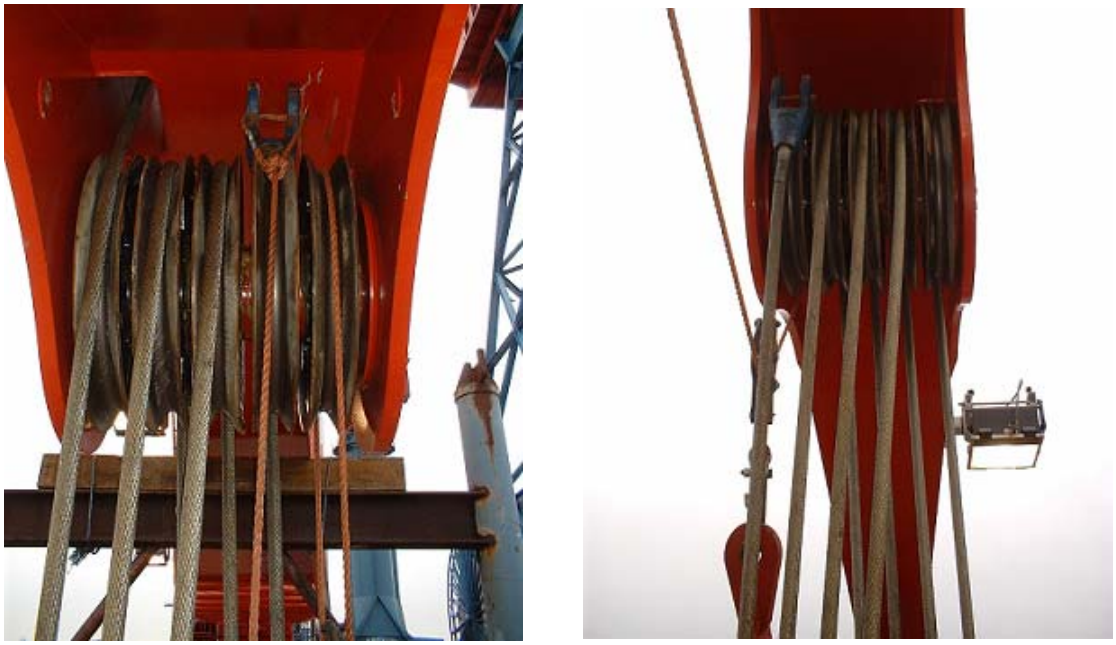


Figure 6-94: Pulling the socket through the boom head (typical)

10. Remove the whip wire, and reconnect the wire end connection.
11. Put the wire retaining rods back in place, both in the sheave block and at the boom head.

12. Hoist the boom to its highest position, and lower the block.
13. Set the reeving configuration of the crane to a mode that fits the new number of falls. This is done on the operator display, in the “Operations” screen (see Figure 6-79 p.159).

6.9.2 SEA FASTENING

When it is at extreme environmental conditions, like wind speed, wave height, temperature and vessel inclination exceed the values specified for the load chart, as well as during sea travel, it is strongly recommended to put the boom in the boom rest position. If this is ignored, damage may occur to the crane.

The boom rest is not supplied by Huisman. In addition to sea fastening the boom, it is advised to mount the rain protection cover on the opening in the crane house, at the height of the highest position switch for the boom hoist system.

6.10 EMERGENCY PROCEDURES

6.10.1 EMERGENCY STOP PROCEDURE

Applying one of the emergency stop buttons will cause immediate braking and shutdown of the crane and HPU. In case of a dangerous situation anywhere in or around the crane, or if the operator is no longer able to control the crane, the crane has to be stopped as soon as possible. The procedure is:

1. Press the emergency stop button.

This will cause an immediate braking and shut down of the crane.

WARNING



Perform brake test after an emergency stop.

6.10.2 BRAKE APPLY FAILURE

If a brake apply failure occurs, do not shut down the PMC immediately, first place the load on to a safe location.

WARNING



Lower the load on to the safe location as soon as possible!

In case of a brake apply failure detected, do the following:

1. Slew into a safe location.
2. Lower the load.
3. Lower the boom onto the boom rest.
4. Press emergency stop.
5. Check the brakes of the applicable movement.

WARNING



Do NOT use the crane until the cause of the malfunction has been found and the problem has been solved!

6.10.3 EMERGENCY LOWERING

In an emergency situation, it is possible to lower the load manually, by means of a hydraulic hand pump, serving to lift the brakes in a controlled manner. The hand pump has a built-in oil reservoir containing 3 liters. If required, the tank has to be refilled during operation.

The principle of emergency lowering is more or less the same as use of the diesel driven HPU. Because no power is available, only lowering is possible.

A hand pump (P048) is provided for emergency lowering of the winches without use of the diesel HPU. The pump can be used to lift the brakes of the following winches:

- Main hoist winch.
- Whip hoist winch.
- Boom hoist winch.

NOTE *In emergency situations the slew system cannot be used without the standard or the diesel driven HPU.*
The tugger winch can only be used with its main pump.



Figure 6-95: Hand pump

Procedures for emergency lowering with the hand pump are specified on the emergency operation tags. These are located near the hand pump. They can also be found in reference drawing A17-42000-88-040 in Appendix A: "Reference drawings"

6.10.4 EMERGENCY DIESEL HPU

A stand alone diesel unit is included in the crane in order to provide hydraulic power in case of an electrical power failure. The diesel can be used to perform emergency operations. The emergency unit can operate without external electrical power and is not interfaced with the control system. The following drive systems can be powered with the diesel HPU:

- Boom hoist winch
- Whip winch
- Main hoist winch
- Slew system

NOTE The tugger winch cannot be operated in case of a general power failure

The diesel engine has its own battery to start up. The battery is always connected to the power supply of the crane by means of a charger. The charger will load continuously with a small current, to keep the battery in best possible condition.

Procedures for emergency operation with the emergency diesel HPU are specified on the emergency operation tags for the diesel driven HPU. These are located on the winch frame, near the slewing manifold and near the diesel driven HPU. They can also be found in reference drawing A17-42000-88-040 in Appendix A: "Reference drawings"

6.11 TROUBLESHOOTING

6.11.1 FAILURES

Table 6-36 p. 192 lists examples of the PMC action when a certain component fails.

Component	Status	Action
E-motor	Overheated	Alarm is activated. HPU starting is not allowed.
Drum	Slack rope detected	Alarm is activated. The hoisting and lowering movements are stopped.
Joystick	Failure	Alarm is displayed. The movement is not allowed.
Brake	Lift failure	If “brake lift failure” is detected when the winch is moving, the crane will have a fast stop. If “brake lift failure” is detected when the winch is not moving, movement is not allowed.

Table 6-36: Failure

6.11.1.1 Sensor failure

All analog sensors send their information using an electrical current between 4 and 20 mA. If the current drops below 2 mA, for instance, because of a wire breakage, an alarm is generated and the movements concerned are stopped. In case of a failure, check the power supply to the sensor and the current from the sensor in reference to GND in order to assess if it is the wiring or the sensor. An incorrectly mounted sensor could also produce a sensor failure.

6.11.2 INVALID SELECTION

Invalid Sea State

Sea state is selected via PC and the selection is transferred to the PLC by Profibus. An invalid sea state could be caused by defective SCADA configuration or the PLC program not running.

Invalid Lift Type

Lift type is selected via PC and the selection is transferred to the PLC by Profibus. An invalid lift type could be caused by defective SCADA configuration or the PLC program not running.

Invalid reeving

Reeving from main hoist is selected via PC and the selection is transferred to the PLC by Profibus. An invalid reeving could be caused by defective SCADA configuration or the PLC program not running.

APPENDIX A: REFERENCE DRAWINGS

Document ID	Rev.	Document title
Mechanical drawings		
A17-42000-00-001	B	General arrangement
A12-48000-00-0088	B	Greasing schedule
A17-42000-00-101	C	Interface drawing
A12-48000-12-000	A	Crane house - head section
A17-42000-12-040	A	Crane house - head section
A12-48000-15-0108	A	Boom pivot section
A12-48000-15-0208	A	Boom rectangular section
A17-42000-15-030	A	Jib head & fly jib
A12-48000-59-011	A	Whip/boom/main hoist drum stickers
A17-42000-59-030	A	Crane identity plate
A12-48000-21-0108	B	Main hoist winch
A12-48000-21-0208	B	Whip hoist winch
A12-48000-21-0308	B	Boom hoist winch
A12-48000-21-0408	C	Tugger roller
A12-48000-21-0508	A	Winch frame
A12-48000-21-0708	A	Tugger winch
A17-42000-31-010	A	Reeving diagram
A12-48000-33-0108	B	Main hoist lower block
A17-42000-33-020	B	Whip hoist lower block 30 mt
A12-48000-33-0308	A	Snatch block for tugger wire
A12-48000-51-0208	A	Crane cabin access
A12-48000-61-0118	A	Band brake testing
A17-42000-00-730	A	Critical zone drawing - Arrangement
Electrical drawings		
10016927A-07-900-01	07	Electrical diagram
A12-48000-00-401	A	Sensor drawing - Arrangement
A17-42000-93-000	B	Cable interface diagram
Hydraulic drawings		
A12-48000-80-010	C	Hydraulic diagram
A12-48000-80-019	B	Hydraulic parts
A12-48000-80-018	B	Hydraulic hose list
Procedures		
A17-42000-88-040	A	Emergency operation tags

APPENDIX B: REFERENCE DOCUMENTATION

Document ID	Rev.	Document title
Wire-Rope 66-100	D	User manual steel wire rope
A17-42000-C0-001	A	Technical Specification
A12-48000-09-002	C	Paint Specification
CSSCA-MAN-020	A	Huisman SCADA Standard - User Manual
A17-42000-71-002	A	Safety diagram
A17-42000-C0-031	A	Load curves
A17-42000-00-005	B	Load charts
LMP-66-100	2.6	User manual load measuring pin
D00001578-01-123	B	Bolt wire securing
RC-DM-66-100	1.0	Repair criteria - Dents and misalignments
RC-CA-66-100	1.0	Repair criteria - Corroded area
E-stops list	-	E-stops list

APPENDIX C: ABBREVIATIONS

	Abbreviation	Meaning
A	AFT	Stern side of vessel (“after”)
	AOL	Aeronautical Obstruction Light
B	BT	Block Tugger
C	CCTV	Closed Circuit Television
	CCW	Counter Clock Wise
	COG	Centre Of Gravity
	CPU	Central Processing Unit
	CT (hoist)	Constant Tensioning
	CT (Tuggers)	Constant Tension
	CW	Clock Wise
D	DP	Dynamic Positioning of vessel
E	ELCA	Electronics Cabinet
	E-motor	Electric motor
	EPU	Electrical Power Unit
	E-room	Electrical equipment room
	ESD	Emergency Shutdown
	EV	Equalizer Valve
F	FWD	Forward
H	HMC	Hydraulic Motor Controller
	HP	High Pressure
	HPU	Hydraulic Power Unit
	Hsig	Significant wave height
	HVAC	Heating, Ventilation and Air Conditioning
K	kip	Kilo pounds force
	kW	Kilo Watts
L	LP	Low Pressure
	LT	Load Tugger
M		
	MH	Main Hoist
	MOPS	Manual Overload Protection System
	mT / t	(metric) tons
O	OPS	Overload Protecting System
P	PC	Personal Computer
	PED	Pedestal
	PIU	Pressure Intensifier Unit
	PLC	Programmable Logic Controller
	PMS	Power Management System
	POCA	Power Cabinet

	Abbreviation	Meaning
	PS	Port Side
R	RPM	Rotations Per Minute
S	SB	StarBoard side
	SCADA	Supervisory Control and Data Acquisition
	SH	Sling Hoist
	sht	Short ton
	SL	Slewing
	SSI	Synchronous Serial Interface
	SWL	Safe Working Load
	SWB	Switch board
T	TRDP	Third Party Equipment
	UPS	Uninterruptable Power Supply
U	UGDS	Umbilical and Guide Wire Deployment system
V	VFD	Variable Frequency Drive
	VMS	Vessel Management System
W	WAB	Walk Around Box
	WH	Whip Hoist
	WIP	Watchdog Interface Print

APPENDIX D: SAFETY SIGNS

It is responsibility of the client to apply the appropriate safety signs at the appropriate locations in the system (e.g. warnings for moving loads, dangerous voltage etc.).

The following safety signs are to be applied at the appropriate locations in the system.

Sign	Meaning
	Keep away from moving loads. Extreme caution is required.
	General warning sign. Caution is required (e.g. moving machine parts).
	Potentially lethal voltages are present in the cabinets.
	Wear safety gloves to protect skin from aggressive cleaning or during maintenance.
	Wear safety glasses.
	Wear safety boots.
	Wear ear protection.
	Wear a safety helmet.
	Beware of automatically starting machines.

Table 10-37:

Sign	Meaning
	Beware of rotating parts.
	Fire extinguisher.

Table 10-37:

APPENDIX E: CONVERSION TABLE

Conversion table SI - I

Units	Equal to	Conversion	Units
1 mm	=	0.0394	inch
1 inch	=	25.4	mm
1 kN (1000N)	=	0.225	kipf
1 kipf	=	4.448	kN
1 bar	=	14.504	psi
1 psi	=	0.0689	bar
1 Pa (1 N/m²)	=	0.000145	psi
1 psi	=	6 894.76	Pa
1 m/s²	=	39.37	in./s²
1 in./s²	=	0.0254	m/s²
1 mt (metric ton)	=	2204.6	lbs
1 lbs	=	0.000454	mt
1 mt (metric ton)	=	1.1	sht (short ton)
1 sht (short ton)	=	0.91	mt

Table 11-38: