RETRACTABLE "DROP DOWN" MULTI-BEAM SOUNDER SPECIFICATION

CCGS DES GROSEILLIERS

For

Pêches et Océans Canada
Fisheries and Oceans Canada
Garde côtière
Coast Guard

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Document

C17-66-003-01-R0
Retractable "Drop-Down" Multi-Beam Sounder Specification

Revisions descriptions

Rev	Date	Description	By	Approved by
0	2017-11-28	For CCG comments	L. Beaulieu, J-C Laurin & S. Laguë	S. Laguë, ing.

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1 Scope of Work

1. The intent of this specification is for the Contractor to perform the installation of a Retractable "Drop Down" Multi-Beam Sounder of type EM 712 from Kongsberg, with deployment mechanisms and auxiliary systems, and including an integration package of the electronic equipment package associated with the sounder itself on the CCGS Des Groseilliers. Integration of the Multi-Beam Sounder implies vessel structural modification of some of the exiting compartments of the vessel.

2. In order to permit the installation of an EM 712 retractable Multi-beam sounder, including the deployment system, the structural arrangement of certain tanks and compartments must be modified. Therefore, the existing Heeling Compartment will be divided in two, by adding a longitudinal bulkhead on the central axis of the vessel. The EM 712 Multi-Beam Retractable Sounder will be installed on the port side, and the port side compartment will become the Multi-Beam Sounder Compartment, in which different components of the Multi-Beam Sounder are to be installed.

3. The Multi-Beam Sounder must be able to be deployed under the total hull surface (approx. 600mm below keel). A cofferdam will be built in No.1 Double Bottom Port Fuel Tank, in order to isolate Mounting Flange from fuel in this tank. Also in order to permit installation of the Multi-Beam Sounder in the retracted position, a well will need to be built in the port heeling tank. This new well will be part of the Multi-Beam Sounder Compartment volume, and will be used for the arrangement of the new emergency exit for this compartment.

4. All steel work needed for the installation of the Multi-Beam Sounder will be performed during a dry-docking period. Different piping systems will need to be modified to permit installation of this new equipment. This specification describes the overall work that needs to be performed in order to install the EM 712 Multi-Beam Retractable Sounder aboard the CCGS Des Groseilliers. It is to be noted that the Multi-beam sounder, made by Kongsberg, as well as all its components, will be supplied by the Canadian Coast Guard.

5. The drawing No.C17-66-601-01 Vessel Modification Key Plan illustrates all the changes needed to install the Multi-beam sounder. The electrical specification and drawings are included in *Appendix A & Appendix B* respectively.

2 Vessel Particulars

General particulars

Signal letters	CGDX
Official number	802160
Port of registry	Ottawa
Owners	The Minister of Transportation, In right of H.M. the Queen, Ottawa, Ontario, CND.
Builders	Port Weller Dry Docks, (A division of Upper Lakes Shipping Ltd.), St. Catharines, Ontario, CND, L2R 7C1.
Gross tonnage	Canadian: 6097.80 U.S.: 5210.55 Panama: 6450.64
Net tonnage	Canadian: 1799.88 Panama: 1576.44

Principal particulars

Length overall	98.238 m	(322'- 3 5/8'')
Length B.P.	87.935 m	(288'- 6')
Breadth moulded	19.507 m	(64'- 0'')
Depth mld. to upper dk.	10.820 m	(35' – 6'')
Load draft (ext.) in s. w.	7.438 m	(24'- 4 7/8'')
Block coefficient	0.652	(0.652)
Displacement in s. w.	8550 tonnes	(8415 l. tons)
Deadweight in s. w.	2919 tonnes	(2873 l. tons)
Lightweight	5631 tonnes	(5542 l. tons)

3 References

3.1 Guidance Drawings and Document supplied

3.1.1 Concept Naval Drawings and Reference Documents

For the complete list of Concept Naval drawings and their last revision, see document *C17-66-009-01 Documents List*. This list will be updated and joined to any revision made to drawings.

Number	Documents / Drawings
C17-66-601-01	Vessel's Modification Key Plan
C17-66-620-01	Capacity Plan
C17-66-026-01	Docking Plan
C17-66-165-01	Structural Modification
C17-66-180-01	Grey Water System Skid
C17-66-185-01	GPS Antenna Arrangement
C17-66-185-02	IMU Arrangement
C17-66-201-01	Piping Modification
C17-66-626-01	Doors, Hatch and Manholes
C17-66-003-01	Retractable "Drop-Down" Multi-Beam Specification
MT-3001-V3	Electrical Specification Multi-Beam Sounder Installation (EM 712)
1043-A414011	Cable Diagram (EM 712 Sensors)
1043-A414021	Cable Diagram (EM 712 Interfaces and External Systems)
1043-A414031	Cable Diagram (Power Cables)

3.1.2 Coast Guard Reference Drawing

- 68-H-101-T General Arrangement
- 68-H-20/4 Double-Bottom Units. Units A7 & A8
- 68-H-22/3 17’-0” Flat Frames 127-165 Unit No. 6-7 & 8
- 68-H-23/3 Main Deck Frame 127-165 Unit No. 6-7 & 8
- 68-H-107 Key Plan and List of Manholes
- 68-H-114 Insulation Plan
- 68-2000-2 Bilge and Ballast Arrangement
- 68-2100-1 Fuel Oil Filling and Transfer Diagram
- 68-2040-1 Grey Water System Diagram
- 68-2040-5 Grey Water System Arrangement
- 68-2450-4 Hydraulic Piping for Heeling Pump
- 68-2430-3 Arrangement of C02 System - OMS

3.1.3 Suppliers Reference Documents

1. The Engineering cover under this specification and drawings package has been produced based on Kongsberg information available at during Engineering phase. Many of Kongsberg documents were preliminary.

3.1.3.1 Kongsberg Maritime

- 378828 rev.A HYDROGRAPHIC WORK STATION / OUTLINE DRAWING
- 385422 rev.B PROCESSING UNIT / OUTLINE DIMENSIONS
- 396402 rev.A TX UNIT / OUTLINE DIMENSIONS
- 396428 rev.A RX UNIT / OUTLINE DIMENSIONS
- 401027/A EM712 MULTIBEAM ECHO SOUNDER / INSTALLATION MANUAL
- 406276 rev.B HIPAP LOCAL CONTROL CABINET / CONNECTION DRAWING
- 407161 rev.B HIPAP LOCAL CONTROL CABINET / OUTLINE DIMENSIONS
- 417715 rev.A EM712 TRANSDUCER HOUSING / ASSEMBLY DRAWING
- 424455 Pro01 GENERAL ARRANGEMENT HL3200 EM712
- n.a. miniSVS Sound Velocity Sensor 2017-11-09

3.1.3.2 LK Valves (Kongsberg supply)

- Q-37317 rev.D GATE VALVE DN1200
- N.A. HPP INSTALLATION MANUEL AND OUTLINE DIMENSIONS 2017-10-24

3.2 Applicable Regulations

- LLOYD'S REGISTER, RULES AND REGULATIONS FOR THE CLASSIFICATION OF SHIPS, PART 5
- LLOYD'S CLASS NOTIFICATION 100A1 Ice Class 1A Super LMC Arctic Class 2 vessel operating on Unlimited, beyond 200nm voyages
- TRANSPORT CANADA, C.R.C., c. 1431, HULL CONSTRUCTION REGULATIONS
- TRANSPORT CANADA, SOR 90-264 MARINE MACHINERY REGULATIONS
- TRANSPORT CANADA, C.R.C., c. 353, Arctic shipping Pollution Prevention Regulation
- IACS No 47 Shipbuilding and Repair Quality Standard
- CANADA SHIPPING ACT – Marine Machinery Regulation
- CSA W59-08(R2008) –Welded Steel Construction
- CSZ W47.1-09–Certification of Companies for Fusion Welding of Steel
- TP 11469 - Guide to Structural Fire Protection

Notes:

1. For applicable electrical regulations, see document Electrical Specification Multi-Beam Sounder Installation (712) in *Appendix A*.

3.3 Equipment list

Notes:

1. Unless specified elsewhere, all equipment listed below is owner supplied;
2. This list is not exhaustive, and the contractor is responsible for identifying all pieces of equipment which will be required for installation;
3. Refer to the *Electrical Specification Multi-Beam Sounder Installation (712) in* for the electric cables.

3.3.1 Multi-beam Sounder Compartment

- Mounting Flange, Kongsberg;
- Hydraulic Power Pack, Kongsberg;
- DN1200 Gate valve, Kongsberg;
- Mounting trunk, Kongsberg;
- Intermediate flange, Kongsberg;
- EM16 Hull Unit, Kongsberg;
- EM712 Transducer housing and intermediate pipe, Kongsberg;
- EM712 RX transducer, Kongsberg;
- EM712 TX transducer, Kongsberg;
- SVS Sound Velocity Sensor, Kongsberg;
- IMU, Kongsberg;
- IMU mounting plate (Contractor supplied);
- HIPAP local control cabinet, Kongsberg;
- Telephone (Contractor supplied);
- Camera (Contractor supplied);
- Watertight sliding door (Contractor supplied);
- Watertight hinged doors (Contractor supplied);
- 350cfm fan and its control, Twin City, model TB or equivalent, (Contractor supplied);
- Lighting (2) (Contractor supplied);
- Hi level float sensor for the new bilge well (Contractor supplied);
- Bilge 4” Remote controlled valve with air compressed actuator (Contractor supplied);

3.3.2 Heeling Compartment

- Watertight hinged door (Contractor supplied);
- 350cfm fan and its control, Twin City, model TB or equivalent, and control (Contractor supplied);
- 460-230V transformer (Contractor supplied);
- 460V power distribution panel (Contractor supplied);
- 230V power distribution panel (Contractor supplied);
- EM712 TX Unit, Kongsberg;
- EM712 RX Unit, Kongsberg.

3.3.3 Locker no.3 / Main Deck

- Hydraulic Power Pack of the new watertight sliding door (Contractor supplied)

3.3.4 Special Navigation Chart Room

- UPS (Contractor supplied);
- EM712 Processing Unit 19'' Std. mount, Kongsberg;
- POSMV Processor 19'' Std. mount, Kongsberg;
- Hydrographic Work Station 19'' Std. mount, Kongsberg;
- Post Processing Work Station 19'' Std. mount, (Contractor supplied);
- Ethernet Switch 19'' Std. mount, (Contractor supplied);
- Monitor, keyboard and mouse for the Hydrographic Work Station (Contractor supplied);
- Monitor, keyboard and mouse for the Post Processing Work Station (Contractor supplied).

3.3.5 Aft Mast

- GNSS Antennas (2), Kongsberg

3.3.6 Bridge

- HIPAP remote control unit, Kongsberg
- Remote display monitor (Contractor supplied)

4 General Notes

1. All the following work specified herein and all repairs, inspections and renewals shall be completed to the satisfaction of the Coast Guard Technical Authority (CGTA), who, unless otherwise advised, will be the Chief Engineer of the ship. Upon completion of each item of the specification, the CGTA shall be so notified so that he may inspect the work prior to final closing up and after complete closing up. Failure to give notification does not absolve Contractor of the responsibility of providing the CGTA the opportunity to inspect any item. Inspection of any item by the CGTA does not substitute for any required inspection by Transport Canada Marine Safety Branch (TCMSB), Lloyds Register of Shipping, Public Works & Government Services Canada (PWGSC), or Health Canada.

2. Any item of work involving the use of heat in its execution requires that Contractor advises the CGTA prior to starting such heating and upon its completion. Contractor shall be responsible for maintaining a competent and properly equipped fire watch during and for one full hour after all hot work. The fire watch shall be arranged such that all sides of surfaces being worked on are visible and accessible. Contractor shall provide sufficient suitable fire extinguishers and a fire watch during any such heating and until the work has cooled. Ship's extinguishers are not to be used except in an emergency. Contractor shall abide by the Coast Guard Hot Work Policy. Contractor shall be responsible to ensure that Contractor’s personnel including any subcontractors shall follow the policy.

3. Contractor to include in quote the costs of any and all transportation, staging, rigging, slinging, cranage, removals, and installations of parts and equipment such as may be required to carry out work.

4. Any piping, manholes, parts and/or equipment requiring removal to carry out specified work and/or to gain access shall be replaced upon completion with new jointing, nuts, bolts, anti-seize compound, clamps and brackets as applicable (Contractor supply), and secured in original condition. Any removals shall be jointly inspected by both Contractor and the CGTA prior to removal.

5. Contractor to ensure that all spaces, compartments, and areas of the ship, both internal and external, are left in as clean a condition as found. The cost of removing dirt, debris, and associated material shall be included in the quote on each item of this specification.

6. Contractor to supply the CGTA with marine chemist's certificates in accordance with CGSSB TP 3177E before any cleaning, painting or hot work is commenced in confined spaces or machinery compartments. Certificates shall clearly state the type of work permitted, and shall be renewed as required by the regulations.

7. Whenever any work is being carried out involving a ship's firefighting or fire detecting system, it shall be done in such a way as to leave the vessel and any persons aboard with adequate protection against fire at all times. This may be so accomplished by removal or

disarming of only a portion of the system at a time, by replacement with spares while work is in progress or by other reasonable means acceptable to the CGTA.

8. Unless specified otherwise, any replacement and/or disturbed steel work to be given a minimum of two (2) coats of marine primer (CGSB 1-GP-48M) immediately upon completion of work.

9. All materials, unless otherwise specified, shall be supplied by Contractor. Contractor to supply all necessary tools to perform specified work except for specialty tools which will be issued by and returned to the CGTA. Otherwise, ship's tools and equipment will not be available for Contractor's use. Where a particular item is specified, or where substitution must be made, the chief engineer or representative must approve all material offered.

10. Contractor to be responsible for calling in the services of Transport Canada Marine Safety Branch (TCMS), Lloyds Register of Shipping and Health Canada. Inspectors when and as required for survey and inspection.

11. During the period that this vessel is in refit, members of the ship's crew, ship's engineers, Regional staff and service specialists will be carrying out repairs to, or maintenance of, various ships' equipment not covered in this specification. Every effort will be taken to ensure that this self-maintenance will not interfere, or conflict, with that being carried out by Contractor's personnel.

12. The successful Contractor to provide at Pre-Refit Meeting a Production Bar Chart showing commencement and completion dates for each item in this specification. This document shall highlight any critical dates and be capable of showing the effects of late completion date of the work package. Updated Production Schedules shall be presented by Contractor at each refit meeting or more frequently if requested by CGTA.

13. Public Service Smoking Policy forbids smoking in Government ships in all areas inside the ship where shipyard personnel will be working. Contractor shall inform shipyard workers of this policy and ensure that it is complied with in all cases.

14. The overhaul and installation of all machinery and equipment specified herein shall be as per the manufacturers' applicable instructions, drawings and specifications.

15. All tests results, calibrations, measurements, trials and readings shall be properly tabulated, compiled and three typewritten copies and one electronic copy shall be provided; two hard copies and one electronic copy to CGTA and one copy to PWGSC Contracting Authority. All test and trials shall be performed to the satisfaction of CGTA. TCMS inspector and Lloyds Register of Shipping inspector where applicable.

16. Contractor shall use fully qualified, certified and competent tradesmen and supervision to ensure a uniform and high level of workmanship as judged by normally accepted shipbuilding standards to the CGTA satisfaction.

17. Any items or equipment to be removed and subsequently reinstalled in order to carry out the work specified or arising shall be jointly inspected for damages prior to removal by both Contractor and CGTA.

18. Contractor shall provide adequate temporary protection for any equipment or areas affected by this refit. Contractor shall take proper precautions to maintain in a proper state of preservation any machinery, equipment, fittings, stores or items of outfit which might become damaged by exposure, movement of materials, paint, sand grit or shot blasting, welding, airborne particles from sand grit or shot blasting, welding, grinding, burning, gouging, painting or airborne particles of paint. Any damage shall be the responsibility of Contractor.

19. Contractor must ensure that welding is performed by a welder certified by the Canadian Welding Bureau (CWB) in accordance with the requirements of the following Canadian Standards Association (CSA) standards:

a) CSA W47.1, Certification for Companies for Fusion Welding of Steel Structures (Minimum division level 2.0); and
b) CSA W47.2-M1987 (R2003), Certification for Companies for Fusion Welding of Aluminum (Minimum division level 2.1).

20. All drawings and drawing revisions that Contractor is requested to do during this contract shall be of a quality equal to that of the drawings that are requested to be updated.

21. All materials supplied and work carried out by Contractor shall be adequate to meet the following service conditions:
    - outside air temperature of minus (-) 40^0 C to plus (+) 35^0 C;
    - wind velocity of 50 knots;
    - water temperature of minus (-) 2^0 C to plus (+) 30^0 C;
    - Shock loading of 2.5g horizontal, 1.5g vertical.

22. The contractor must refer to the Coast Guard painting procedure for all surface preparation, coating and painting work.

5 Technical Description

5.1 Preparation

5.1.1 Dry-Docking

1. In order to carry out the steel work and permit the installation of the Multi-beam Retractable Sounder, the ship will need to be dry-docked. The Contractor will need to supply the Coast Gard Technical Authority (CGTA), within two (2) weeks of the contract allowance, the Vessel's Docking Plan. The Contractor will pay special attention not to install any docking blocs in the vicinity where the sounder is to be installed. This area is lactated between frames 140 and 146, 9'-0''outboard from centerline, port side. Drawing *C17-66-026-01 Docking Plan* is supplied to Contractor as reference.
2. The height of the docking blocs should be sufficient so as to permit deployment of the sounder under the hull, when the functional testing will be held. The needed height to properly test the sounder is approximately 1000mm below baseline.

5.1.2 Tanks cleaning before steel work

1. The following tanks will need to get hot work done on each of them, and will need to be drained, cleaned out, ventilated and tested, so as to make sure that the air quality is acceptable for hot work. Contractor to supply the CGTA with marine chemist's certificates in accordance with CGSSB TP 3177E before any hot work is commenced in tanks, confined spaces or machinery compartments. Certificates shall be posted at the entrance of each tank and clearly state the type of work permitted, and shall be renewed as required by the regulations. The tanks are:
    a. No.1 Double Bottom O/F Tank Port, frames 123 to 165 (fuel)
    b. No.1 Double Bottom O/F Tank Starboard, frames 123 to 165 (fuel)
    c. Center Deep O/F tank Port, frames 146 to 165 (fuel)
    d. Center Deep O/F Tank Starboard, frames 146 to 165 (fuel)
    e. Forward O/F Wing Tank Port, frames 138 to 158 (fuel)
    f. Forward O/F Wing Tank Starboard, frames 138 to 158 (fuel)
    g. Lower Flume Tank, frames 127 to 138 (fuel)

5.1.3 Dismantling

5.1.3.1 Cargo Hold

1. This section describes all the dismantling work that needs to be performed in the cargo hold to go ahead with all modification work of the different systems for the installation of the new Multi-Beam Sounder on the vessel.

5.1.3.1.1 Removal of equipment, tools and material

1. To enable all the work required during the dry-docking, the Shipyard will need to store in a secured and protected store room all equipment, tools and material that are actually stored in the vessel's cargo hold, this includes, but is not limited to the following items:

    - Mooring lines (blue);
    - Wooden pallets;
    - Rolls of steel cables;
    - C-Clamps;
    - Band saw;
    - Trash cans;
    - Step ladder;
    - Tool boxes;
    - Band sander;
    - Other miscellaneous tools;
    - Straps;
    - All steel and wooden beams or planks, in permanent racks;
    - All battens (aluminium);
    - Grey cabinet.

2. The spare anchor, bolted to the aft bulkhead in the cargo hold, can stay in the cargo hold. It must be protected for the whole work period in the cargo hold. The Contractor will need to produce a list of all the items removed from the cargo hold, and get it signed by the CGTA.

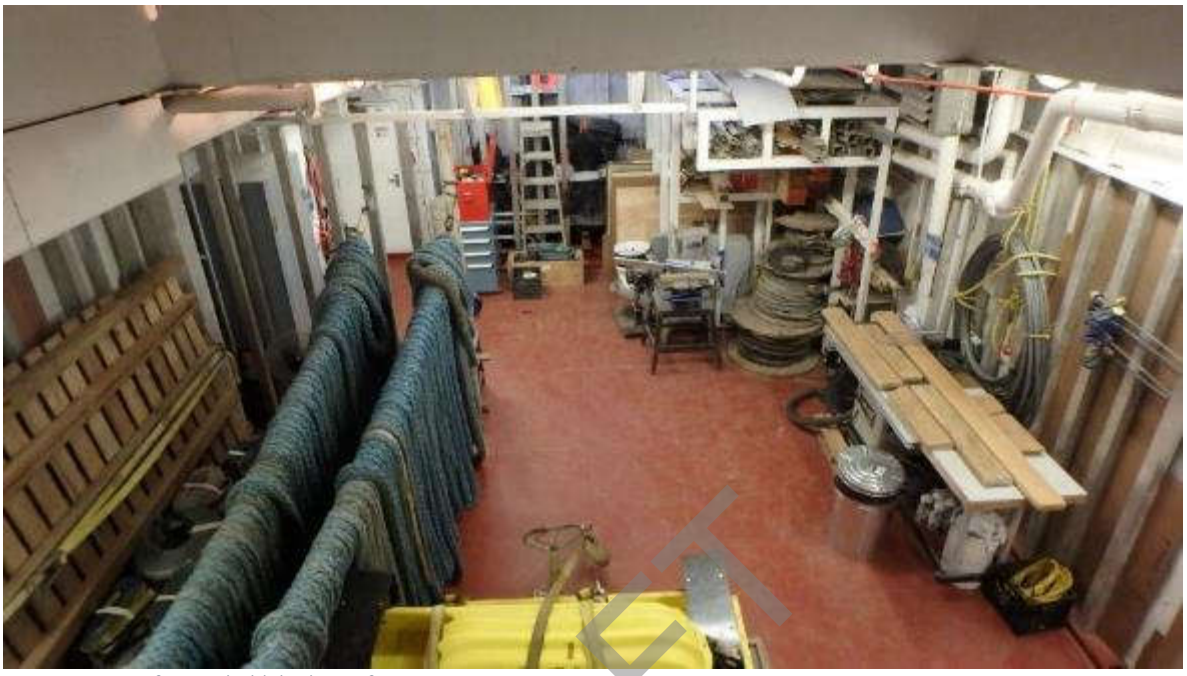


Figure 1 View of cargo hold, looking aft

5.1.3.1.2 Dismantling Work next to Port Longitudinal bulkhead

5.1.3.1.2.1 Port Aft Lumber Rack

1. In order to permit the planning of the work necessary for the installation of the Emergency exit from the Multi-Beam Sounder Compartment, the aft lumber rack on the portside of the Cargo Hold will need to be partially removed. The forward part of the rack will be removed definitely, as well as the deck and bulkhead tie-downs in this section (See *Figure* 2).

Figure 2 Lumber rack

2. Also during this work period, the rack must be removed and stored in a secure and protected warehouse. Once all work is completed, the rack will be reinstalled aboard vessel.

5.1.3.1.2.2 Hydraulic Piping

1. Behind the lumber rack, between frames 144 and 145, there are two (2) hydraulic lines that are not used anymore. In order to fit the new supply air ducting for the Multi-Beam Sounder Compartment, these two (2) pipes, as well as all the pipe supports will be removed permanently. Before dismantling these pipes, they will be cleaned, drained and gas freed. These two (2) lines, comprising of a total of six (6) pipes, will then be dismantled from the flanged connections. The two (2) flanges under main deck will be sealed using bolted blind flanges. The following pipes will need to be removed:
   - Pipe no.5-HH-3;
   - Pipe no.5-HH-4;
   - Pipe no.5-HH-5;
   - Pipe no.4-HH-2;
   - pipe no.4-HH-3;
   - Pipe no.4-HH-4.

2. These pipes are shown on drawing no.*68-2450-4 Hydraulic Piping for Heeling Pump.* Both these pipes are also visible in the Heeling Compartment and will need to be completely removed. The Contractor must ensure that these two (2) pipe penetrations in the cargo hold deck are plugged, so as to permit the installation of fresh air supply ducting for the compartment. Otherwise, the shipyard will install a doubler plate to close the holes.

5.1.3.1.2.3 Grey Water Piping

1. Behind the lumber rack, two (2) pipe lines will need to be dismantled for the whole work period, so as to permit modification work in front of longitudinal port bulkhead. Before dismantling these pipes, they will be cleaned, drained and gas freed (if necessary). Once work is completed, they will be reinstalled in their original position. The following pipes will need to be dismantled (also see *Figure* 3):

   - Pipe no.165-WC-4;
   - Pipe no.151-WC-8;
   - Pipe no.151-WC-7;
   - Pipe no.158-WC-2.

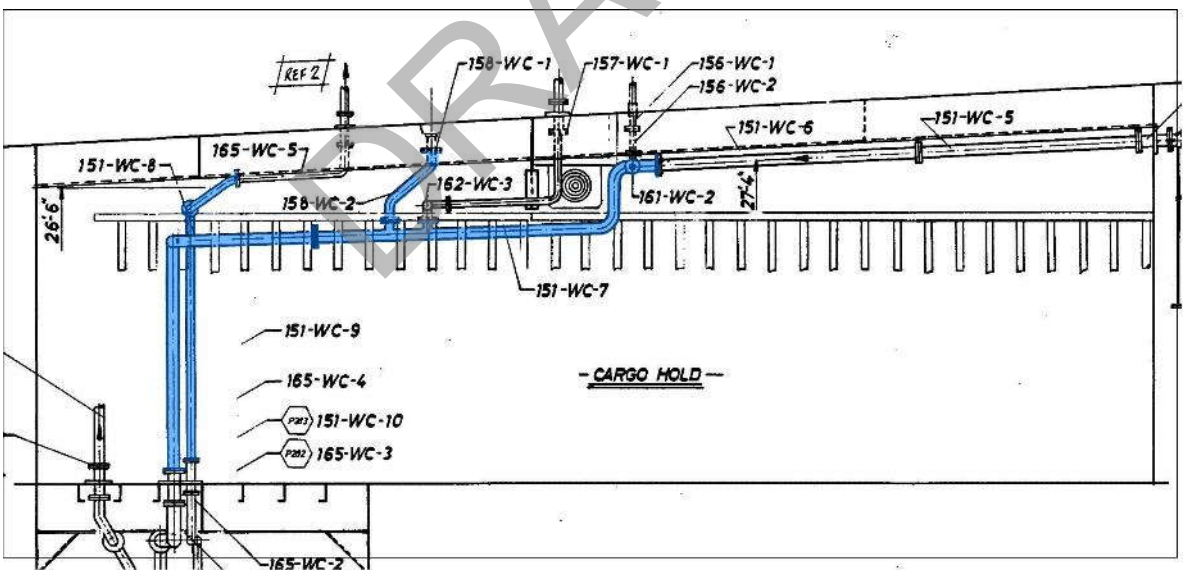


Figure 3 Grey water lines

2. For referencing, see ship drawing no.*68-2040-5 sheet 2 Grey Water System Arrangement*.

5.1.3.1.2.4 Arctic Fuel Piping (P-50)

1. The Arctic fuel transfer line will need to be dismantled and removed during the duration of work on the Multi-Beam Sounder project. This will be to permit modification work in front of port longitudinal bulkhead. Before dismantling these pipes, they will be cleaned, drained, and gas freed. The removed pipes will be reinstalled in their original position at the end of the installation of the sounder. The pipe run starts at deck level, frame 145 and terminates at frame 159 (see *Figure 4*).

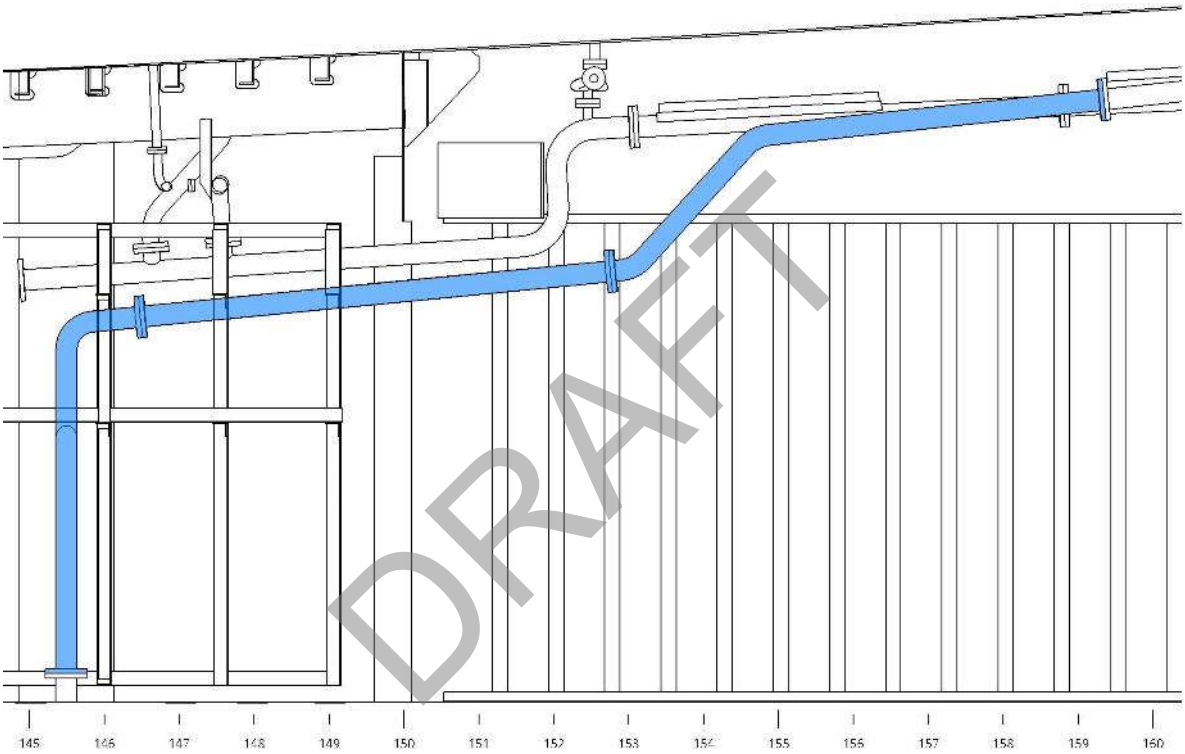


Figure 4 Artic Fuel

5.1.3.1.2.5 Insulation

1. The insulation material installed on the port bulkhead will need to be partly removed to permit welding work on the bulkhead. Insulation material between frames 141 and 149 will be completely removed, from floor to deck head. Insulation material from frame 149 to 153 will be removed from floor up to a height of 5 feet only. On completion of work, new insulation material will be installed in place of previously removed insulation material. New Fibre Glass, AF331, two (2) inches thick or equivalent material, will be installed. The new insulation will be covered with an aluminium perforated sheet metal covering, as described on drawing no.*68-H-114 Insulation Plan*.

5.1.3.2 Heeling Compartment

5.1.3.2.1 CO2 System

1. The actual CO2 system installed in the compartment will be completely dismantled and taken out of the vessel. This includes the three (3) CO2 cylinders, all CO2 piping, CO2 diffusers, alarms, as well as local control system and remote control system located on main deck at frame 139, starboard side (see *Figure* 5 *& Figure 6*). All equipment supports, brackets, tie-down bolts, piping, etc. linked to these systems are to be removed and taken off vessel. This system is illustrated on original drawing no.*68-2430-3 Arrangement of CO2 System – OMS.*

Figure 5 CO2 System

Figure 6 CO2 Pull Box Station, frame 139, main deck starboard

2. A hole in the passageway wall panel, caused by the removal of the pull box station, will need to be repaired by using a small cover plate, of a similar color as the passageway wall covering.

5.1.3.2.1.1 Compressed Air System

1. The compressed air system in the Heeling Compartment is not used anymore. The system will need to be removed. This include the main air receiver, with all piping, valves, and attached accessories. The tank supports, as well as all pipe supports will be removed and taken off the vessel. All piping to be removed up to the feed flange, illustrated at *Figure 7*.

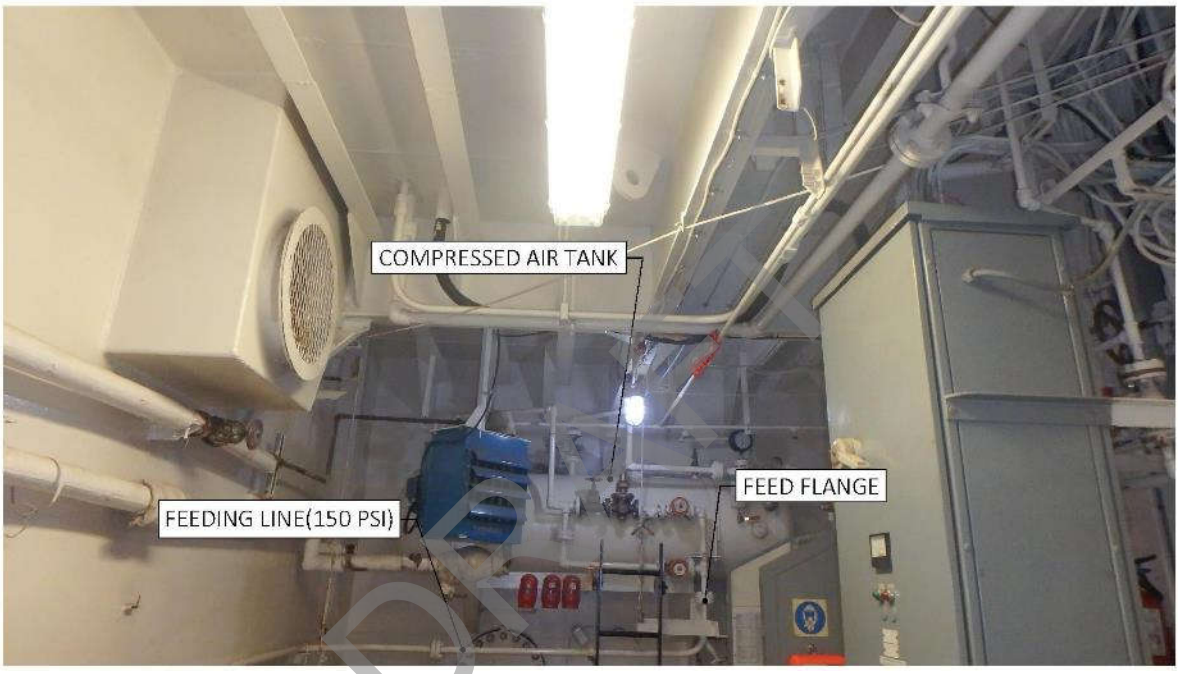


Figure 7 Air receiver, piping and accessories

5.1.3.2.1.2 Jerry can Support and Steel Shelving

1. In the Heeling Compartment, close to the aft bulkhead, there is a jerry can support, as well as a steel shelf. These two (2) items are to be dismantled and removed from the Heeling Compartment to enable the construction of the main longitudinal bulkhead. They will not be reinstalled (see *Figure 8*).

Figure 8 Jerry can support and steel shelving

5.1.3.2.1.3 Cable trays

1. The cable tray illustrated in *Figure* 9 is positioned on the aft bulkhead of the Heeling Compartment, at the center of the vessel. To permit the installation of the new central watertight bulkhead, this cable tray will need to repositioned slightly towards portside, (approximately 1 foot), as to permit installation of the new bulkhead.

2. As an alternative, the cable tray could also be reinstalled on the new central bulkhead, if need be. The cable tray's final position will need to be accepted by CGTA.

Figure 9 Cable tray

5.1.3.2.1.4 Heeling Compartment Raised Floor

1. The Heeling Compartment raised floor will almost be completely removed. The raised floor on the portside will be removed up to 6 feet from the center line on the starboard side. This includes all the plating material, as well as all the structure (stringers, stiffeners, etc.) that is part of the compartment raised floor. As the Grey Water system will need to be repositioned on the starboard side of the compartment, part of the raised floor, in front of the forward bulkhead will also be removed.

5.2 Structural Work

1. Important: All measurements present in the *5.2 Structural Work* section must be considered as informative. Those measurements and distances are given to facilitate the comprehension of the specification and to locate approximately the concerned works. For any actual measurements, please refer to drawing: *C16-77-165-01 Structural Modification Plan.*

5.2.1 Double Bottom

5.2.1.1 Structure removal

1. At frame 139, the bracket located on the 5'-7 ½" girder will be cut 18" under the tank top. The flat bar located on the 9' girder will also be cut 18 inches under the tank top (see *Figure 10*).
2. At frame 141, the tank top stiffener must be removed ½" before girder at 9' off centerline to 12' from centerline on port side (see *Figure 11*).
3. At frame 142, the floor will be removed from 9' to 16' off centerline, on port side (see *Figure 12*).
4. At frame 143, the tank top stiffener and bottom stiffener must be removed from ½" before girder at 9' off centerline on portside to 16' off centerline on port side. The bracket located between the two stiffeners on girder at 16' off centerline must also be removed (see *Figure 13*).
5. At frame 144, the floor must be removed from 9' to 16' off centerline, on port side (see *Figure 12)*.
6. At frame 145, the tank top stiffener and bottom stiffener must be removed from ½" before girder at 9' off centerline on portside to 16' off centerline on port side. The bracket located between the two stiffeners on girder at 16' off centerline must also be removed (see *Figure 13)*.
7. The bottom girder located at 12'-5 ½" off centerline on port side must be removed from frame 142 to frame 146.

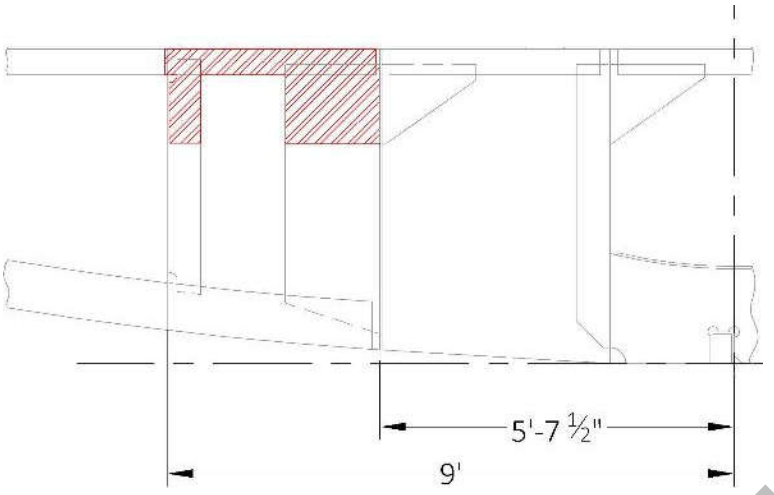


Figure 10 Structure dismantling, frame 139

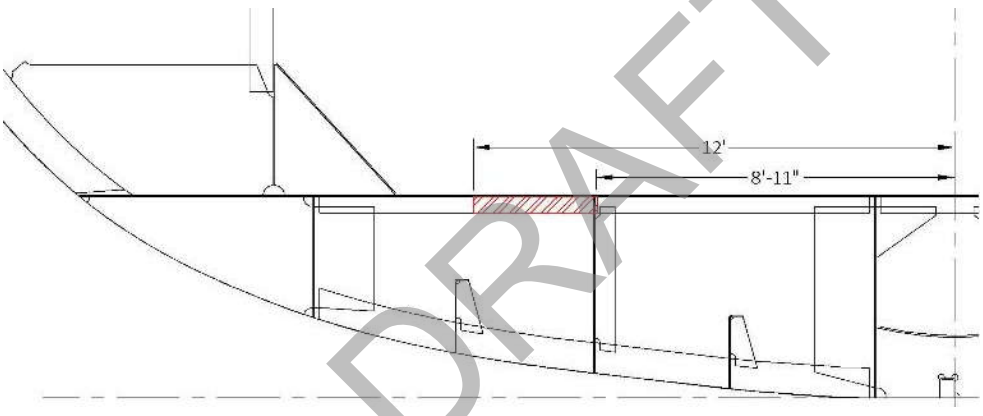


Figure 11 Structure dismantling, frame 141

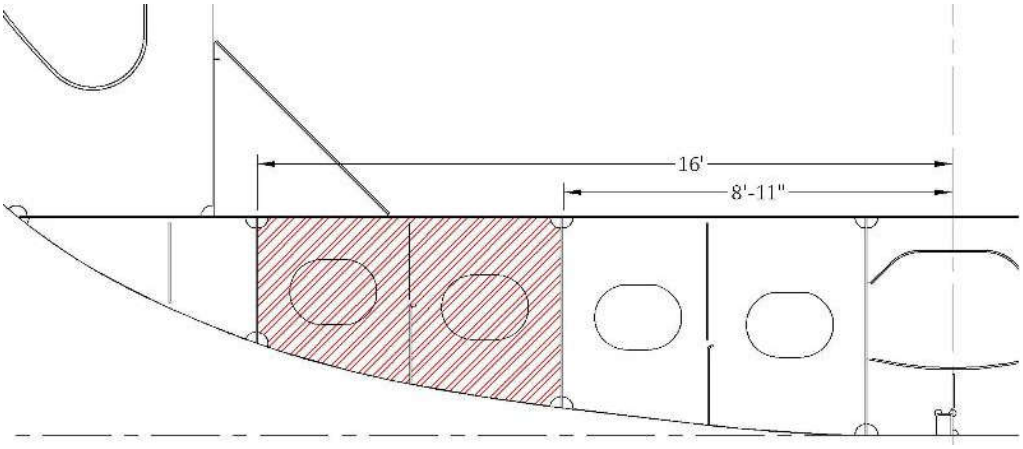


Figure 12 Structure dismantling, frames 142 & 144

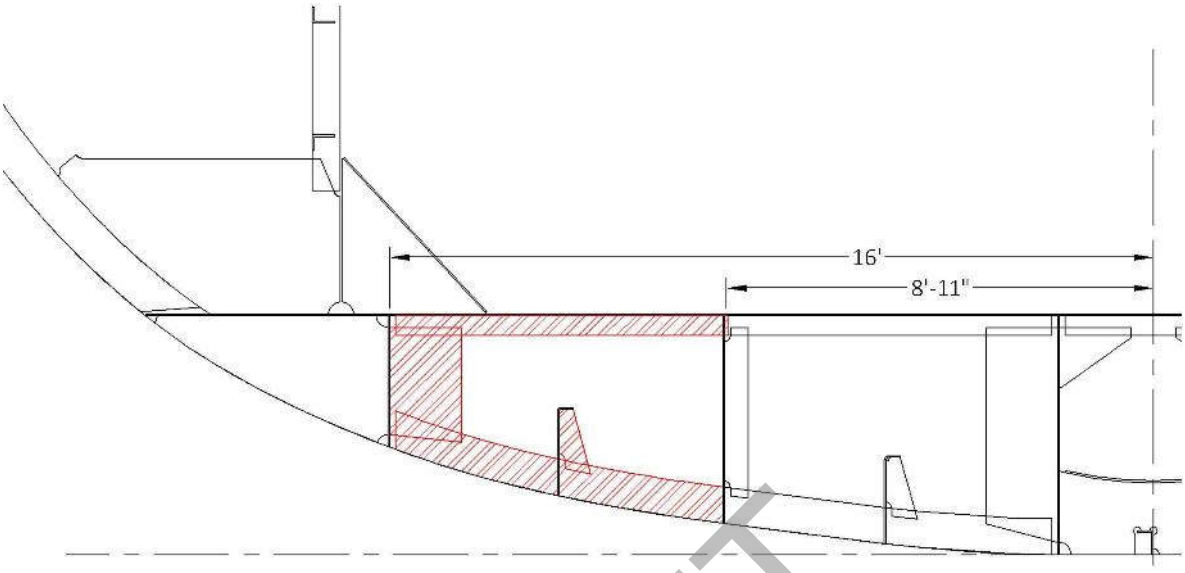


Figure 13 Structure dismantling, frames 143 & 145

5.2.1.2 Lightening and Drain Holes Closure

1. Scallops, drains and lightening holes are to be fitted with plating to blank off openings:
    a. On frames 140 and 146, between 9’ off centerline and the side shell;
    b. On girder at 9’ off centerline, from frame 140 to 146;
2. Watertight collars are to be fitted to tank top stiffeners and bottom stiffeners, in way of girder at 9’ off centerline, from frame 139 to 146.
3. Plate covers to be welded both sides.

5.2.1.3 Mounting Flange installation

1. A 1280mm diameter opening located at 11’-6” from the center line and 3’-8” aft of frame 146 is to be cut in the shell plate. Diameter opening to be verified with the latest Kongsberg Mounting Flange drawing.
2. Mounting Flange supplied by Kongsberg will be installed in the double bottom.
3. The extra length of the Mounting Flange shall be cut fit to the hull bottom and welded as prescribe in the drawing C17-66-165-01 Structural Modification Plan.
4. The Mounting Flange top shall be installed 8 inches above the tank top plate.
5. Brackets to be fitted to pipe, flange, and shell plate and welded in place. See *5.2.1.4. New structural elements.*

6. Flange is to be properly aligned on ship axis, following drawings. Alignment of Mounting Flange to be approved by Coast Gard Technical Authority and Kongsberg Field Service Representative (FSR) before final welding.

7. The Mounting Flange shall be brought in the Multi-Beam Sounder Compartment via the Cargo Hold. Once in the Cargo Hold, the Mounting Flange will need to pass through the new hatch opening made in place of the existing one, see *5.3.5.1 Hatch*. It will be easier to pass the Mounting Flange in the hatch opening prior the installation of the hatch bolting flange. The Mounting Flange may not pass through the opening if the structural arrangement that made the hatch watertight is installed.

5.2.1.4 New structural elements

All new structural elements are shown in drawing *C16-77-165-01 Structural modification*. Below is a listing of the principal structural modification but not the extent of. See drawing for full structural modification.

1. At frame 142, between girder at 9' off centerline and the Mounting Flange, a floor will be added. The floor will be knuckled 4" after the girder, toward the center of the Mounting Flange. Between girder at 16' off centerline and the Mounting Flange, a floor will also be added. The floors thickness is 1/2".
2. At frame 143, a floor will be added between the 16' off centerline and the Mounting Flange. The floor will be fitted with a lightening hole of 20" in diameter. The floor thickness is 1/2".
3. At frame 144, between girder at16' off centerline and the Mounting Flange, a floor will be added. The floor will be fitted with a lightening hole of 24"x18"at its center. The floors thickness is 1/2". Between girder at 9' off centerline and the Mounting Flange, a plate will be fitted. The floors thickness is 1/2".
4. At frame 145, between girder at 9' off centerline and the Mounting Flange, a floor will be added. The floor will be knuckled 12" after the girder, toward the center of the Mounting Flange. The floor will be fitted with a lightening hole of 20"x8" at its center. Between girder at 16' off centerline and the Mounting Flange, a floor will also be added. The floor will be knuckled 36" before the girder, toward the center of the Mounting Flange. The floor will be fitted with a lightening hole of 24"x18"at its center. The floors thickness is 1/2".
5. A brackets shall be added on top of the girder at 12'-5½", aft of the Mounting Flange. Forward of the Mounting Flange, a new girder sill be added. The girder thickness to be ½". The girder will be fitted with a lightening hole of 18"x14" at its center. The hole will be fitted with a 4"x½" flange.

6. Between frame 138 and 139, at 5’-7 ½” off centerline, a new bilge well need to be added.

5.2.2 Tank top

5.2.2.1 Tank top opening

1. An opening for the new bilge well will be fitted in the tank top, between frames 138 and 139. The opening will be 12”x20”, located at 6’-2” off centerline, on port side.
2. An opening for the Mounting Flange will be fitted in the tank top. The opening will be 1280mm in diameter and its center will be located at 11’-6” from the center line and 3’-8” aft of frame 146. Diameter opening to be verified with the latest Kongsberg Mounting Flange drawing.

5.2.3 17’-0” Flat

5.2.3.1 Structure removal

1. Stiffeners located at centerline, on bulkhead 138, and its associated brackets at top and bottom will be removed.
2. Bracket located at centerline under girder, on bulkhead 146, will be removed.
3. Stiffener at frames 143 on starboard side, will be removed from 6’-5” off centerline to ½” off centerline on port side (other side of girder) (see *Figure 14*).
4. Stiffeners at frame 144 and 145, on starboard side on the existing hatch, will be removed from 6’-5” off centerline to the transverse stiffener (see *Figure 14*).
5. Transverse stiffener located approximately at 5’ off centerline will be dismantled (see *Figure 14*).
6. Stiffeners at frames 144 and 145, on port side of the existing hatch, will be dismantled from free end to ½” after girder, on port side (see *Figure 14*).

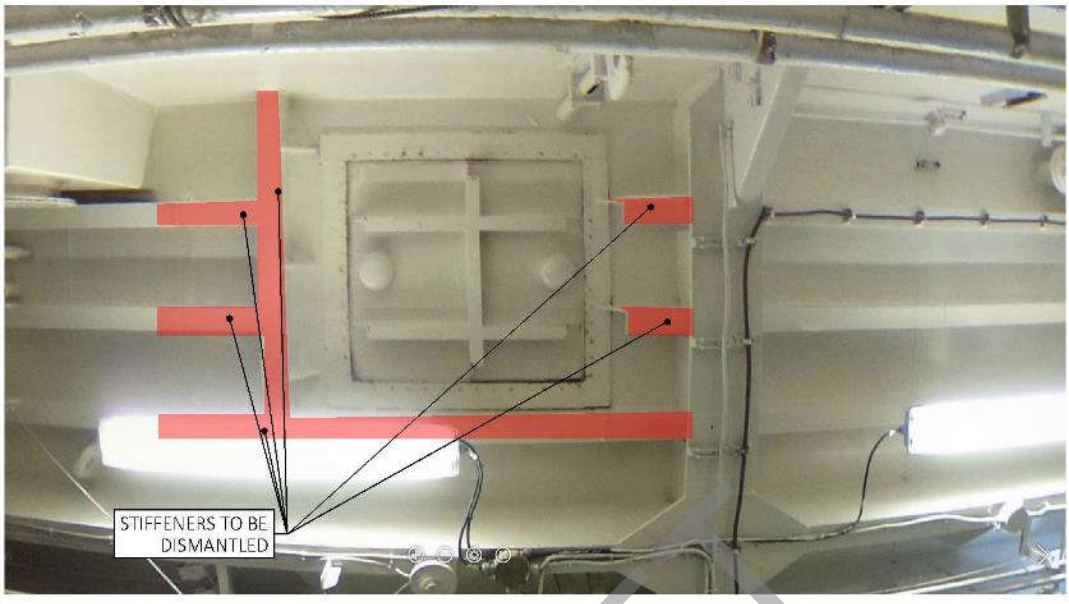


Figure 14 17'-0" flat structure arrangement. Looking from under

5.2.3.2 Bulkhead at centerline

1. Between the 17’-0” flat and the tank top, a watertight bulkhead will be fitted at centerline.
2. The bulkhead will rest on the tank top and under the existing girder.
3. The bulkhead will be fitted with 7”x4”x1/2” angle bars, with a spacing of 16”.
4. The bulkhead plate will be 5/16”.
5. The bulkhead will be fitted with opening and bulkhead pieces for pipes lines. See drawing *C16-77-201-01 Piping modification* for the detail of those pieces.
6. The bulkhead will be fitted with a watertight sliding door. See *5.3.4.1 Watertight sliding door.*
7. An opening of 8”x4” is to be made between frames 139 and 140 for the re-routing of the main cable tray. A watertight transit shall be installed to allow the cables to pass through the bulkhead.

5.2.3.3 Openings in 17’-0” flat

1. The 17’-0” flat will be fitted with two openings, one for the Multi-Beam EM716 Hull Unit and one for the escape route to the watertight door giving access to the Cargo Hold. The opening will be located in the heeling tank, about 11’-8” from centerline. See drawing for details.

5.2.4 Main deck

5.2.4.1 Structure removal

1. In the Port Heeling Tank, at frame 142, the stiffener located on the longitudinal bulkhead at 10’ off the centerline will be removed. Its attached brackets on top and bottom shall also be removed.
2. In the Port Heeling Tank, at frame 148, the stiffener located on the longitudinal bulkhead at 10’ off the centerline will be removed. Its attached brackets on top and bottom shall also be removed.
3. The deck stiffener at frame 148 shall be cut between 10’ and 14’ off centerline, on port side. The stiffener is located in the Port Heeling Tank.

5.2.4.2 Trunk in Port Heeling Tank

A new trunk will be fitted in the Port Heeling Tank, between frame 142 and 148.

1. A bulkhead will be added at frame 142, between 10’ and 14” off centerline, on port side. The bulkhead will be stiffened by a 7”x4”x1/2” angle bar, located at bulkhead center. The bulkhead will be fitted under the web frame in the heeling tank.
2. A bulkhead will be added at frame 148, between 10’ and 14’ off centerline, on port side. The bulkhead will be stiffened by a 7”x4”x1/2” angle bar, located at bulkhead center. The bulkhead will go from the 17’ flat to the Main Deck.
3. A longitudinal bulkhead will be fitted between frames 142 and 148, at 14’ off centerline, on portside. The bulkhead will be stiffened by 7”x4”x1/2” angle bars, space 16” apart. Watertight collars will be added at the top of the bulkhead, to allow the passage of the existing deck stiffeners.
4. All bulkheads to be watertight.
5. All bulkhead to be 5/16” plate

5.3 Structural outfitting

1. Important: All measurements present in the *5.3 Structural outfitting* section must be considered as informative. Those measurements and distances are given to facilitate the comprehension of the specification and to locate approximately the concerned works. For any actual measurements, please refer to drawing: *C16-77-626-01 Doors, hatch and manholes plan.*

5.3.1 Double bottom

5.3.1.1 Manholes

1. A flush-deck type manhole will be installed on the longitudinal girder at 9’ off centerline, on portside. The manhole will be located 2’-2¼” under tank top and will be centered on frame 143. The clear opening will be 15”x23”.

5.3.2 Tank top

5.3.2.1 Manhole closing

1. The existing manhole leading to the no.1 Double-Bottom Oil Fuel Tank (port side) will be closed. The raised flange and cover of the manhole will be dismantled.

5.3.2.2 Manholes

1. A flush-deck type manhole will be installed on top of the new Sounder Cofferdam. The manhole will be located 1’-1” forward of frame 140 and 10’-5’’ off centerline, on portside.
2. Sounder Cofferdam to be pressure tested with air to test tightness of the welds in way of the collars and covers.
3. On completion, paint coatings in sounder cofferdam to be repaired and restored.
4. A raised type manhole will be installed for access to the no.1 Double-Bottom Port Oil Fuel Tank. The manhole will be located 8” aft of frame 140 and 7’-4” off centerline, on portside.
5. No.1 Double-Bottom Port Oil Fuel Tank to be pressure tested with air to test tightness of the welds in way of the collars and covers.

5.3.3 Bulkhead frame 146

5.3.3.1 Manhole

1. A manhole will be fitted on the bulkhead at frame 146. The manhole is leading to the Port Fwd Fuel Oil Tank. The manhole is located 3’-7” above tank top and 5’ off centerline, on port side. The manhole is a flush-deck type, with handles. Clear opening is 15”x23”.
2. Port Forward Fuel Oil Tank to be pressure tested with air to test the tightness of the manhole.
3. On completion, paint coatings on bulkhead 146 to be repaired and restored.

5.3.3.2 Ladder

1. The Multi-Beam Sounder Compartment will be fitted with a ladder leading to the emergency exit.
2. The ladder is located on the bulkhead at frame 146, 11’-4" off centerline, on port side.
3. The ladder height is approximately 11’.
4. The first ladder rung is located 12” above the tank top.
5. The ladder sides are made of two flat bars 4”x1¼” and the rungs are made of 1”x1” square bars.
6. At the 17’-0” flat, two handrails, one on each side of the ladder, will be fitted. The handrails will be positioned to ensure a good grip and to avoid falls when going up or down the ladder.

5.3.4 Bulkhead at centerline

5.3.4.1 Watertight sliding door

1. In the new watertight bulkhead at centerline, under the 17’-0” flat, a sliding watertight door will be fitted. The clear opening of the door will be 2’-6”x 5’-9”. The watertight door box will be located on portside of the bulkhead. To open, the door must slide from aft to forward of the compartment. The door is located between frame 140 and 142 and will be installed as low as the manufacturer allows.
2. The door will be fitted with an inscription bearing “Keep door closed”.
3. A descriptive sign installed on each side of the door must clearly explain its operation.
4. The new sliding door will enter the compartment by the 17’-0” flat. In order to do so, the Contractor must pass through the new access hatch located on starboard side. However, depending of the dimension of the sliding door and its frame, it may not pass through the new hatch opening. Therefore, the Contractor must made a temporary opening wider than the new hatch opening to ensure that the door can enter the compartment below. The disassembly of the ventilation box on starboard side may be needed in order to make the temporary opening.

5.3.5 17’-0” Flat

5.3.5.1 Hatch

1. A bolted watertight hatch will be constructed and fitted in the 17’-0” flat to allow the installation and removal of equipment in the Heeling Compartment and the Multi-Beam Sounder Compartment. The hatch will be installed in the same area than the existing one. The existing hatch will be dismantled.
   a. The dimension of the hatch are 5’-10” wide by 5’-0 5/16” long.
   b. The clear opening will be 5’-2 9/16”x4’-4¾”.
   c. The hatch is located between frame 142 and 146, between the centerline and 6’-5” off centerline, on starboard side.
   d. The hatch will be fitted with two flush deck lifting lugs, with a S.W.L. of 0.5 tonne each.
   e. The hatch will be fitted with one flexible drainpipe to ensure any trapped water goes to the Heeling Compartment bilge instead of the compartment. The pipe end will be fitted with a ball valve to control the trapped bilge water.

5.3.5.2 Lifting lugs

1. A total of 12 lifting lugs are to be installed inside the Multi-Beam Sounder Compartment and the Heeling Compartment, six (6) in each, under the 17’-0” flat. Lug capacity is 5 tonnes each. The lugs will be installed under the deck, at a location estimated as the best by the Contractor for the installation of all the equipment in both compartments, with the approval of the Coast Gard Technical Authority. Two (2) additional lifting lugs will be added in line with the lifting points on the Mounting Trunk, in the Multi-Beam Sounder Compartment.

5.3.6 Cargo Hold

5.3.6.1 Longitudinal bulkhead at 10’ off centerline, on portside

5.3.6.1.1 Manhole

1. A manhole will be fitted in the longitudinal bulkhead at 10’ off centerline, on portside. The manhole is leading from the Cargo Hold to the Port Heeling Tank. The manhole is located 3’ above the 17’-0” flat and 9¾” forward of frame 150. The manhole is a flush-deck type, with handles. Clear opening is 15”x23”.
2. Port Heeling Tank to be pressure tested with air to test tightness of the welds in way of the collars and covers.

5.3.6.1.2 Watertight door

1. A watertight door will be fitted in the longitudinal bulkhead at 10' off centerline, on portside. The door is the emergency exit from the Multi-Beam Sounder Compartment. The door is located between frames 146 and 148, with a sill of 6 inches.
    a. Door clear opening will be 24"x66".
    b. The door will be a hinged quick-acting door, with wheel on each side.
    c. The door will open from trunk to cargo hold, from aft to forward.
    d. The door will be fitted with an inscription bearing "Keep door closed".
    e. Trunk in heeling tank to be pressure tested with air to test tightness of the welds in way of the collars and covers.

5.3.6.2 Partial bulkhead at frame 140

5.3.6.2.1 Watertight door

1. A watertight door will be fitted in place of the actual fire door leading to the Heeling Compartment. The door is located on bulkhead at frame 140, in the cargo hold, on starboard side.
    a. Door clear opening will be 30"x72".
    b. The door will be a hinged quick-acting door, with wheel on each side.
    c. The door will open from Heeling Compartment to cargo hold.
    d. The door will be fitted with an inscription bearing "Keep door closed".
    e. The actual fire door will need to be dismantled.
    f. Minor steel work will be necessary on bulkhead to fit the new watertight door
    g. The insulation on the bulkhead will be dismantled before the modification. It shall be re-installed after all work is completed.
    h. The Pull station cloaked next to the existing door will be dismantle bore the modification take place. It shall be re-installed after the completion of the work.

5.3.6.3 Keep battens

1. At frame 149, the existing support for the battens ends on the lumber storage rack. As the rack will be dismantled in this area, more battens will be added to protect Emergency Exit Route (see *Figure* 15*)*
2. One battens support made of an aluminum channel 5"x2½" of approximately 5' in length will be added a frame 149, on port side. The channel will be installed on deck, in line with the new upper support.

3. The lower support will be fastened to the deck with the same method as the existing support. It will be fastened with 4" long, ½" diameter nelson stud, with a ½" hex nut and a stainless steel washer. The studs will be spaced 24" apart.
4. The upper support will be made of 5"x1¾"x6.7# steel channel. The upper support will be 5' in length and will be installed approximately 8'-6" above deck, to match the existing supports location.
5. Three new battens will be installed in the new section. The holes for the battens will be made in the support prior to installation.
6. The battens are made of 3"x3" aluminium square tubes. The battens are 8'-7" long, see drawing *68-H-147 Forward Cargo Hold*.

Figure 15 New battens supports

5.3.7 Aft Mast

1. Extension arms and mounting brackets are to be installed on each side of the aft mast for the installation of the GNSS antennas. See drawing *C17-66-185-01 GPS Antenna Arrangement* for location and structural arrangement.

5.4 Piping modification

1. Following is a description of all pipes modification that need to take place during structural works to ensure proper sounder installation and all the equipment. It is important to note that all measurements present in the following section must be considered as informative. The measurements and distances are given to facilitate the comprehension of the specification and to locate approximately the concerned works. For any actual measurements, please refer to drawing: *C17-66-201-01 Piping Modification.*

5.4.1 Heeling Compartment and Multi-Beam Sounder Compartment

5.4.1.1 Fuel system

1. Two fuel lines will be dismantled to allow the trunk and gate valve installation. The two lines will be re-assembled with a new pipe path, as shown in drawing *C17-66-201-01 Piping modification*. One pipe needs to be modified to pass through the new watertight bulkhead at centerline. Flanges will be added to the pipe line to allow the bulkhead installation.
2. In Multi-Beam Sounder Compartment, transfer fuel oil pipe 28-OF needs to be disassembled from the connection at valve on bulkhead frame 146 to the flange connection on bulkhead frame 138. Valve doesn't need to be disassembled (see *Figure* 16 and *Figure* 17). Re-assembly to be as shown in drawing mentioned above.

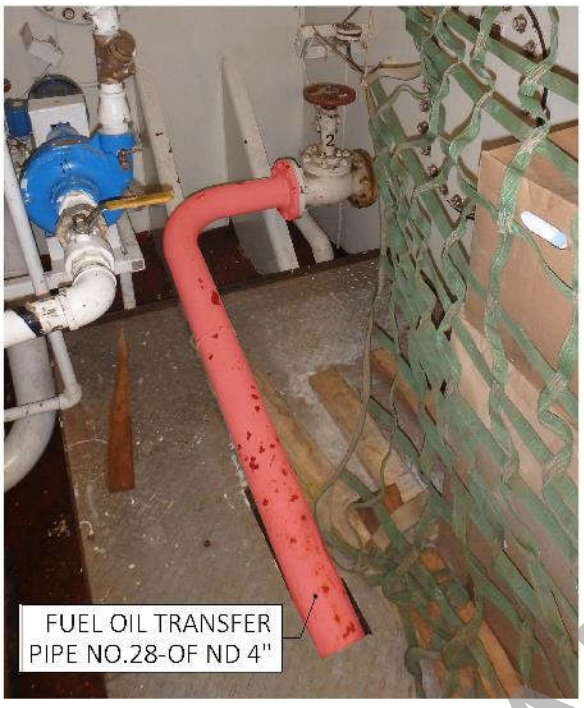


Figure 16 Fuel oil transfer, connection at bulkhead 146

Figure 17 Fuel oil transfer, connection at bulkhead 138

3. Still in the Multi-Beam Sounder Compartment, the fuel oil transfer pipe 27-OF, Nominal Diameter of 4”, will be disassembled from the valve connection at longitudinal bulkhead at 17’ off centerline to the flange connection at bulkhead 138. The valve doesn’t need to be disassembled. The pipe will be re-assembled with a new pipe path, as shown in the drawing *C17-66-201-01 Piping modification* (see *Figure* 18 and *Figure* 19).

Figure 18 Fuel Oil transfer 27-OF, connection at bulkhead 138

Figure 19 Fuel Oil Transfer 27-OF, connection at longitudinal bulkhead

4. The fuel line to be modified to permit the bulkhead installation is connected to the ballast system, because it's used for the flume tanks. The spool to be modified is 1-FL-1 from *68-2000-2 Bilge and ballast Arrangement*. The pipe will be cut at 1'-6" off centerline on portside and at 6½" off centerline, on starboard side. Flanges will be added to the pipe line. A new spool, of 2'-1" long, with a flange at each end, will be installed between the two new flanges on spool 1-FL-1. A bulkhead piece will be welded to the new pipe before the flange installation (see *Figure 20*).

Figure 20 Line 1-FL-1 to be modified

5.4.1.2 Bilge system

1. The bilge system will need to be modified to allow the installation of the new watertight bulkhead at centerline. The upper section of the bilge line in the compartment will need to be re-routed. On portside, the bilge line needs to be dismantled from the flange connection close to the 17' flat, at 5' of the centerline to the "Tee" located at 12" off centerline on starboard side. The pipe on starboard needs to be dismantled from the flange close to the 17' flat at 5' of the centerline to the "Tee" located at 12" off centerline on starboard. The "tee" needs to be removed and the pipe 65-BL-5 (from drawing *68-2000-2 Bilge and Ballast Arrangement*) to the flange located at 5' above the tank top. The two existing valves (BL-35 & BL-90) will be dismantled and re-installed on the new bilge line. The new bilge lines are shown in *C17-66-201-01 Piping modification (*see *Figure 21* & *Figure 22*).

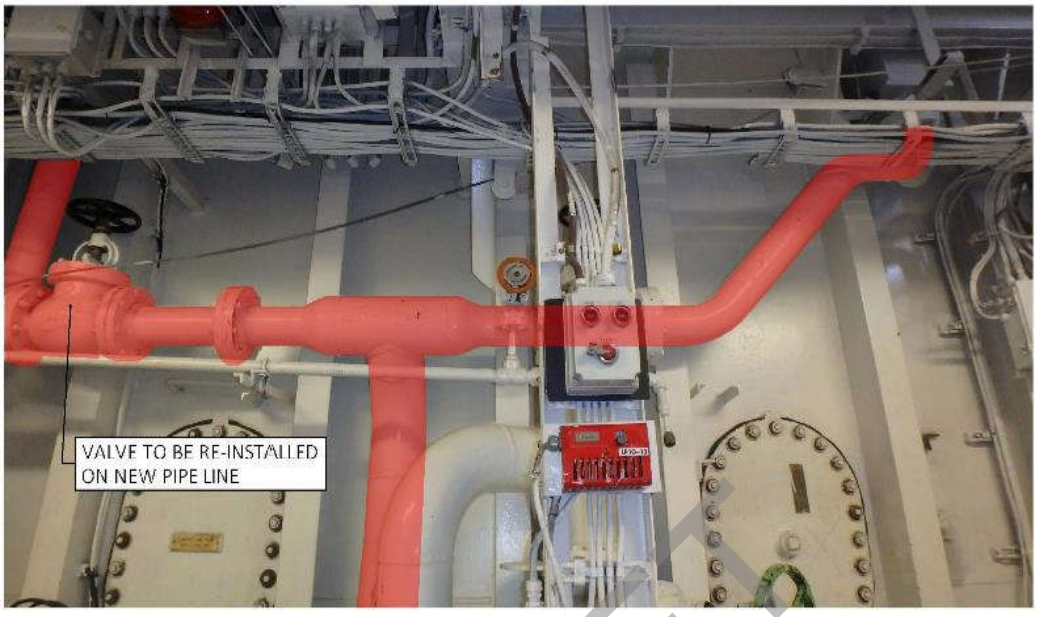


Figure 21 Upper section of bilge line

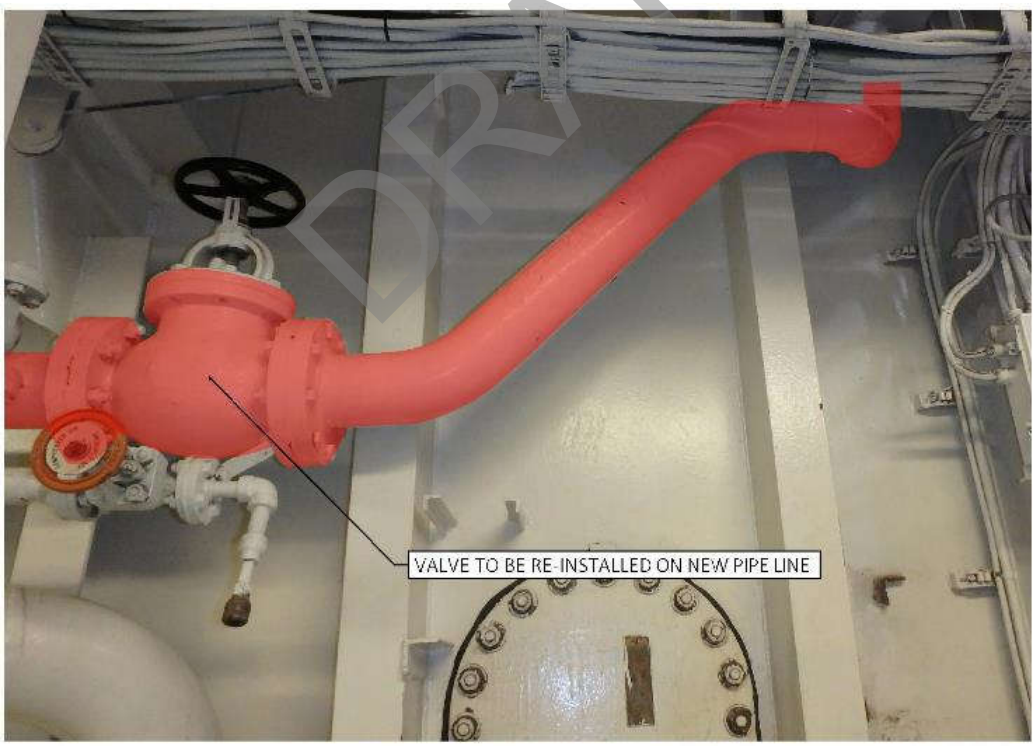


Figure 22 Port upper section of bilge line

2. A new line leading to the new bilge well on portside will be added. The new line will be connected to the pipe 65-BL-3, 8 inches above tank top. The pipe will run on port side, reaching the bilge well located 85" off centerline. A pneumatic remote-controlled valve will be fitted on the new pipe line. The valve control system will be integrated to the existing system of the ship, see drawing *2043143 Schéma global du contrôle*, from Pneutech. A control wire (24V D/C) run from each pneumatic actuator to the control panel *Boitier Électrique 2043143* at upper deck, at frame 54. The valve will be operated using the existing compressed air in the compartment. The existing line will be dismantled as required by5.1.3.2.1.1 Compressed Air System. From there, a new pressure reducing station will be added. It shall be composed of a two globe valves, 2 pressure gages, one strainer and one pressure reducing valve (see *Figure 23*). The line will be made of a 1 inch pipe. The pressure shall be reduced from 150 PSI to 100 PSI. After the pressure reducing station, the line will split in two to go to the two new pneumatic operated valves. A mud box will be fitted at the end of the line, in the well. The new line is shown in the drawing mentioned above.

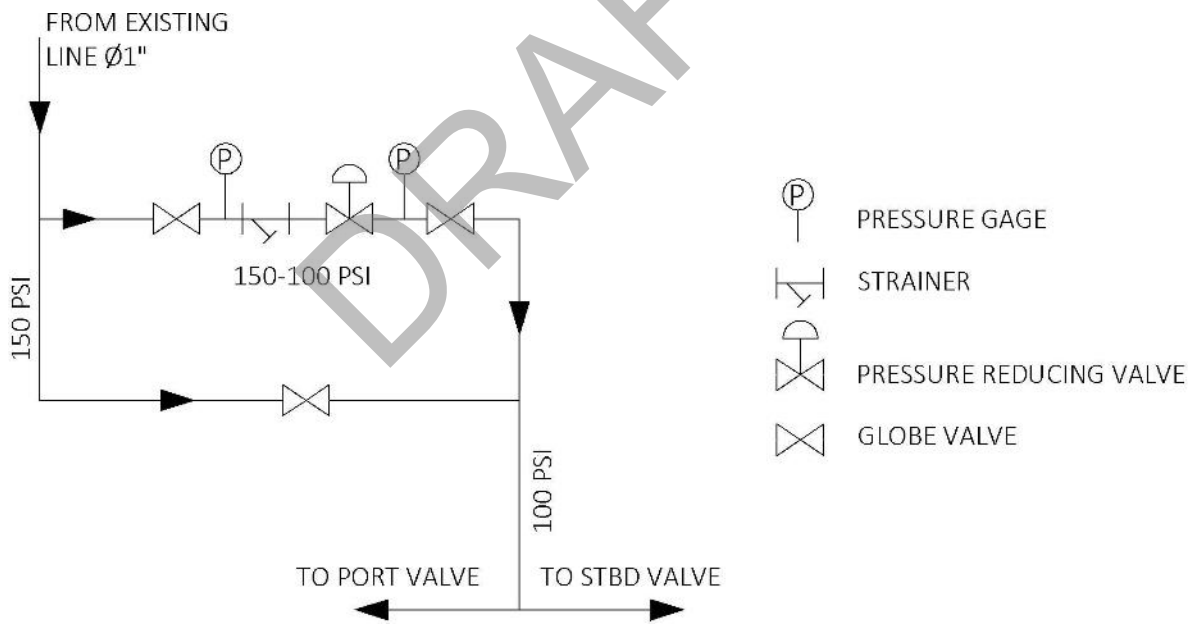


Figure 23 New pressure reducing station

3. On the existing line going to the bilge well on starboard side, the valve will be replaced with a new pneumatically remote-controlled valve. The valve control system will be integrated to the existing system of the ship, as mentioned above.

5.4.1.3 Ballast system

1. The actual configuration of the ballast line is not compatible with the installation of the watertight bulkhead at centerline. Therefore, the ballast line will be modified to fit the new design of the compartment. The pipe needs to be dismantled from the valve located on spool 8-BA-2, located just off the centerline, to the Tee connection located 3’ above tank top. From the Tee, the line on starboard will be dismantled up to the valve connection. On Portside, the line will be cut at 3’-10” off centerline (see *Figure 24* and *Figure 25*). The new ballast line is shown in the drawing *C17-66-201-01 Piping modification*. Note that the existing valve need to be rotated. It shall be re-installed with the handle pointing forward.

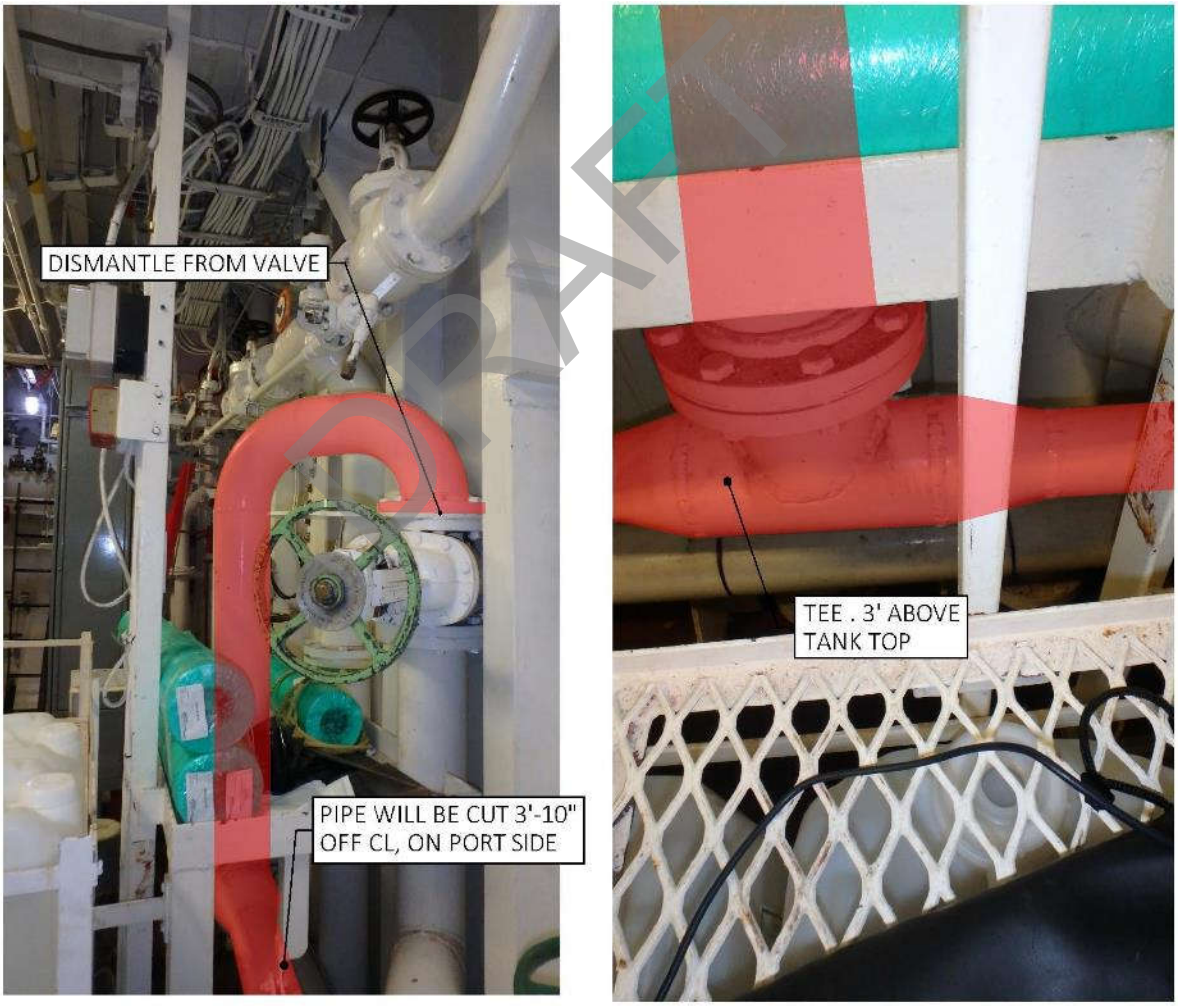


Figure 24 Ballast line to dismantle

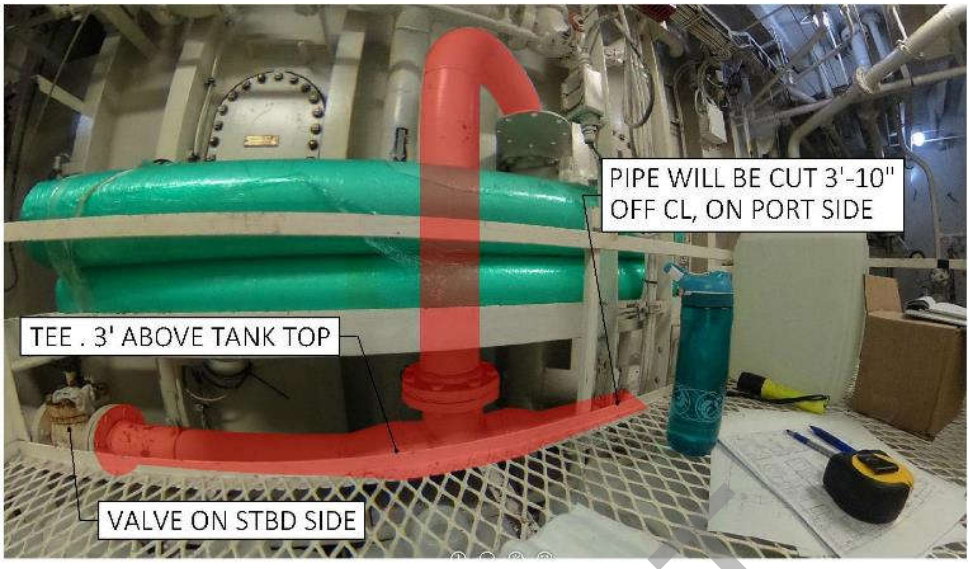


Figure 25 Ballast line, looking aft

5.4.1.4 Grey Water System

1. The grey water plant needs to be moved from portside to starboard side. It shall be located alongside the bulkhead at frame 146. See drawing *C17-66-180-01 Grey water system skid* for exact location. Due to the re-location of the system, the existing pipes coming from the 17'-0 flat and going to the system will be dismantled. New pipe lines will be routed in the compartment from starboard to port, passing through the watertight bulkhead at centerline. The existing deck penetration on portside shall remain the same (see *Figure 26* & *Figure 27)*. The new lines are shown in *C17-66-201-01 Piping modification.*

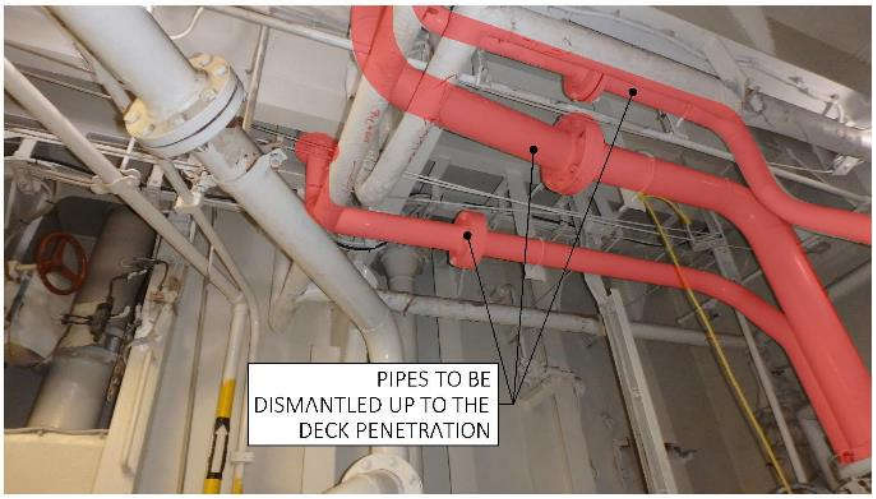


Figure 26 Grey water pipe under 17'-0" flat

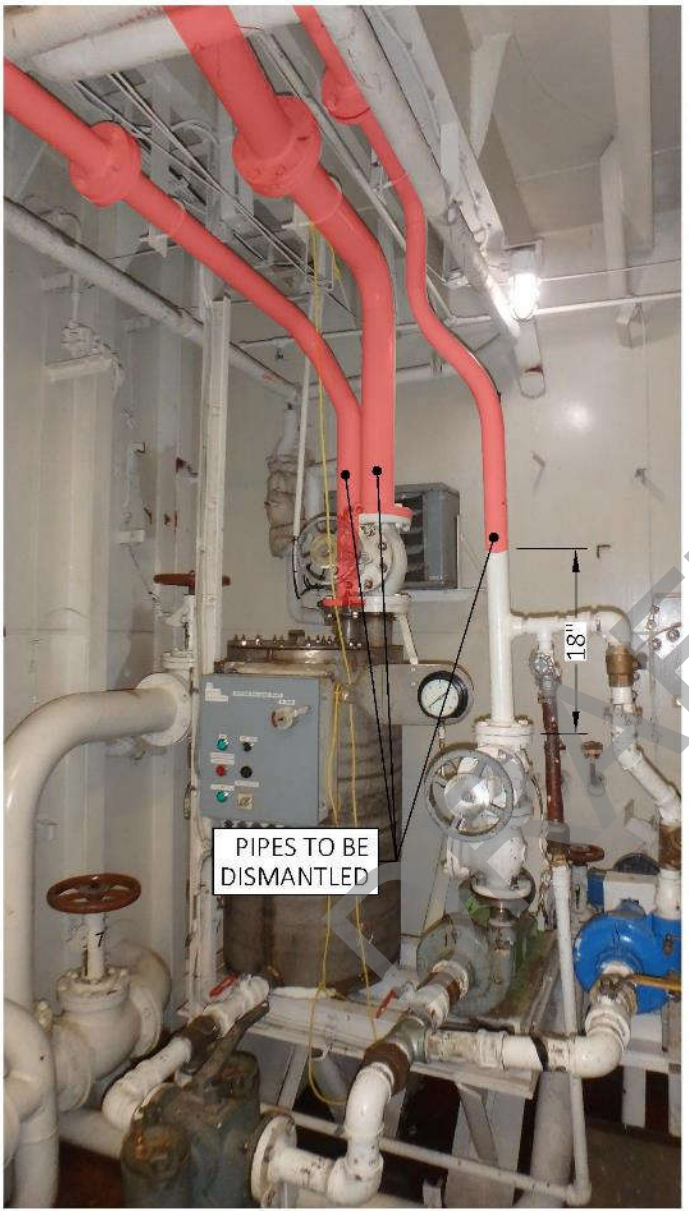


Figure 27 Grey water system

5.4.1.5 Sounder cofferdam air vent

1. A new air vent will be added to the new sounder cofferdam, located in the double bottom. The piping diameter will be 2 ½". The air vent will be going up through the cargo hold, main deck and outside on the upper deck. The pipe shall run as close as possible to the new air supply conduct in the cargo hold and accommodation. On the upper deck, the air vent will be ending with a goose neck. The goose neck shall have a minimum height of 30" above the deck. The goose neck will be fitted with a self-closing appliance.

5.4.1.6 Bleeder

1. One ½" diameter air bleeder air pipe to be fitted from the mounting trunk to 30" above main deck, fitted with a goose neck, for further connection on ram unit bleed valve.

5.4.1.7 Sounding pipe

1. A sounding pipe will be installed for the new sounder cofferdam, located in the double bottom. The new sounding pipe is shown in the drawing *C17-66-201-01 Piping modification*. The sounding pipe will be fitted with a self-closing device and a screw cap on top. Pipe diameter to be 1 ½". A striking plate shall be installed at the bottom of the pipe to protect the bottom of the compartment when sounding.

5.4.1.8 Hot water pipe

1. To ensure that no ice is trapped in the Mounting Flange (supplied by Kongsberg), hot water will be sent in the Mounting Flange. The hot water will come from the steam condensate heat exchanger located in the forward engine room. The heat exchanger is located on starboard side, at frame 96, on the second level of the engine room. The heat exchanger discharge line (sea water) runs under the engine room flat (17' above base line) toward portside. A connection with a Tee will be made on that line. The new line will be a 1 inch diameter pipe. A ball valve will be added after the connection with the discharge line. The new line will go under the raised floor, at centerline, and run forward up to frame 122. At frame 122, the line will go forward in the duct keel tunnel until it reaches frame 145. At frame 145, the line will run up in the Multi-Beam Sounder Compartment and be connected on the Mounting Flange. The hot water pipe will be connected to the Mounting Flange with a ball valve and a check valve as close as possible to avoid breaking / leaking, see detail in drawing *C17-66-201-01 Piping modification*.

5.4.1.9 Steam pipes

1. Two (2) steam pipes going from one heater to the other pass through the new watertight bulkhead. The two pipes will be cut on each side of the centerline and flanges will be added at the cut edges. A new pipe with flanges at each end will be added. See *C17-66-201-01 Piping modification* (see *Figure 28).*

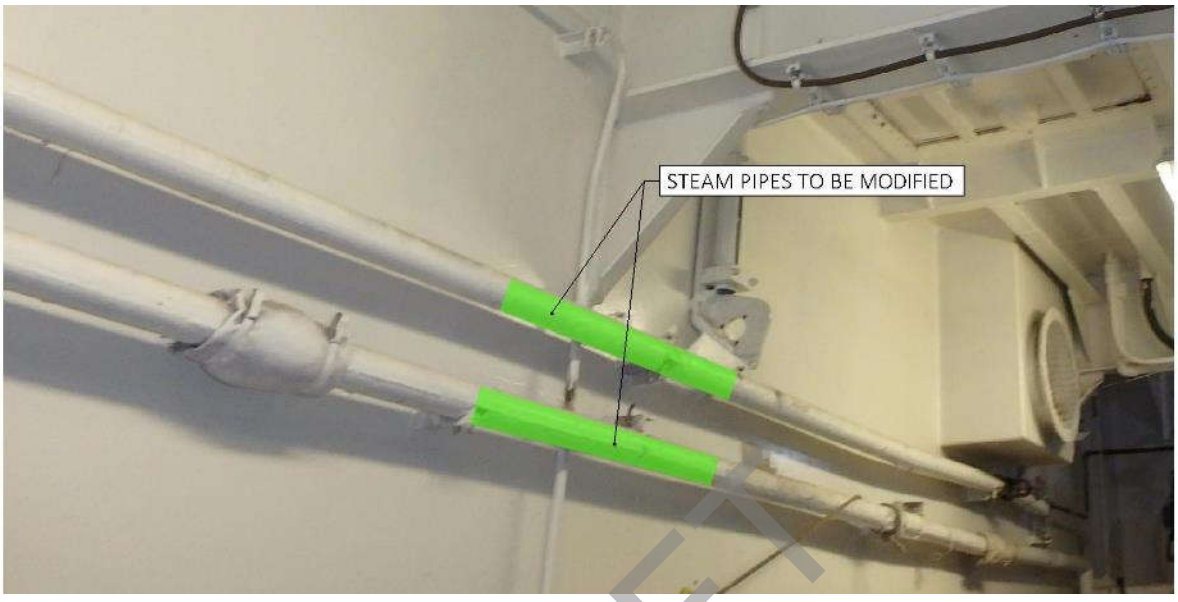


Figure 28 Steam pipes

5.4.2 Cargo Hold

5.4.2.1 Sounding pipe

1. The sounding pipe of the Port Oil Fuel tank, line no. 27-VS, with a pipe diameter of 1½", shall be dismantled from the upper deck to the end of the pipe. This include spools no. 27-VS-1, 27-VS-2, 27-VS-3 AND 27-VS-4. The pipe shall be relocated 6' to port side. Its new position is 15'-6" off centerline, on portside. It will now pass through the Port Heeling Tank under main deck and in the gymnasium locker between main deck and upper deck. The section of pipe running through the heeling tank shall be in sch.80.

5.4.2.2 Steam pipes

1. Two (2) steams pipes need to be modified to fit the new design of the Multi-Beam Sounder Compartment ventilation. A new ventilation trunk will be added between frame 144 and 145 in the cargo hold as the steams pipes are in the way. The steam pipes will be removed from frame 145 to frame 143. One pipe is identified as spool 103-AS-8 on drawing *68-2220-3 Steam and condensate arrangement*. Two new lines will be fitted on the existing ones, in a way to get round the new ventilation trunk. The connections between the old and new pipes will be made with flanges. Pipes diameter to be ¾".

5.4.2.3 Port Heeling Tank sounding transducer

1. On the port longitudinal bulkhead, around frame 143 and 144, is located a level sounder for the heeling tank. With the installation of a new cofferdam in the port heeling tank, the use of this sounding transducer became void. The sounding transducer and valve will need to be moved. The sounding transducer and its attached monitoring cable, will be moved into the new cofferdam, on the longitudinal bulkhead located 14' off centerline. The sounding transducer needs to be re-installed at the same height from the flat than its actual position. This would allow the sounding transducer to be re-installed without being re-calibrated.

5.5 Ventilation

1. In the existing Heeling Compartment, there is one ventilation trunk for air supply and one for air outlet (see *Figure 29* and *Figure 30*). With the installation of the new watertight bulkhead at centerline, each new compartment is short of one ventilation trunk (supply for the starboard one and outlet for the port one). Following is the description of the modification to take place to add ventilation supply and outlet for the two new compartments. The drawing *C17-66-601-01 Vessel modification key plan* shows the location of the new trunks.

Figure 29 Existing ventilation on port side

Figure 30 Existing ventilation on starboard side

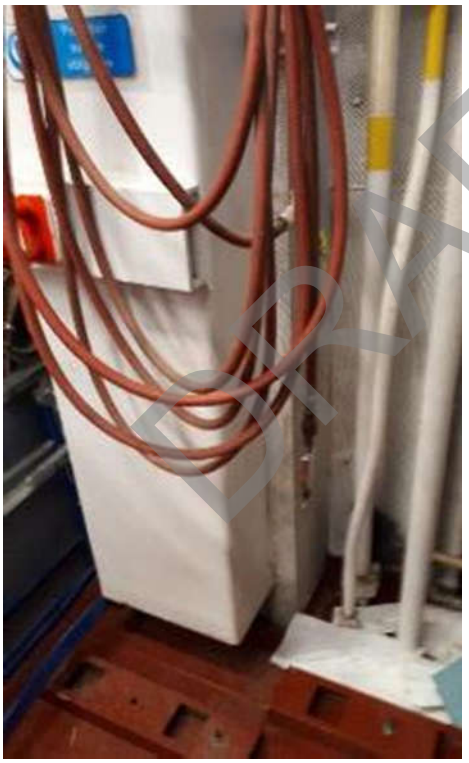
5.5.1 Cargo hold

1. The actual cargo hold ventilation outlet trunk is located on starboard side, between frame 145 and 146. The trunk run from the upper deck to the bottom of the cargo hold. This trunk will be converted in an air outlet for the Heeling Compartment. A new air outlet ventilation trunk for the cargo hold will be installed. The new trunk will be located on the forward bulkhead of the cargo hold, at frame 165. The trunk center is to be placed at 3'-2" off centerline, on starboard side. It will run between the cargo hold stairs and the forward bulkhead, next to the existing ladder.
2. The new trunk will run from the bottom of the cargo hold (4 inches above the 17'-0" flat) to the upper deck. The trunk will pass through the front of the hatch coaming. Outside the cargo hold, the ventilation trunk will end with a goose neck, 30" above the upper deck.
3. The new trunk need to have the same area than the existing one, to avoid back pressure or bad air circulation. Trunk dimension to be at least 8"x 1'-8". The trunk will be made of ¼" steel plate.

5.5.2 Heeling Compartment (on starboard side)

1. The actual vent box in the Heeling Compartment will be modified. The vent box will be divided in two sections, one on starboard and one on port. The starboard section of the ventilation box will be the inlet air and the port section, the outlet.

2. The inlet is already connected to a ventilation trunk that runs up to the upper deck, ending with a goose neck above deck. On the starboard side of the ventilation box, a new duct will be connected. The duct will be 14 inches in diameter. It will run from the vent box toward starboard, for 3'. The duct will be fitted with a supply fan at its end. The fan will be a Twin City model TB, format 14B105, see 5.6.12 New Ventilation Fans. The port section of the vent box will be the air outlet of the Heeling Compartment. The outlet will have to be connected with the existing trunk located above, in the cargo hold (see

3. 

4. Figure 31).

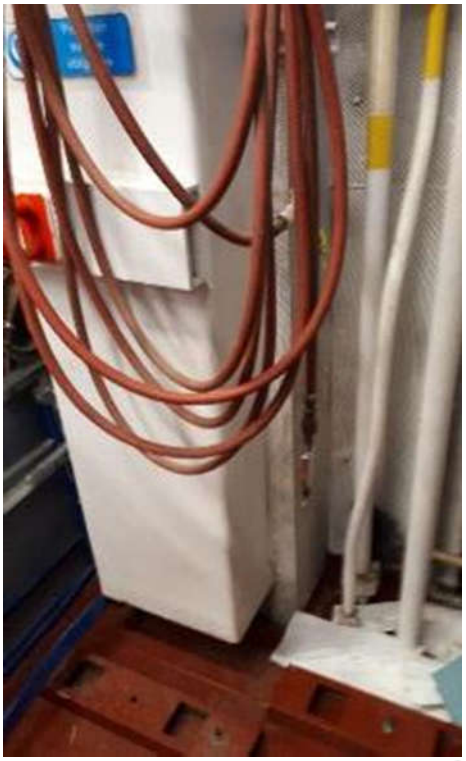


Figure 31 Existing cargo hold air outlet to be modified

5. The existing trunk is the outlet trunk for the cargo hold ventilation. The connection will be made through the 17'-0" flat. The port section of the vent box will be fitted with a small duct section, 14" in diameter. This section will be about 6 inches long and will be fitted with a grid at its end.
6. In order to connect the existing trunk with the ventilation box below the 17'-0" flat, some items will need to be dismantled prior to the hot work.
    a. The two lower supports for the battens will be dismantled, then re-installed after the modification (see *Figure 32*).
    b. The insulation located on the existing ventilation trunk behind the air outlet will need to be dismantled on 2' from the deck. The insulation will be re-installed after modification.
    c. The insulation located on the longitudinal bulkhead will be dismantled on 12" on each side of the trunks, and on 2 feet high. The insulation will be re-installed after modification.

Figure 32 Lower support of battens

7. On the upper deck, the nameplates of the two existing goosenecks that are connected to the ventilation trunk shall be renamed indicating the new compartment they serve.

5.5.3 Multi-Beam Sounder Compartment (on port side)

1. The ventilation box in the Multi-Beam Sounder Compartment will need to be modified. The existing duct and fan connected to the box will be dismantled. The hole thus created will need to be blanked. A new opening, in the bottom of the box, will need to be made. The opening will be 13” long by 20” wide. The opening will be fitted with a grid.
2. A new ventilation box will be constructed aft of the existing one, between frames 144 and 145. The box will be 16” long x 12” wide by 29” high. The box will be made of 5/16” steel plate. A ventilation duct will be fitted to the new box. The duct will run toward the centerline of the vessel. The duct will be 14” in diameter, in 16 gage steel sheet. The duct will be 12’-8” long. An elbow will be fitted at its end. A supply fan will be fitted on the elbow. The fan will be a Twin City model TB, format 14B105, see 5.6.12 New Ventilation Fans. See drawing *C17-66-601-01 Vessel modification key plan* for an arrangement of the new ventilation duct and fan.
3. An opening will be made in the 17’-0” flat, in line with the new ventilation box. The opening is located between frame 144 and 145, from 9’ to 10’ off centerline, on port side. A new supply air trunk will be installed in the cargo hold, above the opening and new ventilation box, next to the existing one. The new trunk will be located between frame 144 and 145, on the bulkhead on portside of the hold. The trunk will run from the 17’-0” flat to the upper deck. Once on the upper deck, the trunk will be fitted with a 14” diameter pipe, ending with a goose neck. The goose neck will have a minimum height of 30”. Between the main deck and the upper deck, the trunk will run in the accommodation. After installation, the ventilation trunk will need to be enclosed in lining at the main deck level. Lining material and specification to be as per CCG requirement. The section of the trunk located in the cargo hold shall be insulated as required by the vessel’s insulation plan.

5.6 Equipment Installation

1. The following describes all the equipment that needs to be installed by the Contractor. Please refer to article 3.3 to view the equipment list that will be supplied by the Contractor, and the equipment list that will be supplied by the Canadian Coast Guard.
2. Kongsberg FSR services, supplied by CCG, will be available during Modification Work. Time of availability shall be agreed between CCG and Contractor.

5.6.1 Handling of Heavy and Cumbersome Items

1. The Contractor will be responsible to plan, supply and install all necessary equipment to lift, displace and position heavy and cumbersome items. If necessary, the Contractor will

add additional lifting lugs and ensure their maximum lifting capacity, by checking structural arrangement and sampling according to different lift angles, all verified by a professional engineer. The lug welding work will need to undergo non-destructive testing to validate high quality of welds. (See 5.3.5.2)

5.6.2 New Electric Cable Routing

1. This item will explain the preferred routing of all electrical cabling from one compartment to another. The main scheme is to use, as much as possible, the existing cable trays. If this option is not possible, the Contractor will need to install new cable trays and transits, in accordance with the *Electrical Specification, Appendix A*.
2. We have identified four (4) main existing cable routes (trays) that will need to be used by the Contractor for new cabling routing:
   a. Aft mast cable tray (exterior);
   b. Vertical cable tray between main deck and navigation deck;
   c. New sounding compartment cable tray;
   d. Horizontal cable tray on main deck.
3. For a better understanding, please refer to drawing no.*C17-66-601-01 Vessel's Modification Key Plan* for the following descriptions.

5.6.2.1 Aft Mast Cable Tray

1. The mast is equipped with an external cable tray. It is situated on the aft part of the mast, for the full length of the mast.
2. At the Officer's deck level, the new cabling must pass through the aft bulkhead, in the emergency generator compartment at frame 66 (see *Figure 33*).

Figure 33 Existing cables between aft mast and emergency generator compartment

3. New cables will be able to follow the existing cable tray and go through Officers Deck, at frame 71 starboard, to arrive in the Static Inverter compartment.
4. The new cabling will go down the existing vertical route to the Static Inverter compartment, frame 71 starboard, and go through Flight & Boat deck (see *Figure 34*).
5. On the upper deck above suspended ceiling in Supply Officers office, the new cabling will pass through the starboard longitudinal bulkhead, at frame 71, to join on the other side the existing cable tray that follows the entire length of the passageway.
6. The new cabling will need to follow the existing cable tray, to be able to enter into the Electric Locker at frame 125, in which we can find the main vertical cable tray (see *Figure 35).*
7. Refer to main vertical cable tray between main deck and navigation deck.

Figure 34: Vertical route in static inverter compartment

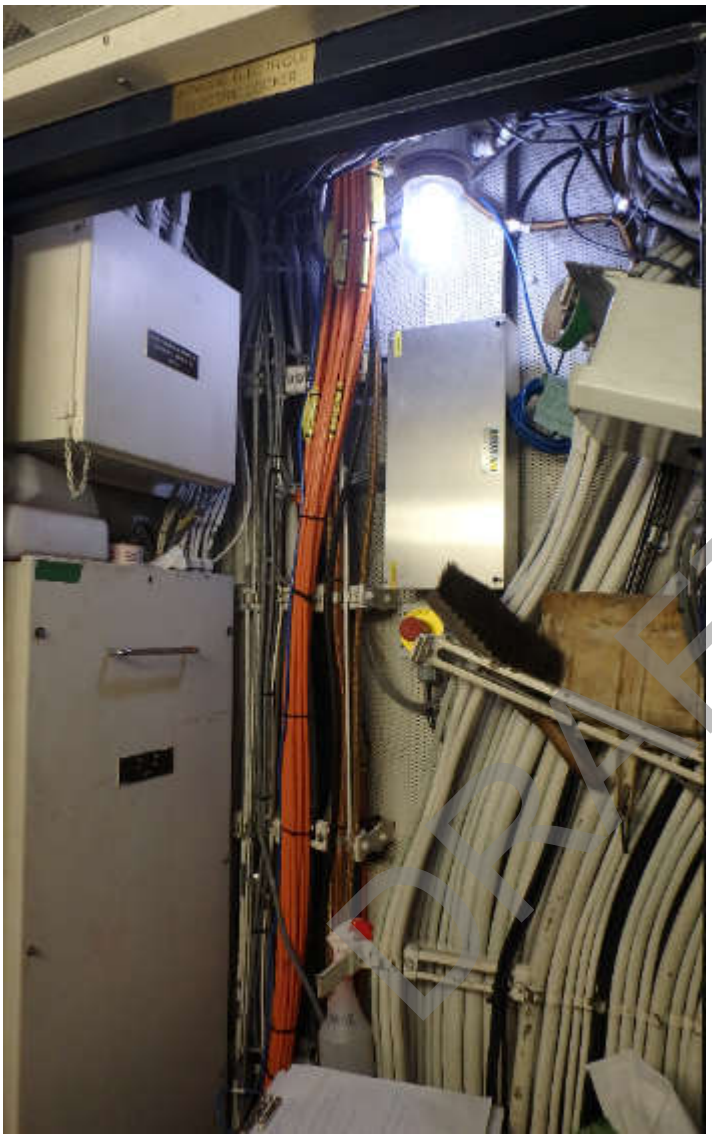


Figure 35: Electrical locker

5.6.2.2 Main Vertical Cable Tray between Main and Navigation deck

1. Cable tray between Main and Navigation deck already exists. It is situated between frames 123 & 127, on starboard side of Elevator Machinery compartment.
2. On main deck, this cable route is accessible from Elevator Machinery room (see *Figure 36).*

Figure 36 Elevator Machinery room

3. On Main deck, this cable tray is accessible inside Electric locker (see *Figure 35)*.
4. On Flight & Boat deck, this cable tray is accessible inside another distinct electric locker.
5. On Officers deck, the same cable tray is accessible inside removable wall finishing panel, in starboard passageway.
6. On Navigation deck, part of this vertical cable tray enters void space (Crawl Space) below the bridge, and continues vertically, up to the suspended ceiling on this same deck.

5.6.2.3 Cable Routing for new Multi-Beam Sounder Compartment

1. On main deck, you will find a vertical cable tray, located in front of frame 165, starboard inboard, in a recess next to watertight door (see *Figure 37*)

Figure 37: Watertight door recess, main deck starboard inboard, at frame 165. See bow thruster hydraulic oil header tank

2. All new cabling will need to follow this vertical cable tray, via the suspended ceiling on main deck, in order to enter the Multi-Beam Sounder Compartment.
3. To have better access to this cable tray, Contractor will need to temporarily remove hydraulic header tank. This tank must first be emptied of hydraulic oil. Once work is completed, Contractor will reinstall header tank and fill it up with new hydraulic oil of same grade as used in bow thruster (see *Figure* 37).
4. This vertical cable tray goes through main deck and enters bow thruster compartment.
5. In the same area, under main deck, you will find another transit that will permit cabling to be led aft through frame 165, and enter the main cargo hold.
6. Always in cargo hold, under main deck, this cable tray runs practically in a straight line right up to frame 138, to then plunge down towards the bottom, down to the 17'-0" Flat level. The cable tray section that is positioned in the cargo hold is protected with a removable sheet metal covering. The Contractor will temporarily remove this metal protection cover to complete work and reinstall after work completion.
7. This cable tray leads directly to the Heeling Compartment deck head, by passing through the 17'-0'' Flat level. As the Heeling Compartment has been considerably transformed to incorporate the new Multi-beam Sounder, the Contractor is responsible for the installation of new cable trays and cable transits for the new cabling, as well as repositioning existing remaining cabling through new central transverse bulkhead, making sure all equipment (new and old) in compartments are well connected and functional.

5.6.2.4 Cable routing on main deck

1. An existing cable tray is already installed above suspended ceiling on main deck, and runs all along starboard passageway.
2. This existing horizontal cable tray will serve to connect the main vertical cable tray, the new Multi-Beam Sounder Compartment and forward equipment room.
3. In the forward Equipment room, on Main deck, you will find the main Motor Control Center (M.C.C.), in which you will find the 460-volt feeder to supply power to the new electrical control panel in the Heeling Compartment. This panel will supply power for certain components on Multi-Beam EM712 sounder, and also for the hydraulic power pack (see *Figure 38)*.

Figure 38 Spare M-701 feeder, in forward equipment room

5.6.3 460-Volt distribution panel

1. A 460-volt distribution panel will need to be installed on the new longitudinal bulkhead, which separates the Heeling Compartment from the new Multi-Beam Sounder Compartment, as per instructions in the Electrical Specification. The new distribution panel will be situated in the Heeling Compartment (starboard), as illustrated on general arrangement drawing no.*C17-66-601-01 Vessel's Modification Key Plan*. The distribution panel will be secured/bolted to 2 angle irons, previously installed on the bulkhead.

5.6.4 230-Volt distribution panel

1. A 230-volt distribution panel will need to be installed on the new longitudinal bulkhead, which separates the Heeling Compartment from the new Multi-Beam Sounder Compartment, as per instructions in the Electrical Specification. The new distribution panel will be situated in the Heeling Compartment (starboard), as illustrated on general arrangement drawing no.*C17-66-601-01 Vessel's Modification Key Plan*. The distribution panel will be secured/bolted to 2 angle irons, previously installed on the bulkhead, next to the new 460-Volt panel.

5.6.5 460/230-Volt Transformer

1. A new 460/230-Volt transformer will need to be installed in the Heeling Compartment, near the new 460 and 230-Volt distribution panels, as per indications in the Electrical Specification. The transformer attachment device must be capable of supporting the total weight of the new transformer.

5.6.6 Hydraulic power pack for main gate valve

1. The hydraulic power pack is used to operate (open/close) the main gate valve. The Contractor must install the new power pack in accordance with the Manufacturer's instructions and as per drawing no. *C17-66-601-01 Vessel's Modification Key Plan*.
2. The Contractor must manufacture beforehand the power pack seating and install the seating in the Multi-Beam Sounder Compartment. The Contractor must insure that the power pack is protected against any shock, weld splatter, etc., while installing the unit in the compartment. The Contractor is also responsible for the supply and installation of all hydraulic piping, and all accessories and pipe supports needed for proper installation of the gate valve power pack. The main hydraulic lines will have a nominal diameter of ½", and material used will be stainless steel 316.
3. The Contractor must also provide appropriate flexible hydraulic piping for connexion of main unit and pump, which develops up to 30 MPa. The Contractor must also connect all electrical cables and wiring, such as main power and control, as per Electrical Specification and in accordance with Manufacturer's instructions. The Contractor is also responsible, after installation and prior to final testing, for cleaning out the whole hydraulic system, including tank, lines to and from valve actuators, controls, etc. Once clean-out is completed, the Contractor will carry out full system testing, demonstrating all functions and control of gate valve opening and closing. The contractor will also supply the hydraulic oil necessary to fill up the gate valve power pack, using ISO VG 32 grade oil, or equivalent. The Contractor will also supply and install a nameplate indicating all normal and emergency sequences for hydraulic valves, including proper order of operation of each sequence.

5.6.7 Gate Valve

1. Before installing the Gate Valve, the Mounting Flange installation must be completed, including all structural steel work related to hull modifications, new bulkhead addition in compartment, leakage test and painting. It is possible to insert the new gate valve through the new bolted hatch above the Heeling Compartment. Once in the Heeling Compartment, the valve will be moved through the new longitudinal bulkhead watertight

door, which separates the Heeling Compartment from the Multi-Beam Sounder Compartment

2. The Contractor shall be responsible that the gate valve is installed in accordance with Manufacturer's instructions. The gate valve Manufacturer will supply all hardware, including all bolts, nuts, and gasket for the spherical mechanical seal. At the end of this step, the Contractor must demonstrate the gate valve tightness, before any other subsequent installation.

5.6.8 EM16 Hull Unit

1. The following items comprise the EM16 Hull Unit (see drawing no.*C17-66-601-01 Vessel's Modification Key Plan*):

   a. Mounting trunk;
   b. EM16 retractable ram;
   c. Intermediate pipe (KM417639);
   d. EM712 Transducer Housing (KM322346);
   e. EM712 RX 2 Transducer;
   f. EM712 TX 2 Transducer;
   g. Sound Velocity Sensor (SVS);

2. The following items explain in detail the main installation steps of the EM16 hull unit. The Contractor has the responsibility to fully understand and master each of these steps and to make sure that all work will respect all Manufacturer's installation constraints.

5.6.8.1 Mounting Trunk

1. Before installing the Mounting Trunk, the Gate Valve installation must be completed. It is possible to insert the mounting trunk through the new bolted hatch, above the Heeling Compartment. It can then be put through the new watertight door on the new longitudinal bulkhead, right into the Multi-Beam Sounder Compartment. The Contractor has the responsibility to install the mounting trunk in accordance with Manufacturer's requirements. The mounting trunk Manufacturer will supply all hardware, including all bolts, nuts, and gasket for the spherical mechanical seal.

5.6.8.2 EM16 Retractable Ram & Intermediate Flange

1. Before installing EM16 Retractable Ram and Intermediate flange, all work on Mounting Flange must be completed. The retractable ram must be assembled to the Mounting Trunk, via the intermediate flange. There are 2 lifting lugs on the top part of the retractable ram, and 2 more on the intermediate flange. In fact, it is easier to manipulate the retractable ram and intermediate flange if they are pre-assembled. However, both these parts will need to be inserted in the Multi-Beam Sounder Compartment separately, through cargo hold, then assembled in the Multi-beam Sounder Compartment.
2. Once both parts are in the Multi-Beam Sounder Compartment, they will only then be pre-assembled together, before being installed on the mounting trunk. The Contractor has the responsibility to install all these parts in accordance with Manufacturer's requirements. The Manufacturer will supply all hardware, including all bolts, nuts, and gasket for the spherical mechanical seal.
3. The Contractor will also proceed with all electrical connections, in accordance with the Electrical Specification (see *Appendix A)*.
4. The Contractor will also proceed with the installation of a vent pipe to the vent valve connection on the EM16 hull unit. The valve is supplied and intended to be installed on the lower part of the EM16 hull unit. The vent pipe will need to be routed up to the upper deck; the 1-inch schedule 80 steel pipe will be hot dip galvanized. A nameplate will be installed on the valve hand wheel, indicating that this valve is the Mounting Trunk vent line valve, which normally should be left open. The vent pipe on the upper deck should also be fitted with a nameplate indicating that this pipe is the vent line for the Multi-beam sounder, (see 5.4.1.6)

5.6.8.3 EM712 Transducer Housing & Intermediate pipe

1. The intermediate pipe mechanically joins the transducer housings to the retractable arm. In fact, the housing is basically the casing for the 2 transducers. The sound velocity sensor (SVS) is connected to the housing. The Contractor has the responsibility to connect all electrical cabling to all components, in accordance with Manufacturer's requirements and in accordance with the Electrical Specification (see appendix A), prior to final assembly on the retractable arm. The Manufacturer will supply all hardware, including all bolts, nuts, and gasket for the spherical mechanical seal. The Contractor is also responsible to proceed with a final leakage test for Coast Gard Technical Authority and Transports Canada Marine Safety or Class.

5.6.9 HIPAP Local Control Cabinet

1. This local control panel controls the EM16 Retractable Ram and the open/close action of the gate valve, via the hydraulic power pack. This control panel must be installed by the Contractor in the Multi-Beam Sounder Compartment on 2 angle bars previously welded to the bulkhead. The Contractor is also responsible for the installation and connection of all electrical wires and cabling, in accordance with the Electrical Specification and Manufacturer's requirements. All tests must demonstrate proper functioning of the EM16 gate valve and retractable arm, including all positioning relays (limit switches). If functional tests are not conclusive, the Contractor will proceed with final relay (limit switch) adjustments.

5.6.10 IMU – Inertial Motion Unit

1. The Contractor must install the IMU on the mounting trunk, as per drawing C17-66-185-02 IMU Arrangement. The Contractor is also responsible for electrical cabling installation, in accordance with the Electrical Specification. An ''As Fitted'' drawing must also be supplied by the Contractor, following final installation, to reflect IMU's position, in respect with vessel's main structural elements, such as the double bottom for its vertical position, the central bulkhead for its transverse position, and the bulkhead at frame 146 for its longitudinal position.

5.6.11 Hi level float switch for the new bilge well

1. This Hi level float switch is to be installed in the new bilge well located in the Multi-Beam Sounder Compartment. The sensor is to be connected and fully integrated to the existing alarm and monitoring system of the ship.

5.6.12 New Ventilation Fans

1. Two (2) new 350cfm fans are to be installed and connected to the new ducts described in sections 5.5.2 and 5.5.3. One fan is located in the Multi-Beam Sounder Compartment and the other one, in the Heeling Compartment.

   Fan specification:

   a. Twin City, model TB, format 14B105 or equivalent.
   b. Axial tube type, belt driven, arrangement 9, installation horizontal. Double belt & pulley arrangement.
   c. External Drive Motor.
   d. High speed air flow rate 375 CFM @ static pressure of 0.25-inch water column, 1380 RPM.

e. Motor type ODP, 1 HP, 2-speed double winding, 1800/1200 RPM, 460 volts/3 phases/60 cycles.
f. Belt Guard included.
g. Inlet & outlet flanges, c/w protective grid on outlet
h. Steel construction with Heresite VR 506 protective coating, including all accessories
i. Drive shaft seal included.
j. Grease nipples (long).
k. 3-pole disconnect, without fuses, NEMA 3R, sold separately

2. Electric installation is to comply with the Electrical Specification and the manufacturer's recommendations. Each fan will be locally controlled and is to be connected to the ship's existing ventilation emergency shut-down system.

5.6.13 Lighting

1. Two (2) new lighting fixtures are to be installed by the Contractor, at the deck head level of the Multi-Beam Sounder Compartment. The new fixtures shall be an equivalent model to the ones already installed in the Heeling Compartment. The existing lighting fixtures will be recovered and reinstalled depending on final arrangement of the two (2) compartments (Multi-Beam Sounder Compartment and Heeling Compartment). The Contractor must also supply and install all electrical cabling, in accordance with the Electrical Specification.

5.6.14 115V Electrical Outlets

1. The Contractor will be responsible in supplying and installing one (1) 115-volt electrical outlet in the Multi-Beam Sounder Compartment, and one (1) 115-volt electrical outlet in the Heeling Compartment, in accordance with the Electrical Specification.

5.6.15 Telephone

1. There is actually one (1) telephone in the Heeling Compartment. This telephone must remain in position, and will be dedicated to the Heeling Compartment. The Contractor will need to install a new telephone in the Multi-beam Sounder Compartment, similar to the one installed in the Heeling Compartment. The new unit will be of equivalent quality and installation as the actual telephone in the Heeling Compartment. The Contractor will also be responsible to connect the new telephone in accordance with the Electrical Specification.

5.6.16 Camera

1. The Contractor is to install a camera in the Multi-beam Sounder Compartment, in accordance with the Electrical Specification. He will also fabricate and install an adequate support for this camera, which will permit the camera to be able to aim and frame in its entirety the *gate valve* and the *EM16 Hull unit*. The camera seating will take into account the dynamic effect of an icebreaker in operation. The Contractor will also connect this camera to the existing camera system aboard the vessel.

5.6.17 Hydraulic Power Pack for the new watertight door

1. The HPP of the new watertight door is to be located in the locker no.3 on the main deck. The Contractor shall present an arrangement plan of the HPP in the Locker for Client's approval prior to its installation. Electric cables shall be connected following the Electrical Specification in Annex.
2. The new watertight sliding door system is to fulfil the same specification as the existing watertight doors of the ship. This is a brief description of their functions, but the contractor is responsible for selecting a watertight sliding door that will match the way the existing doors are operated:
   - The watertight sliding door HPP is to be connected to the remote control on the Bridge allowing the opening or the closing of the door.
   - On each side of the door, a local control allowing its opening or its closing is to be installed. If the doors are closed via the Bridge remote control and the new door is in the closed position, crew will to be able to open the door with the local control, but it will automatically raise an audible alarm (locally and on the bridge), and this alarm will continue ringing until door has automatically fully closed.
   - The HPP is to be provided with a hand pump. Following a black out, crew will be able to close/open the door from the Locker no.3 on the main Deck.
3. The watertight sliding door is to be provided with a hand pump each side. Following a black out, crew will be able to close or open the door each side.

5.6.18 GNSS Antennas

1. GPS Antennas must be properly mounted on their mounting brackets on the aft mast as per drawing *C17-66-185-01 GPS Antenna arrangement,* in accordance with manufacturer's recommendations.
2. Cable is to be routed as per this document and in accordance with the Electrical Specification.

5.6.19 Special Navigation Chart Room

1. The Contractor will be responsible for the installation in the *Special Navigation Chart Room* (see *Figure 39 & Figure 40*) of all the following equipment, in accordance with the Electrical Specification, and as per Manufacturer's requirements:

    - UPS;
    - Standard 19-inch PC tower, that includes :
        - EM712 Processing Unit;
        - POSMV Processor;
        - Hydrographic Work Station;
        - Post Processing Work Station;
        - Ethernet Switch.
    - Screen, keypad and mouse for Hydrographic Work Station;
    - Screen, keypad and mouse for Post Processing Work Station.

Figure 39 Special navigation chart room

Figure 40 Special navigation chart room

1. The Contractor will present to the Client, for approval, the final arrangement for this room by illustrating the final position of all new equipment. All the cabling that needs to be connected to equipment outside this room will need to be routed above the suspended ceiling, to join the main vertical cable tray routing described at article 5.2.2.2. The Contractor will also supply all hardware and finishing materials, to allow for an adequate installation of all the equipment, considering the dynamic effects of an icebreaker in icebreaking mode.

5.6.20 Bridge

1. The Contractor will be responsible for the installation, on the bridge, of all the following equipment, in accordance with the Electrical Specification, and as per Manufacturer's requirements:

    - A video monitor, to retransmit all information emanating from the Hydrographic Work Station or the Post Processing Work Station. The screen must be positioned at the navigation station. The Contractor must supply an arrangement drawing of the

position of this screen, for Client approval, before proceeding with installation. Again the Contractor must guarantee proper installation of the screen, considering the dynamic effects of an icebreaker in icebreaking mode;

- Integrate the operation (open/close + visual check) of the new watertight door, which separates the Multi-beam Sounder Compartment from the Heeling Compartment, to the present watertight door system installed on the bridge, port side console;
- Integrate the control system of the EM16 retractable arm and EM16 gate valve into the bridge starboard console. This control must be secured by a keyed-type switch. This control system will also supply the following information:
    - Hydraulic power pack electrical power supply (on/off);
    - EM16 retractable arm power supply (on/off);
    - Sliding watertight door position, separating Multi-beam Sounder Compartment from Heeling Compartment (open/close);
    - Heeling Compartment watertight door (open/close);
    - Multi-Beam Sounder Compartment (open/close).

5.7 Coating and Painting Procedure

1. For all surface preparation, coating and painting, refer to section *1 - General Notes, article #22.* Following is a list of all the items that need coating or painting after modification. All new structural steel, steel outfit, insulation surface and piping elements need to be painted after installation. The list below is non-inclusive but present a good summary of items cover by this Engineering Package that requires painting work:

   - The inside of the new sounder cofferdam;
   - New bilge well on port side, see 5.2.1.4 v.;
   - Mounting Flange, internal and external ;
   - The inside of the Mounting Flange shall be painted with the same coating than the adjacent hull section;
   - New watertight bulkhead at centerline, see 5.2.3.2;
   - Port heeling tank;
   - New cofferdam structural elements in port heeling tank, see 5.2.4.2;
   - Tank top in new Multi-Beam Sounder Compartment and Heeling Compartment;
   - Bulkhead 146, near the new manhole installation, see 5.3.3.1;
   - New escape ladder;
   - 17'-0" flat in the area of the new watertight hatch; see 5.3.5.1;
   - New lifting lugs, see 5.3.5.2;
   - Port longitudinal bulkhead in cargo hold, inside the Cargo Hold and inside the Port heeling Tank;
   - New aluminium sheet cover over insulation on cargo hold;
   - 17'-0" flat in the area surrounding the new battens supports;
   - Extension arms and mounting brackets in the aft mast, see 5.3.7;
   - New fuel lines in Multi-Beam Sounder Compartment, see 5.4.1.1;
   - New bilge lines in Heeling Compartment and Multi-bema sounder compartment, see 5.4.1.2;
   - New compressed air lines in Heeling Compartment, see 5.4.1.2;
   - New ballast system lines; see 5.4.1.3;
   - New ballast system lines and skid, see 5.4.1.4;
   - New sounder cofferdam air vent, see 5.4.1.4;
   - New sounder compartment sounding pipe, see 5.4.1.7;
   - New hot water pipe, see 5.4.1.8;
   - New section of steam pipes, see 5.4.1.9;

- New sounding pipe located in heeling tank, see 5.4.2.1;
- New section of steam pipes, see 4.2.2.2;
- Ventilation boxes in Multi-Beam Sounder Compartment and Heeling Compartment, see 5.5;
- New cargo hold ventilation outlet trunk, see 5.5.1;
- New supply air trunk for the Multi-Beam Sounder Compartment, see 5.5.3.

6 Proof of Performance

6.1 Quality Assurance, Inspection and Testing

1. The CCG welding specification is to be called up. Non-destructive examination of welds is to be specified, including radiography and UT where appropriate.
2. All vents, valves, power cables, manholes, access points, piping are to be clearly labelled.
3. Hydraulic operation of the valve and operation of the position sensors to be verified.
4. Extension of the ram to be tested both manually and with the electric motor.

7 Deliverables

7.1 As Fitted Drawings

1. The Contractor is to produce all as fitted drawings and these drawings shall be handed to the CCG.
2. This shall include as-fitted versions of the drawings produced specifically for this project as well as as-fitted changes to affected existing ship's drawings.

7.2 Equipment Manuals

1. All documentation supplied with the new equipment shall be handed over to the Owner’s Representative.

Appendix A
Electrical Specification Multi-Beam Sounder Installation (EM 712)

Electrical Specification

Multi-beam Sounder Installation (EM 712)

CCGS Des Groseilliers

Multi-beam Sounder Installation (EM 712)

Document Details

Canal Project No	7662	**Owner**	Canadian Coast Guard
Install Period		**Installation**	CCGS Des Groseilliers
Location		**Key Equipment**	Kongsberg Multi-beam Sounder (EM 712)

Revision History

Rev	Description	Date (dd/mm/yy)	Prepared by	Reviewed by	Approved by
A	For Review prior to submittal	14/09/17	Donald MacNearney	Chris Wright	Chris Wright
1	Submitted to Concept Naval	17/11/17	Donald MacNearney	Chris Wright	Chris Wright
2	Concept Naval Comments Incorporated	23/11/17	Donald MacNearney	Chris Wright	Chris Wright

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FIGURES

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1. INTRODUCTION

This document describes the electrical requirements that must be met by the contractor during the installation of a new multi-beam sounder, the Kongsberg EM 712, on the CCGS Des Groseilliers. This sounder will enable this vessel to perform detailed mapping of the Arctic seabed while undergoing standard Coast Guard operations.

The information contained herein is intended for use by the installer of this equipment. This specification contains guidelines relating to the electrical installation of the multi-beam sounder. This information is to be used in conjunction with a complete shipyard specification document.

2. GENERAL

This specification deals only with the electrical system requirements for the installation of the multi-beam sounder. It is to be used in conjunction with a more complete specification that will detail the mechanical requirements for this installation. The complete specification is to be prepared by Concept Naval, and in no way is Canal responsible for incorrect installation due to the usage of only part of the complete specification package.

In addition to this specification, installation of the multi-beam sounder must meet the requirements detailed in other specifications from regulatory bodies. In particular, the publications TP127E[1], from Transport Canada, and 70-000-000-EU-JA-001, from Fisheries and Oceans Canada and the Canadian Coast Guard, shall be adhered to in full.

2.1 Equipment

The installation of a multi-beam sounder will utilize the following major pieces of equipment. This list is not exhaustive, and the contractor is responsible for identifying all pieces of equipment which will be required for installation.

- Kongsberg EM 712 multibeam echo sounder[2]
- Kongsberg EM 712 processing unit with cables
- Kongsberg EM 712 Hydrographic Workstation
- Post Processing Workstation
- Applanix POS MV 320 with inertial sensor and GNSS antennas[3,4]
- AML Micro SV Velocity Meter[5]
- HiPAP Retractable Ram and Hoist Motor
- Gate Valve, Power Pack and Motor
- Remote Control Bridge Panel
- Watertight Door, motor and remote control electronics
- Camera (in Multi-beam Sounder Compartment)
- Telephone (in Multi-beam Sounder Compartment)
- Fans (in Heeling Compartment and Multi-beam Sounder Compartment)

3. INSTALLATION OF THE KONGSBERG EM 712

The Kongsberg EM 712 system and associated remote sensors shall be interconnected according to the provided one-line drawings, 1043-A414, sheets 1-3.

The information provided in this specification should be sufficient to complete the electrical installation of the Kongsberg EM 712 system. However, in addition to this information, it is recommended that the contractor review the installation manual for the EM 712[2], available on the internet, to ensure that all requirements in this manual are fully met.

The figures contained in the following pages depict the main components of the Kongsberg EM 712 system, to give the reader an association between the descriptions contained herein and the physical devices in question.

Figure 1: EM 712 Transducer Depiction[2]

Note: The red protective coating on the transducer must not be damaged during installation. This coating is waterproof, and any leak in the coating requires that the transducer be replaced.

Note: The transducer must not be activated when it is out of the water! This will damage the sensitive equipment.

Figure 2: EM 712 TX Unit[2]

Figure 3: EM 712 RX Unit[2]

3.1 Location of Sounder

The multi-beam sounder and retractable ram is to be fit on the portside of the heeling compartment in the CCGS Des Groseilliers, inside a new compartment denoted the Multibeam Sounder Compartment (MBSC). The full details of the sounder location are contained within the complete mechanical specification document, and will not be discussed further here. This document pertains to the electrical specifications of the system only.

3.2 Processing Equipment

There are two processing units which will need to be located and installed for the EM 712 system. These processing units are explained here.

3.2.1 EM 712 Processing Unit

The first processing unit is the EM 712 sounder processing unit, which is connected to the EM 712 transmitter and receiver units with combined Ethernet and power cables (-EM 712/C40 and -EM 712/C42). The sounder processing unit is to be fit in a rack located in the Special Navigation Chart Room (SNCR).

The sounder processing unit requires 120 VAC to operate. This shall be delivered from a new marine rated UPS supply, which will provide both power conditioning and continuity of power.

Figure 4: EM 712 Sounder Processing Unit[2]

3.2.2 POS MV 320 Processing Unit

The second processing unit is part of the POS MV 320 system, and supports the inertial measurement unit (IMU) and GNSS antennas. It is proposed that this processing unit be fit in a rack located in the Special Navigation Chart Room. The POS MV 320 processing unit shall be connected to the EM 712 processing unit by an Ethernet cable (-EM 712/C33).

The positioning system processing unit requires 120 VAC to operate. This shall be delivered from a new marine rated UPS supply, which will provide both power conditioning and continuity of power. This may be the same UPS as that which supplies the EM 712 processing unit.

Figure 5: POS MV 320 System Components[4]

3.3 Hydrographic Workstation

The Hydrographic Work Station, along with an additional post processing workstation, shall be located in the Special Navigation Chart Room. Details of the workstations shall be developed with input from the suppliers, CHS and CCG Project Officer.

The hydrographic workstation requires 120 VAC power to operate. This shall be delivered from a new marine rated UPS supply, which will provide both power conditioning and continuity of power. This may be the same UPS as that which supplies the EM 712 processing unit.

Figure 6: EM 712 Hydrographic Workstation[2]

3.4 Post Processing Work Station

The post processing work station shall be a CPU, complete with display monitor, mouse, and keyboard, that may be selected by the contractor prior to installation. A new off-the-shelf CPU unit will be suitable, with enough computing power to perform all necessary duties required by the operating personnel. These duties will relate to standard data processing and manipulation operations that might be expected from a modern computer.

3.5 K-Rem Remote Control System

A separate system from Kongsberg, denoted the K-Rem system, will be used to start and stop the multi-beam sounder remotely. This system is separate from the EM 712, but will also be provided by Kongsberg for install. The proper cables for connecting this system to the EM 712 should be provided by Kongsberg as well.

3.6 Bridge Equipment

3.6.1 Remote Display Monitor

There shall be a remote display monitor located near the navigation position. Input to this monitor shall be from either of the hydrographic workstations (CPUs installed in the Special Navigation Chart Room). Two video feeds shall enter this monitor, and the bridge operators may select which input they wish to have displayed. This is to display bathymetric and hydrographic information to the navigator and bridge crew.

3.6.2 HiPAP Remote Operation Bridge Panel

A remote panel will be provided by Kongsberg, which will provide controls for operating the gate valve and retractable ram from the bridge. This panel will also provide feedback on the position of the gate valve and the ram. This panel will communicate with the HiPAP Local Control via an Ethernet cable (-EM 712/C75).

3.6.3 Watertight Door Remote Operation

The watertight door remote operation and monitoring shall be integrated with the existing remote operation and monitoring panels for the existing watertight doors. A suitable electrical integrator should be engaged to ensure that this integration works seamlessly with the installation of the new watertight door.

Remote operation of the watertight door will involve running new cables between the existing remote door operation panel in the bridge and locker #3 on the Principal Deck, where the relay rack (AD27863) is located. A new junction box (denoted JB 16) will be installed in locker #3. This junction box should be similar to existing door control junction boxes JB 1 through 15. The hydraulic power pack for this door will also be in locker #3, and the hydraulic lines will run to the door on the lower deck.

The exact details of integration into the existing system should be performed by a contracted electrical integrator.

4. POWERING REQUIREMENTS

4.1 Main Power Feed

The main power feed for the EM 712 and HIPAP system shall be taken from a spare breaker in MCC #12. This is located forward, on the main deck, in an equipment room. This panel is currently labelled M-701 (see Figure 7 and Figure 8). The specifics of the spare breaker may be obtained by consulting with CCG.

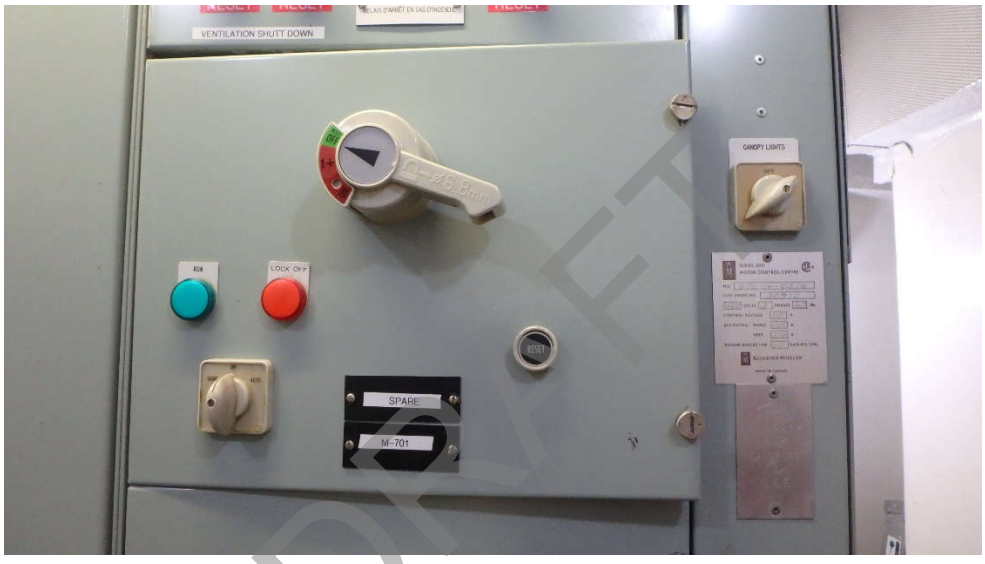


Figure 7: Main Feeder Panel (460V)

Figure 8: Main Feeder Panel Nameplate

Power from this feed shall be routed to a 460V distribution panel in the heeling compartment (cable -EM 712/P01 – see drawing 1043-A41403).

4.2 460 VAC Distribution

A 3-phase, 460 VAC distribution panel shall be provided in the heeling compartment. This panel shall feed the 460-230/115 VAC transformer, two new ventilation fans, as well as the control cabinet for the gate valve and retractable ram. Each system unit in the heeling room should be provided with a separate circuit breaker.

This panel should be selected such that it is adequately protected against water ingress, and be equipped with a drip shield.

4.3 Transformer

A 460-230/115 VAC transformer shall be selected and installed in the heeling compartment (refer to drawing 1043-A41403). This transformer shall take single phase 460 VAC on the primary and provide split phase 230 VAC (i.e. 230 VAC and 115 VAC on the secondary).

The transformer must be suitably sized to meet the power requirements of all associated loads. Drawing 1043-A41403 may be referred to for references to the loads associated with this transformer. The size of this transformer has been estimated at 2 kVA, however this is dependent on what is determined to be suitable for lighting in the heeling and multibeam sounder compartments. The size of this transformer may be changed with approval from CCGS.

This distribution infrastructure may be determined by the contractor, provided that it meets the powering requirements for the system, as determined by the one-line diagram provided.

4.4 230/115 VAC Distribution

The neutral from the transformer shall be grounded in a second distribution panel, which shall provide 230 VAC L-L and 115 VAC L-N. Each system unit in the heeling room should be provided with a separate circuit breaker.

This panel should be selected such that it is adequately protected against water ingress, and be equipped with a drip shield.

4.5 Marine UPS

A new marine rated UPS shall be installed in the Special Navigation Chart Room. This UPS will provide power for the Hydrographic Workstation, the POS MV 320 Processor, and the EM 712 Processing Unit (refer to drawing 1043-A41403). The size of this UPS shall be sized to provide sufficient backup power to these three units (recommended 700VA). CCGS shall be consulted to approve final sizing of this UPS. As an example, the SU700X93 from APC should be suitable – see the following website:

http://www.apc.com/shop/us/en/products/APC-Smart-UPS-700VA-120V-Shipboard/P-SU700X93#

4.6 Watertight Door Power Pack

The power feed for the new watertight door shall be taken from the same source as for the existing watertight doors. The new door shall be integrated seamlessly into the existing door system. It is the responsibility of the contractor to identify this source and utilize it correctly.

The watertight door control power shall also be taken from the same source as the control power for existing doors.

4.7 Fan Power Junction Box

The existing fan power may be used to power both new fans. To do this, a small junction box must be provided to provide each new fan with a separate breaker.

Subject to CCG approval, an alternative means of providing power to the new fans may be utilized.

The junction box must be selected such that it is adequately protected against water ingress, and be equipped with a drip shield.

4.8 Grounding

It is the contractors responsibility to ensure that proper vessel ground is provided to all equipment units. Grounding cables are shown on the one-line drawing (1043-A414). However, it is the contractors responsibility to review and confirm these grounding points, and ensure that every piece of equipment is properly grounded in this installation.

5. INSTALLATION OF THE GATE VALVE AND HIPAP RETRACTABLE RAM

5.1 HIPAP Local Control Cabinet

The HIPAP Local Control Cabinet, provided by Kongsberg, is to be connected to a remote control bridge panel via an Ethernet cable (-EM 712/C75).

Control cables shall carry control signals and feedback from this cabinet to both the retractable ram and the gate valve (-EM 712/C79 and -EM 712/C80, respectively).

5.2 Hoist Motor

A three-phase electric motor shall be selected and purchased by the contractor. This motor shall operate using 460 VAC, with a current rating of 6.5 A.

5.2.1 Powering Requirements

The hoist motor shall be supplied through the HIPAP Local Control Cabinet, provided by Kongsberg. The motor enclosure should be properly grounded to the hull of the vessel. Motor power will pass through a contactor controlled by the HIPAP Local Control Cabinet. (cable -EM 712/P06).

5.2.2 Control Requirements

The hoist motor is controlled by the HIPAP Local Control Cabinet. The retractable ram is raised and lowered by reversing the phases of supply power to the motor, via a contactor arrangement internal to the control cabinet. Refer to K1 and K2 on Kongsberg drawing 406276 for details.

5.3 HPP Motor

The motor to operate the gate valve shall be provided by Kongsberg/LK Valves. The motor operates on 460 VAC, and is rated to consume 5.5 kW.

5.3.1 Powering Requirements

The HPP motor (for the gate valve) shall be supplied through the HIPAP Local Control Cabinet, provided by Kongsberg. The motor enclosure should be properly grounded to the hull of the vessel. Motor power will pass through a contactor controlled by the HIPAP Local Control Cabinet (cable -EM 712/P07).

5.3.2 Control Requirements

The HPP motor supplies hydraulic pressure for the operation of the gate valve. Opening and closing the gate valve occurs by operation of open and close solenoids, via control cable - EM 712/C80, which runs from the HIPAP Local Control Cabinet.

6. INSTALLATION OF SENSORS

The following sensors are required to integrated with the EM 712 system to provide accurate data:

- Sound Velocity Meter
- GNSS (x2)
- Inertial Measurement Unit (IMU)

Note that the sound velocity meter interacts directly with the EM 712 processor, while an additional position processing system is required to gather data from the two GNSS units and the IMU, before communicating with the EM 712 processor. This positioning processing system is called the POS MV 320.

6.1 Sound Velocity Meter

In order to calibrate the multi-beam sounder, it is necessary to measure the sound velocity in water near the sounder. To accomplish this, the sound velocity meter (AML Micro SV) is to be fit on the aft side of the sounder bracket and the signal fed up the ram to the hydrographic workstation located in the Special Navigation Chart Room.

Be sure to refer to the owner's manual for the AML Micro SV to ensure proper maintenance of this equipment.[5]

Figure 9: AML Micro SV - Sound Velocity Meter[5]

6.2 GNSS, IMU, and POS MV 320

To provide precise location information to the bathymetry data, a position and orientation system is to be installed (POS MV 320). The system is comprised of two GNSS antennas, one inertial measurement unit (IMU), and a processing unit (see Figure 5).

Each of the two GNSS antennas and the IMU are to be connected to the POS MV 320 with cables provided with the system. The POS MV 320 is then connected to the EM 712

Processing Unit with Ethernet, as well as the Hydrographic Workstation, and other network devices, through an Ethernet switch.

NOTE: It is important to specify the required length of cable when purchasing the POS MV 320 system. These cables are provided with the system, but the length must be specified correctly. The mechanical specification may be consulted to determine cable run lengths.

The GNSS antennas must be mounted in a location with clear view of the sky from horizon to horizon, with a minimum and maximum separation of 1 m and 5 m, respectively, and rigid with respect to each other and the IMU. *The full details of the mechanical aspects of mounting the GNSS antennas are contained in the accompanying mechanical specification for this project.*

The IMU is to be mounted on the gate valve, so that it is as near to the center of gravity of the ship as possible. Further mounting details for the IMU are contained in the mechanical specification document.

Note should be taken of the following guideline on mounting antennas on CCG vessels:

- "Final antenna sittings must be approved by the Electronic Design Authority prior to commencement of installation"[6]

7. MISCELLANEOUS ELECTRICAL COMPONENTS

In addition to the main multi-beam sounder equipment installation, the following miscellaneous electrical systems shall be installed:

7.1 Watertight Door

A new watertight door shall be selected to match the existing watertight doors on the vessel.

This door shall be installed according to the existing watertight doors. This means preserving the existing functionality of the automatic door open/close system, and integrating the new door with this existing system.

An electrical integrator of suitable knowledge and skill shall be engaged to accomplish this task.

Controls for the new watertight door shall be integrated into the existing remote door operation panel. This will involve, for example, adding additional relays and internal wiring to relay rack AD27863, as well as modifications to the remote indication panel. The electrical integrator shall determine the necessary modifications based on the existing schematics for the door system.

Reference may be made to existing electrical schematics CD27864 (sheets 1 and 2) and CD27865 to assist in integrating this new door.

An alternative watertight door solution may be proposed for CGS approval. If approval is granted, this alternative may be used instead of integrating with the existing system.

7.2 Fans

The existing 750 cfm fan in the heeling compartment will be replaced by two 350 cfm fans, one in the heeling compartment and one in the multi-beam sounder compartment. The reason for this is because a new bulkhead will separate this existing space into two spaces. The existing power feed for the fan may be split into feeds for both new fans, through a separate junction box.

If a suitable alternative solution may be proposed for providing power to these fans, this may be used instead, pending approval from CCG.

7.3 Lighting

Suitable lighting and associated switches shall be provided in the Heeling Compartment and the Multi-beam Sounder Compartment. Power for this lighting may be taken from the transformer and distribution panel – the distribution panel must be suitably sized to allow for this lighting.

The lighting should be wired such that the lights may be turned on or off from either of the two entrances into the compartments.

At least one light for each compartment should be fed from the emergency lighting distribution. Suitable spare breakers should be located and utilized for this purpose.

7.4 Power Outlet

A duplex power outlet shall be provided in the Heeling Compartment and the Multi-beam Sounder Compartment. The power for this outlet may be taken from the transformer and distribution panel – the distribution panel must be suitably sized to allow for this feed.

7.5 Heater

Currently there are two heaters in the heeling compartment (one port and one starboard). As the heeling compartment will be divided into two compartments, one of these heaters may be used for the new Heeling Compartment and one for the Multi-beam Sounder Compartment. A new thermostat must be provided for the Multi-beam Sounder Compartment, which should match the existing thermostat, to be used for the Heeling Compartment.

The new thermostat must be suitably integrated with the existing heating system, such that both the Multi-beam Sounder Compartment and the Heeling Compartment have a functioning heater controlled by its respective thermostat.

7.6 Telephone

A telephone is to be installed in the Multi-beam Sounder Compartment to allow communication with the rest of the vessel. This phone will be specified such that it integrates with the existing telephone system on the vessel.

A person with suitable knowledge in this area shall be engaged to ensure this telephone operates correctly.

A telephone already exists in the Heeling Compartment.

7.7 Camera

A camera is to be added to the Multi-beam Sounder Compartment to allow for remote visualization of the retractable ram and gate valve. This camera is to be selected such that it integrates with the existing camera system on the vessel.

7.8 Ethernet Switch

An ethernet switch shall be provided by the contractor to interconnect the various ethernet supported devices in the system. This switch shall be of industrial quality, with a minimum of 5 ethernet ports.

8. CABLING

8.1 General Cabling Guidelines

The following general guidelines shall be adhered to with regards to cable installations for the EM 712 system:

1) Shielded cables must be properly grounded.

2) Cables for the EM 712 must be separated from other cables with high currents or transients.

3) If the cables between the sonar room equipment and other system units located in different compartments on the vessel pass through hatches or areas where they may be damaged, they must be run through conduits (minimum 2" conduit is recommended).

4) Make sure that all system cables are properly secure, but also installed with some slack. This is essential to withstand vibrations, and to facilitate maintenance.

In addition to these guidelines, the following requirements for the installation of cables on CCG vessels shall be respected:

- "Insofar as is practical, new cable runs shall employ the existing wireways. Where this is not possible, new wireways shall be provided of the KINDORF HANGAR type or approved equivalent. Cables shall be supported and secured at intervals no greater than 60 cm (24 inches), in such a way that they shall remain supported in the event of fire. Metal hangers or straps are to be used."[6]

- "Access shall be provided to wireways to facilitate maintenance. Any access panels marred or damaged by the Contractor in gaining access to existing wireways, shall be replaced with new matching panels."[6]

- "Cables used in the interconnection of electronic equipment shall be per the specification or if not stated in the specification as recommended by the equipment manufacturer, subject to such cables satisfying the safety related requirements of TP127 and/or I.E.E.E 45. In cases where the manufacturer provides an optional cable kit, this shall be used."[6]

8.2 Cable List

It should be noted that the cables provided in the following cable lists should be confirmed prior to installation, as any future changes in scope or design may result in required changes to the cables.

8.2.1 Power Cables

The following is a list of the power cables required in this installation. Cables marked with an asterisk (*) are provided by Kongsberg as part of the EM 712 system, or by other manufacturers.

Table 1: Power Cable List

Cable Name	Cable Type	Rated Voltage	1 - Termination	1 - Location	2- Termination	2 - Location
-CP_414-001	2C+G X 1.5MM2	250V	-DIST TBD:115V	+LOCKER 3	-JB 16:CTRL PWR	+LOCKER 3
-EM 712/C25*			-MARINE UPS:120VAC	+SNCR	-PROCESSING UNIT:PWR	+SNCR
-EM 712/C26*			-PROCESSING UNIT:GND	+SNCR	-GROUND:HULL	+SNCR
-EM 712/C33D	NEMA 5-15P TO IEC C13		-MARINE UPS:120VAC	+SNCR	-POS MV 320 PROCESSOR:PWR	+SNCR
-EM 712/C5*			-MARINE UPS:120VAC	+SNCR	-DISPLAY:PWR	+SNCR
-EM 712/C60*			-414-03:230V	+HEELING COMPARTMENT	-TRANSMITTER UNIT:PWR	+HEELING COMPARTMENT
-EM 712/C61*			-TRANSMITTER UNIT:GND	+HEELING COMPARTMENT	-GROUND:HULL	+HEELING COMPARTMENT
-EM 712/C64*			-414-03:230V	+HEELING COMPARTMENT	-RECEIVER UNIT 1:PWR	+HEELING COMPARTMENT
-EM 712/C65*			-RECEIVER UNIT 1:GND	+HEELING COMPARTMENT	-GROUND:HULL	+HEELING COMPARTMENT
-EM 712/C7*			-HYDROGRAPHIC WORK STATION:PWR	+SNCR	-MARINE UPS:120VAC	+SNCR
-EM 712/C8*			-HYDROGRAPHIC WORK STATION:GND	+SNCR	-GROUND:HULL	+SNCR
-EM 712/P01	3C X 16MM2	600V	-MCC12:M-701	+MCC12	-414-01:460V INPUT	+HEELING COMPARTMENT
-EM 712/P02	2C X 4MM2	600V	-414-01:460V	+HEELING COMPARTMENT	TRANSFORMER:PRI	+HEELING COMPARTMENT

-EM 712/P03	3C X 6MM2	600V	TRANSFORMER:SEC	+HEELING COMPARTMENT	-414-03:230VAC	+HEELING COMPARTMENT
-EM 712/P04	3C X 6MM2	600V	-414-01:460V	+HEELING COMPARTMENT	-EM 16 LOCAL CONTROL CABINET:F1	+MBSC
-EM 712/P05	3C X 1.5MM2	600V	-EM 16 LOCAL CONTROL CABINET:U5	+MBSC	-HOIST MOTOR:460VAC	+MBSC
-EM 712/P06	3C X 2.5MM2	600V	-EM 16 LOCAL CONTROL CABINETU7	+MBSC	-HPP MOTOR:460VAC	+MBSC
-EM 712/P20	2CX1.5MM2	250V	-PWR SUPPLY:24VDC	+BRIDGE	-BRIDGE PANEL:PWR	+BRIDGE

8.2.2 Control Cables

The following is a list of the communication and control cables required in this installation. Cables marked with an asterisk (*) are provided by Kongsberg as part of the EM 712 system, or by other manufacturers.

Table 2: Communication and Control Cable List

-DESIG	Cable Type	Rated Voltage	1 - Termination	1 - Location	2- Termination	2 - Location
-COM_414-001	PHONE CABLE - RJ11		-TELEPHONE:PHONE JACK	+HEELING COMPARTMENT	-VESSEL PHONE SYSTEM:PHONE JACK	+TBD
-COM_414-002	CAMERA CABLE - TBD		-CAMERA:CCTV	+MBSC	-VESSEL CAMERA SYSTEM:CCTV	+TBD
-CT_414-001	4C X 1.5MM2	250V	-RELAY RACK AD27863:BRIDGE CTRL	+LOCKER 3	-RELAY RACK AD27863:DOOR CTRL CABLE	+BRIDGE
-CT_414-002	8C X 1.5MM2	250V	-JB 16:REMOTE ACTUATION + FDBK	+LOCKER 3	-RELAY RACK AD27863:CTRL OUT	+LOCKER 3
-CT_414-003	2C X 1.5MM2	250V	-THERMOSTAT:OUTPUT	+MBSC	-HEATER:ON/OFF	+MBSC
-EM 712/C1*	VGA		-HYDROGRAPHIC WORK STATION:VIDEO OUT	+SNCR	-DISPLAY:VIDEO IN	+SNCR
-EM 712/C10*	ETHERNET		-PROCESSING UNIT:ETH1	+SNCR	-HYDROGRAPHIC WORK STATION:ETHERNET	+SNCR
-EM 712/C19	ETHERNET		-ETHERNET SWITCH:ETHERNET	+SNCR	-HYDROGRAPHIC WORK STATION:ETHERNET	+SNCR
-EM 712/C27*	K-REM CABLE		-PROCESSING UNIT:REMOTE CONTROL	+SNCR	-BRIDGE PANEL:START/STOP SWITCH	+BRIDGE
-EM 712/C3*	KEYBOARD (USB)		-HYDROGRAPHIC WORK STATION:KYBD	+SNCR	-KEYBOARD:KYBD	+SNCR
-EM 712/C33	ETHERNET		-PROCESSING UNIT:CPU3	+SNCR	-POS MV 320 PROCESSOR:ETHERNET	+SNCR
-EM 712/C33A*	GPS CABLE		-GPS1:COM	+MAST	-POS MV 320 PROCESSOR:GNSS1	+SNCR

-EM 712/C33B*	GPS CABLE		-GPS2:COM	+MAST	-POS MV 320 PROCESSOR:GNSS2	+SNCR
-EM 712/C33C*	IMU CABLE		-IMU:COM	+MBSC	-POS MV 320 PROCESSOR:IMU	+SNCR
-EM 712/C34	COAXIAL		-PROCESSING UNIT:CBMF1_1PPS	+SNCR	-POS MV 320 PROCESSOR:1PPS	+SNCR
-EM 712/C36-1*	ETHERNET		-EM 712 PROCESSING UNIT:GbE6	+SNCR	-EM 712 PROCESSING UNIT:CBMF1_ETH1	+SNCR
-EM 712/C36-2*	ETHERNET		-EM 712 PROCESSING UNIT:GbE4	+SNCR	-EM 712 PROCESSING UNIT:CBMF2_ETH1	+SNCR
-EM 712/C4*	MOUSE (USB)		-MOUSE:MOUSE	+SNCR	-HYDROGRAPHIC WORK STATION:MOUSE	+SNCR
-EM 712/C40*	ETHERNET		-TRANSMITTER UNIT:ETHERNET	+HEELING COMPARTMENT	-EM 712 PROCESSING UNIT:GbE0	+SNCR
-EM 712/C42*	ETHERNET		-RECEIVER UNIT 1:ETHERNET	+HEELING COMPARTMENT	-EM 712 PROCESSING UNIT:GbE1	+SNCR
-EM 712/C45*	FIBER		-RECEIVER UNIT 1:SYNC IN	+HEELING COMPARTMENT	-TRANSMITTER UNIT:SYNC_OUT	+HEELING COMPARTMENT
-EM 712/C50*	K-REM CABLE		-TRANSMITTER UNIT:REMOTE_IN	+HEELING COMPARTMENT	-EM 712 PROCESSING UNIT:REMOTE OUT	+SNCR
-EM 712/C52*	K-REM CABLE		-RECEIVER UNIT 1:REMOTE IN	+HEELING COMPARTMENT	-TRANSMITTER UNIT:REMOTE_OUT	+HEELING COMPARTMENT
-EM 712/C70	VGA		-POST PROCESSING WORKSTATION:VIDEO OUT	+SNCR	-DISPLAY:VIDEO IN	+SNCR
-EM 712/C71	VGA		-POST PROCESSING WORKSTATION:VIDEO OUT #2	+SNCR	-BRIDGE REMOTE DISPLAY:VIDEO IN 1	+BRIDGE
-EM 712/C72	VGA		-HYDROGRAPHIC WORK STATION:VIDEO OUT #2	+SNCR	-BRIDGE REMOTE DISPLAY:VIDEO IN 2	+BRIDGE
-EM 712/C73	KEYBOARD (USB)		-POST PROCESSING WORKSTATION:KYBD	+SNCR	-KEYBOARD:KYBD	+SNCR
-EM 712/C74	MOUSE (USB)		-MOUSE:MOUSE	+SNCR	-POST PROCESSING WORKSTATION:MOUSE	+SNCR
-EM 712/C75	ETHERNET		-EM 16 LOCAL CONTROL CABINET:ETHERNET	+MBSC	-ETHERNET SWITCH:ETHERNET	+SNCR
-EM 712/C79	4C X 1.5MM2	250V	-RAM:FDBK	+MBSC	-EM 16 LOCAL CONTROL CABINET:RAM FDBK	+MBSC
-EM 712/C80	8C X 1.5MM2	250V	-GATE VALVE:CTRL	+MBSC	-EM 16 LOCAL CONTROL CABINET:GV CTRL	+MBSC
-EM 712/C81	ETHERNET		-POS MV 320 PROCESSOR:ETHERNET	+SNCR	-ETHERNET SWITCH:ETHERNET	+SNCR
-EM 712/C82	ETHERNET		-ETHERNET SWITCH:ETHERNET	+SNCR	-POST PROCESSING WORKSTATION:ETHERNET	+SNCR
-EM 712/C83	ETHERNET		-ETHERNET SWITCH:ETHERNET	+SNCR	-BRIDGE PANEL:ETHERNET	+BRIDGE
-EM 712/C84	SERIAL - NULL MODEM		-AML MICRO SV:COM	+MBSC	-HYDROGRAPHIC WORK STATION:SERIAL	+SNCR

8.2.3 Kongsberg TX/RX Cables

The follow is a list of Kongsberg provided signal transducer cables which interface directly with between the transmitting and receiving modules and the transmitting/receiving transducers. Note that this positioning system is a 2 degree x 2 degree system (see EM 712 installation manual[2]).

Table 3: Transducer Cables

Cable Name	Cable Type	1 - Termination	1 - Location	2- Termination	2 - Location
-EM 712/RX1-1*	TRANSDUCER	-RX2:1	+MBSC	-RECEIVER UNIT 1:RX1	+HEELING COMPARTMENT
-EM 712/RX1-2*	TRANSDUCER	-RX2:2	+MBSC	-RECEIVER UNIT 1:RX2	+HEELING COMPARTMENT
-EM 712/TX1-1*	TRANSDUCER	-TX2:1	+MBSC	-TRANSMITTER UNIT:RIO1_P3	+HEELING COMPARTMENT
-EM 712/TX1-2*	TRANSDUCER	-TX2:2	+MBSC	-TRANSMITTER UNIT:RIO1_P4	+HEELING COMPARTMENT
-EM 712/TX1-3*	TRANSDUCER	-TX2:3	+MBSC	-TRANSMITTER UNIT:RIO2_P3	+HEELING COMPARTMENT
-EM 712/TX1-4*	TRANSDUCER	-TX2:4	+MBSC	-TRANSMITTER UNIT:RIO2_P4	+HEELING COMPARTMENT
-EM 712/TX1-5*	TRANSDUCER	-TX2:5	+MBSC	-TRANSMITTER UNIT:RIO3_P3	+HEELING COMPARTMENT

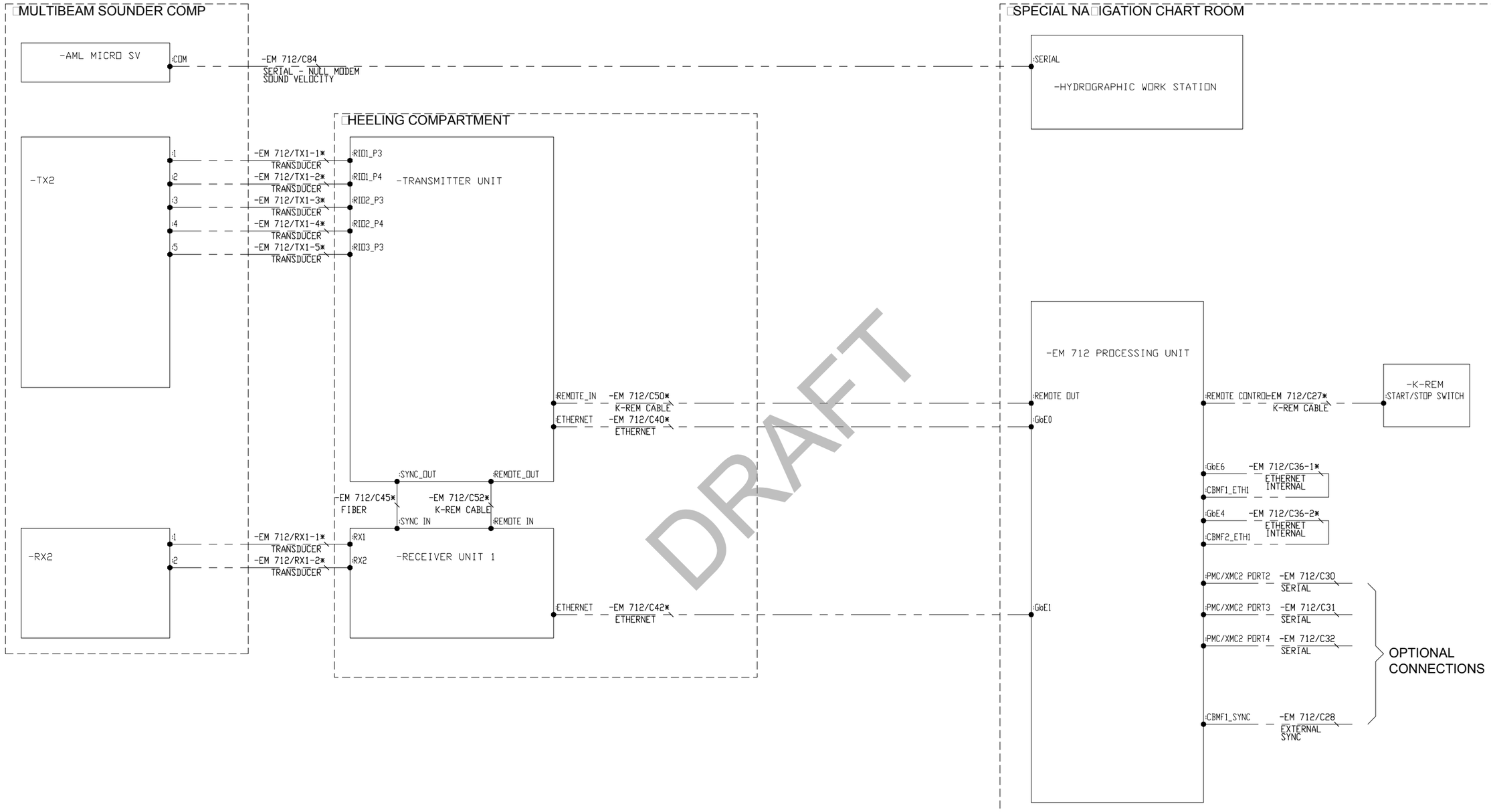
9. REFERENCES

1. Transport Canada. Ships Electrical Standards, TP127E, Revision 02. (2008).
2. Kongsberg. Installation Manual: EM 712.
3. Applanix. Manual: POS MV 320.
4. Applanix. Datasheet: POS MV 320.
5. AML Oceanographic. Manual: Micro SV, V2.2. (2010).
6. Fisheries and Oceans Canada & Canadian Coast Guard. Specification for the Installation of Shipboard Electronic Equipment, 70-000-000-EU-JA-001. (2004).

Appendix B
Cables diagrams

CABLE DIAGRAM (EM 712 SENSORS)

CABLES MARKED □ ITH (□) ARE PRO□IDED
□ ITH THE EM 712 SYSTEM



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1	RELEASED TO CONCEPT NA□AL	17-11-2017	D□M	C□	C□
0	FOR INITIAL RE□IE□	22-09-2017	D□M	C□	C□

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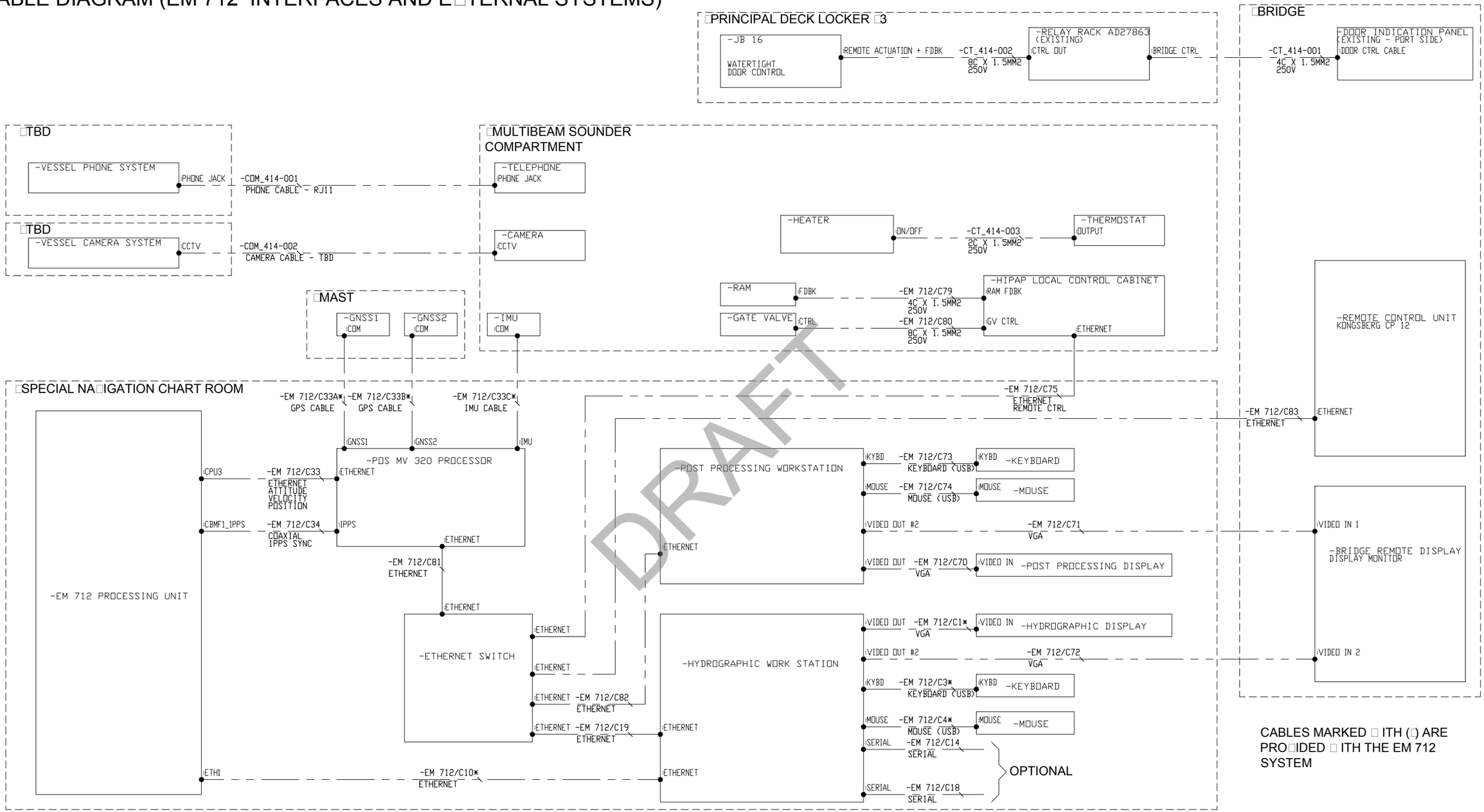
PROJECT No	7662
DATE	17-11-2017
DRAWN	D□M
APPR.	.
SCALE	NTS
DWG. No	1043-A414011
SHEET	1 NEXTSHT 2
REV.	2

FILENAME : 1043-A414012.dwg

CABLE DIAGRAM (EM 712 INTERFACES AND E□TERNAL SYSTEMS)



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1043-A414021			
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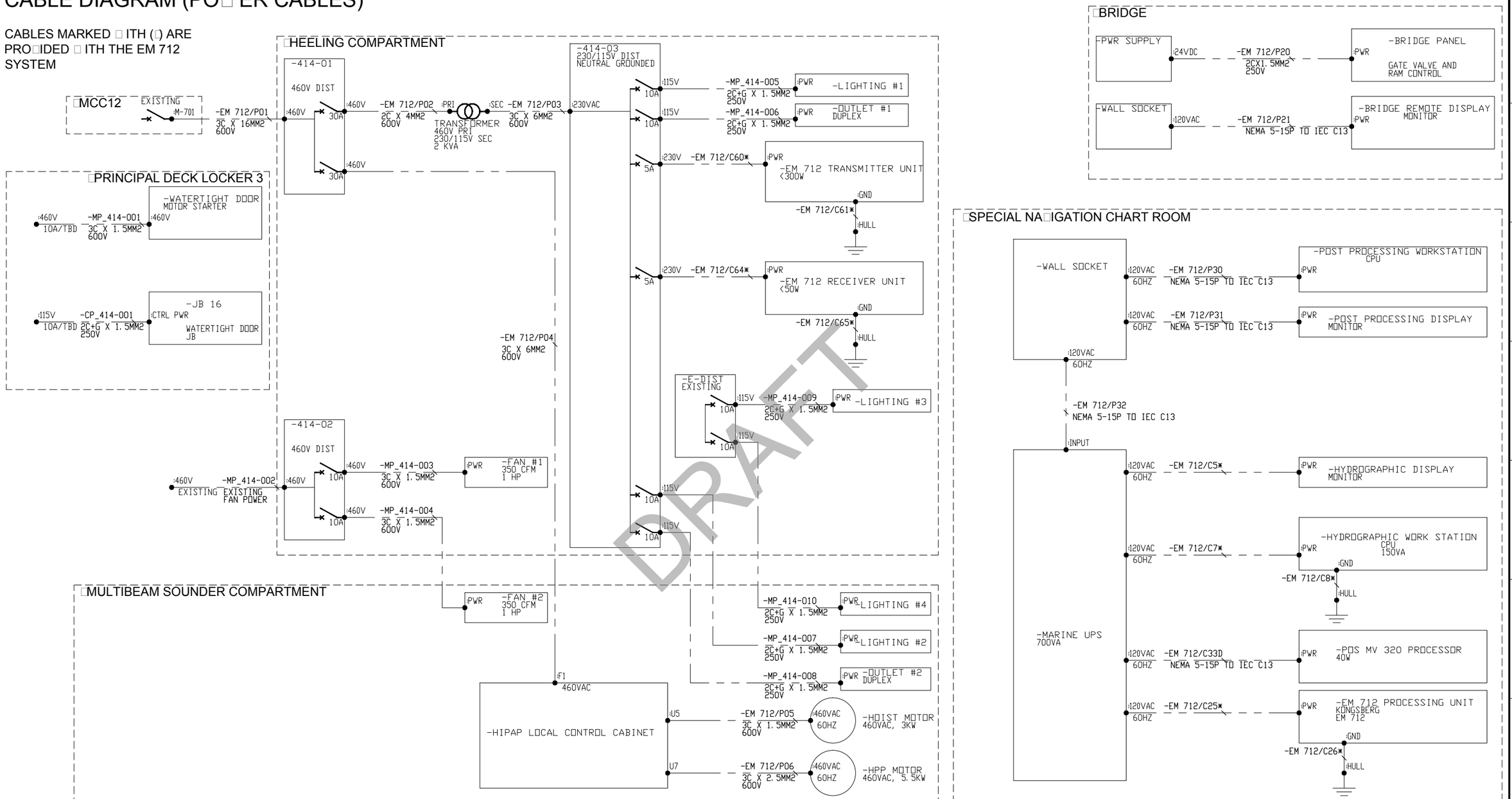
CABLE DIAGRAM (PO□ ER CABLES)

CABLES MARKED □ ITH (□) ARE
PRO□IDED □ ITH THE EM 712
SYSTEM



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JOB MULTIBEAM SOUNDER INSTALLATION FOR
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PO□ ER CABLING

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PROJECT No 7662		DATE 17-11-2017	
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DWG. No 1043-A414031			
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Appendix C
C17-66-009-01 Documents List

C17-66-009-01: Documents List

Concept Naval

Number	Documents / Drawings	Type	By	Revision
C17-66-601-01	Vessel's Modification Key Plan	Drawing	CN	0
C17-66-620-01	Capacity Plan	Drawing	CN	0
C17-66-026-01	Docking Plan	Drawing	CN	0
C17-66-165-01	Structural Modification	Drawing	CN	0
C17-66-180-01	Grey Water System Skid	Drawing	CN	0
C17-66-185-01	GPS Antenna Arrangement	Drawing	CN	0
C17-66-185-02	IMU Arrangement	Drawing	CN	0
C17-66-201-01	Piping Modification	Drawing	CN	0
C17-66-626-01	Doors, Hatch and Manholes	Drawing	CN	0
C17-66-003-01	Retractable "Drop-Down" Multi-Beam Specification	Document	CN	0
MT-3001-V3	Electrical Specification Multi-Beam Sounder Installation (EM 712)	Document	Canal	2
1043-A414011	Cable Diagram (EM 712 Sensors)	Drawing	Canal	2
1043-A414021	Cable Diagram (EM 712 Interfaces and External Systems)	Drawing	Canal	2
1043-A414031	Cable Diagram (Power Cables)	Drawing	Canal	2

Appendix D
Kongsberg Documentation

KONGSBERG

Kongsberg EM 712
Multibeam echo sounder
Installation manual

401027/A

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Disclaimer

Kongsberg Maritime AS endeavours to ensure that all information in this document is correct and fairly stated, but does not accept liability for any errors or omissions.

Warning

The equipment to which this manual applies must only be used for the purpose for which it was designed. Improper use or maintenance may cause damage to the equipment and/or injury to personnel. All users must be familiar with the contents of the appropriate manuals before attempting to install, operate, maintain or in any other way work on the equipment.

Kongsberg Maritime AS disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

Support information

If you require maintenance or repair, contact your local dealer. You can also contact us using the following address: km.hydrographic.support@kongsberg.com. If you need information about our other products, visit http: //www.km.kongsberg.com.

Table of contents

About this manual

Observe this general information about the EM 712 Installation manual; its purpose and target audience.

Purpose

The purpose of this manual is to provide the information and basic drawings required for the physical installation of the EM 712.

For more detailed information about the practical use of the EM 712, refer to the *Operator manual* and/or the *Reference manual*.

Target audience

The manual is intended for technical personnel; such as skilled shipyard workers, electricians, qualified engineers and naval architects. It is assumed that you understand the general principles of maritime electronic equipment. You must also be familiar with computer hardware, interface technology and installation of electronic and mechanical products.

We assume that you are familiar with the basic acoustic principles of sound in water, and that you have some experience with multibeam and/or single beam echo sounders in hydrographic applications.

Installation instructions

You must follow the instructions in this manual to ensure optimal performance. As a guide, installation procedures are presented in the order they must be done.

The equipment described in this manual includes the complete system with relevant cabinets. Units provided locally by the customer, installation shipyard or local representative are not described.

The manual also defines the equipment responsibility, and provides applicable instructions for unpacking and storage of units.

Note

You must follow the instructions given in this manual. If not it may affect the warranty.

Kongsberg Maritime AS will accept no responsibility for any damage or injury to the system, vessel or personnel caused by equipment that has been incorrectly installed or maintained, or by drawings, instructions or procedures that have not been prepared by us.

Installation drawings

The customer, or the shipyard contracted to do the installation, must provide relevant detailed vessel specific mechanical drawings.

Note

If required, all drawings provided by the shipyard for the physical installation of the EM 712 must be approved by the vessel's national registry and corresponding maritime authority and/or classification society. Such approval must be obtained before the installation can begin. The shipowner and shipyard doing the installation are responsible for obtaining and paying for such approval.

Kongsberg Maritime AS may, on special order, provide assistance to these drawings.

Applicable generic outline dimension and productions drawings are provided in the *Drawing file* chapter.

On-line information

For information about the EM 712 and other products from Kongsberg Maritime, visit our website on

- http://www.km.kongsberg.com

Registered trademarks

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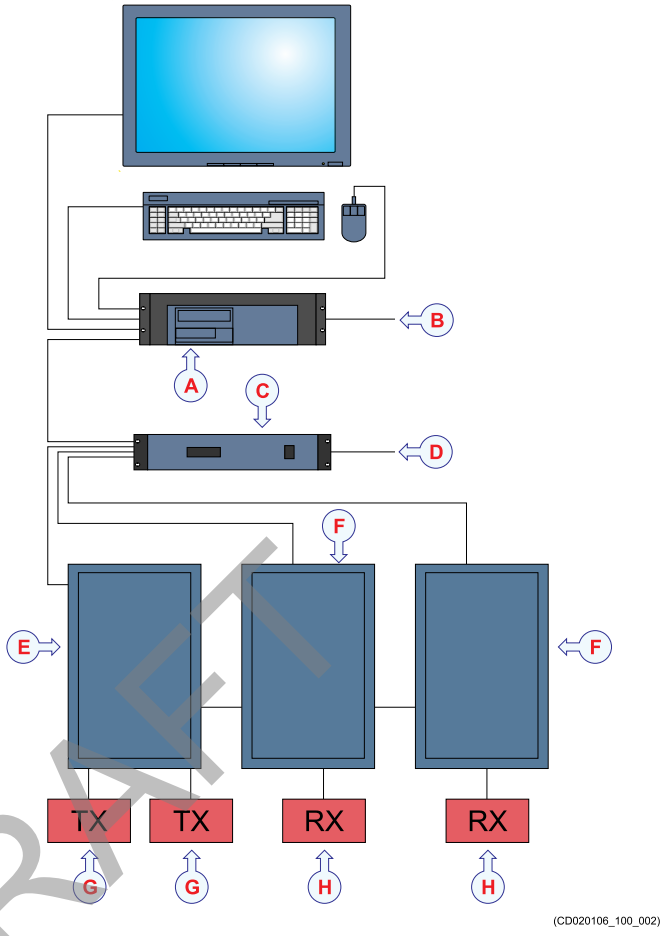
Kongsberg EM 712

Topics

System diagram 0.5 x 0.5 degrees system

The system diagram identifies the main components of a basic EM 712 system, as well as the key connections between the units. Interface capabilities and power cables are not shown.



A *Hydrographic Work Station (HWS)*

B *Interfaces:*

- *Sound speed sensor*
- *Tide*
- *Center depth output*

C *Processing Unit (PU)*

D *Processing Unit interfaces:*

- *Positioning systems*
- *Attitude (roll, pitch and heave)*
- *Velocity*
- *Heading*
- *Clock*

Processing Unit special interfaces:

- *Trigger input/output*
- *Clock synchronization (1PPS)*

E *TX Unit*

F *RX Unit*

G *Transmit transducer*

H *Receive transducer*

System units

EM 712 comprises a modular set of electronic units.

Topics

Transducer description

A transducer is a device that converts one form of energy to another. In an echo sounder system the transducer converts electric energy to sound. The EM 712 uses separate transducer arrays for transmitting and receiving sound pulses. Both transducer arrays can have several modules which are assembled in mounting frames.

The two transducer arrays are normally mounted as “T” or “L” configurations under the vessel’s hull (Mills Cross configuration). The transmit transducer array should be aligned parallel to the vessel’s keel. The receiver transducer array should be aligned 90º on the keel. Both transducers should be horizontal on a plane on the keel.

The EM 712 can use two sizes of transmit (TX) and receive (RX) modules:

- **1 degree transmit transducer**: TX1
- **2 degrees transmit transducer**: TX2
- **1 degree receive transducer**: RX1
- **2 degrees receive transducer**: RX2

The number of individual TX and RX modules in the two arrays depends on the chosen EM 712 configuration. The standard types identified by the “transmission x reception” beam width are:

- **0.5 x 0.5 degrees system**: 2 TX1 modules and 2 RX 1modules
- **0.5 x 1 degree system**: 2 TX1 modules and 1 RX1 module
- **1 x 1 degree system**: 1 TX1 module and 1 RX1 module
- **1 x 2 degrees system**: 1 TX1 module and 1 RX2 module
- **2 x 2 degrees system**: 1 TX2 module and 1 RX2 module

Note

The red protective coating is an vital part of the transducer. It is very important that neither this coating nor the internal parts of the transducer are damaged during the handling, installation or cleaning. Any holes and/or scratches in the transducer surface will allow water to penetrate the transducer. If a leak occurs, the transducer must be replaced.

A transducer must always be handled as a delicate item. Wrongful actions may damage the transducer beyond repair.

Observe these rules:

- **Do not** activate the transducer when it is out of the water.
- **Do not** lift the transducer by the cable.
- **Do not** step on the transducer cable.
- **Do not** handle the transducer roughly, avoid impacts.
- **Do not** expose the transducer to direct sunlight or excessive heat.
- **Do not** use high pressure water, sand blasting, metal tools or strong solvents to clean the transducer face.

TX Unit description

The EM 712 TX (transmit) Unit has all transmit electronics.

The EM 712 TX Unit is a wall-mounted steel cabinet with integrated shock and vibration absorbers. It holds the circuit boards for transmission. It is normally located in a 'sonar room' close to the transducer arrays. An Ethernet cable connects the TX Unit to the Processing Unit.

RX Unit description

The EM 712 RX (receive) Unit has all receive electronics.

The EM 712 RX Unit is a wall-mounted steel cabinet with integrated shock and vibration absorbers. It holds the circuit boards for reception. It is normally located in a 'sonar room' close to the transducer arrays. An Ethernet cable connects the TX Unit to the Processing Unit.

EM 712 Processing Unit description

The EM 712 Processing Unit is provided to process the signals to and from the Transmitter and Receiver Units.

The EM 712 Processing Unit is an industrial computer using both COTS (commercial off-the-shelf) components and custom made components. The unit is designed and tested for rugged use. The Processing Unit is the central controlling device in the EM multibeam system. It administers the transmittal of pings via the TX unit(s) and reception of data from the RX unit(s).

The 48 V output from the Processing Unit can be used for remote control of the Transmitter and Receiver Units.

Hydrographic Work Station description

The Hydrographic Work Station is a maritime computer. It contains the operational software, and offers the user interface that allows you to control the EM 712 system.

A dedicated maritime computer is provided with the Kongsberg EM 712 system. It is set up with all necessary software.

The computer is based on the Microsoft® Windows® 7 operating system.

The Hydrographic Work Station is normally mounted on the bridge or in a scientific laboratory.

In this publication, the computer is referred to as the Hydrographic Work Station.

Preparations

Topics

Necessary tools and equipment for EM 712 installation

The installation of the EM 712 must take place in dry dock, and the work must be done by a qualified shipyard.

In order to do the EM 712 installation, all necessary tools and equipment for mechanical hull work, cabinet installation and electrical wiring must be available. It is not practical to provide a detailed list of all necessary tools and equipment. However, you must make sure that the following specialized tools are available.

- All necessary tools and consumables required for welding
- All necessary tools and consumables required for physical installation of units, cabinets and racks
- All necessary tools and consumables required for electrical installations
- A crane capable of lifting the system cabinets
- A crane capable of lifting the entire hull unit

Note

Whenever specific consumables or special tools or test instruments are required, these are identified in the relevant procedure(s).

Requirements for shipyard worker skills

The installation of the EM 712 is a demanding task. It is very important that the shipyard workers involved in the installation tasks are competent.

As a minimum, the following certified craftsmen must be available:

- naval architects
- welders
- electricians
- project manager

Note

The quality of the welding is critical to the safety of the vessel. Welding must only be done by a certified welder.

The final installation work must be approved by the vessel's national registry, the corresponding maritime authority and/or classification society. The shipowner and shipyard doing the installation are responsible for obtaining and paying for such approval.

Sonar room requirements

Observe minimum requirements to obtain suitable working conditions for EM 712 installation, use and maintenance.

Topics

Environment

The EM 712 cabinets must be installed in a dry and dust-free environment. The cabinets are not fully protected against humidity, dust or water.

Observe the environmental specifications related to the EM 712 cabinets.

Watertight integrity

The size, location and design of the sonar room must fulfil all requirements to the vessel's watertight integrity.

In the event of a major leak in the sonar room, it must be possible to close all watertight hatches and/or doors to the sonar room to maintain the vessel stability and safety.

The physical size of the sonar room must be limited, so that in the event of a major leak, the flooding of the sonar room will not induce instability, or cause the vessel to capsize or sink.

Ensure that all watertight decks and bulkheads are inspected periodically to verify that there are no unprotected openings or improper penetrations that will allow progressive flooding from the sonar room, and that the watertight doors and hatches are in place and in working order.

Ensure bilge high level alarms are arranged to provide the earliest warnings of abnormal accumulation. The high level bilge alarms must be set as low as possible to the deck or bilge well and positioned along the centre area of the compartment or in a location at which the fluids will gravitate to first.

All cables leading in and out of the sonar room must be run in steel conduits. These steel conduits must reach up and above the freeboard deck.

Size and access

A well designed sonar room with a well fitted size and easy access reduces the risk of corrosion, and simplifies maintenance. This increases system reliability.

Note

The physical size of the sonar room must be limited, so that in the event of a major leak, the flooding of the room will not induce instability, or cause the vessel to capsize or sink.

The sonar room must be dimensioned to house all the relevant cabinets that comprise the EM 712 system.

1 The room must not be used for any other heavy machinery.

2 The room must not be unnecessarily obstructed by girders, pipes etc, which may cause installation problems or impede maintenance.

3 The room must be accessible under all conditions at sea or at a berth.

4 All doors or hatches must be designed so that the tools and equipment can be removed without being disassembled.

5 All cables leading in and out of the room must be run in steel conduits. These steel conduits must reach up and above the freeboard deck.

Insulation, heating and ventilation

The bulkheads in the sonar room must be insulated and provided with an interior wall to the deck. The room must be equipped with heater, and it must be connected to the vessel's ventilation system.

Insulation

The insulation in the sonar room should be the minimum equivalent of 50 mm of rock-wool.

In addition, piping passing through the space prone to condensation must be properly insulated.

Heater

This heater in the sonar room must dimensioned to maintain the equipment within its environmental tolerances (at least 1000 W). It must be installed close to the deck.

Heating is an effective method for reducing humidity.

Ventilation

The sonar room must be connected to the vessel's ventilation system. If this is not possible, two 3” vents must be provided from the sonar room to the main deck.

In the room, the air inlet must whenever possible be located close to the deck and the outlet as high as possible. A funnel shaped drip-collector must be mounted below the

vent pipes to divert moisture to the bilge. On the main deck, the best ventilation is provided when the outlet pipe is at least four meters higher than the inlet pipe. To keep out sea water, rain and spray, the ventilation pipes should be fitted with goosenecks or a equivalent design.

Note

If the vessel is likely to operate in tropical conditions, a suitable air conditioning system must be installed. This system must be able to provide an ambient temperature not exceeding the maximum operating temperatures of the cabinets installed in the room.

Electrical installations, cables and communication

The electrical installations in the sonar room must meet minimum requirements to provide suitable lights and supply power.

1 If the cables between the sonar room equipment and other system units located in different compartments on the vessel pass through hatches or areas where they may be damaged, they must be run through conduits (minimum 2” conduit is recommended).

2 The sonar room must be equipped with a telephone, an intercom system, or any other means of oral communication between the sonar room and the bridge and/or control room(s).

3 The sonar room must be equipped with suitable lighting to simplify the installation and to aid future maintenance.

4 Each system unit in the sonar room should be provided with a separate circuit breaker on the mains supply.

5 Proper vessel ground must be provided.

6 A minimum number of additional electrical outlets must be provided for other equipment.

7 Make sure that all system cables are properly secure, but also installed with some slack. This is essential to withstand vibrations, and to facilitate maintenance.

Bilge pump and decking

If the sonar room is located below the water line, it must be connected to the vessel's bilge pump system.

If this is not possible, a separate bilge pump for the sonar room must be installed.

Once the installation has been completed, the sonar room must be suitably decked without restricting access to the equipment and the cables.

Where to install the transducer

Topics

Introduction

A single answer to the question “where to install the transducer” cannot be given.

The physical location of the transducer depends on the vessel's design and construction, how the hull is shaped, and how the water runs along the hull. There are however a number of important guidelines, and some of these are even conflicting.

Note

The information here must be considered as general advice. Each EM 712 installation must be handled separately depending on the hull design.

Mount the transducer deep

In order to achieve the best possible EM 712 performance, mount the transducer as deep as possible under the vessel’s hull.

Consider the situations when the vessel is unloaded, and when it is pitching in heavy seas.

There are several reasons for this.

1 The upper water layers of the sea contain a myriad of small air bubbles created by the breaking waves.

   In heavy seas the upper 5 to 10 metres may be filled with air, and the highest concentrations will be near the surface. Air bubbles absorb and reflect the sound energy, and they may in worst cases block the sound transmission altogether.

2 Another reason to go deep is cavitation.

   Cavitation is the formation of small bubbles in the water close to the transducer face due to the resulting local pressure becoming negative during parts of the acoustic pressure cycles. The cavitation threshold increases with the hydrostatic pressure.

3 The transducer must never be lifted free of the water surface.

Transmitting into open air may damage the it beyond repair. Mounting the transducer at a deep position on the hull will in most cases prevent this.

4 If the transducer is lifted up from the water during heavy seas, it may be damaged when the hull strikes back at the sea surface.

This is especially important for low frequency transducers with large faces.

Avoid protruding objects

Objects protruding from the hull will generate turbulence and flow noise. This will reduce the EM 712 performance.

Such objects may be zinc anodes, sonar transducers or even the vessel's keel. Holes and pipe outlets are also important noise sources, as well as rough surfaces caused by bad welding. All these protruding objects may act as resonant cavities amplifying the flow noise at certain frequencies.

Do not place a transducer in the vicinity of such objects, and especially not close behind them. For the same reason, it is very important that the hull area around the transducer face is as smooth and level as possible.

Even traces of sealing compound, sharp edges, protruding bolts or bolt holes without filling compound will create noise.

Stay far away from the propellers

The propulsion propellers is the dominant noise source on most vessels. The noise is transmitted through the sea water, and may often reduce the performance of your EM 712 system.

For this reason, the transducer must be placed far away from the propellers, which means on the fore part of the hull. Positions outside the direct line of sight from the propellers are favourable.

On small vessels with short distances it is advised to mount the transducer on that side of the keel where the propeller blades move upwards, because the propeller cavitation is strongest on the other side. The cavitation starts most easily when the water flows in the same direction as the propeller blade, and that is to some degree the case at that side of the keel where the propeller blades move downwards.

Choose a position far away from the bow thruster(s)

Bow thruster propellers are extremely noisy.

When in operation, the noise and cavitation bubbles created by the thruster may make your EM 712 system useless, almost no matter where the transducer is installed.

And when not in operation, the tunnel creates turbulence. If your vessel is pitching, the tunnel may be filled with air or aerated water in the upper position and release this in the lower position.

In general, all transducers must therefore be placed well away from the bow thruster. In most cases, a location forward of the bow thruster is advantageous.

However, this is not an invariable rule. Certain thruster designs combined with its physical location on the hull may still offer suitable locations near the thruster. If you are in doubt, consult a naval architect.

Summary and general recommendations

Some of the installation guidelines provided for transducers may be conflicting. For this reason, each vessel must be treated individually in order to find the best compromise.

In general, the most important factor is to avoid air bubbles in front of the transducer face. For this reason, the recommended transducer location is normally in the fore part of the hull, well ahead of the noise created by the bow wave. The maximum distance from the bow is normally equal to one third of the total water line length of the hull.

If the vessel hull has a bulbous bow, this may well be a good transducer location, but also in this case the flow pattern of the aerated water must be taken into consideration. Often the foremost part of the bulb is preferable.

This applies to the vessel in normal trim and speed.

Important

Under no circumstances should the transducer be tilted backwards when the vessel is moving at an appreciable speed. Mounting screws must never be extruding from the transducer, and the space around the screws must be filled with a compound or a locking ring.

Acoustic noise

As with any other hydroacoustic systems, the quality of the EM 712 presentations are subject to unwanted acoustic noise. The echoes from any large and small target must be detected inside the noise.

It is important that we keep this noise level as low as possible in order to obtain long range and dependable interpretations of the echoes. Even with the advanced noise filtering offered by the EM 712, we must address the noise challenge during both planning and preparations for the EM 712 installation.

Topics

Contributing factors

Several factors are contributing to the performance of the hydroacoustic equipment used on board a vessel.

Such factors include:

- The quality and properties of the transmitted signal
- The quality of the receiving system
- The operational settings made during operation
- The properties of the target(s)
- The signal-to-noise ratio

The majority of these factors can neither be controlled nor improved by means of installation methods or transducer locations. The quality and properties of the transmitting and receiving systems are key factors during our product development, while our end user documentation aims to help the user to make the right filter settings during operation. As for the target properties, there is nothing any of us can do with those.

The *signal-to-noise ratio*, however, can be improved by making the correct choices during installation.

> Signal-to-noise ratio (often abbreviated SNR or S/N) is a measure used in science and engineering that compares the level of a desired signal to the level of background noise. It is defined as the ratio of signal power to the noise power, often expressed in decibels. A ratio higher than 1:1 (greater than 0 dB) indicates more

signal than noise. While SNR is commonly quoted for electrical signals, it can be applied to any form of signal [...].

http://en.wikipedia.org/wiki/Signal_to_noise_ratio (September 2013)

For active sonar and echo sounder systems, the signal is the echo that we want to know something about, while the noise is any unwanted signals or disturbances. The echo must be detected in the noise and therefore it is necessary to keep the noise level is as low as possible in order to obtain long range and dependable interpretation. The noise that contributes to the signal to noise ratio on hydroacoustic instruments may be divided into the following types of noise:

- Self noise
- Ambient noise
- Electrical noise
- Reverberation

A The transducer can pick up noise from

- Biological disturbances
- Interference
- Cavitation
- Propeller noise
- Flow noise
- Acoustic noise from other hydroacoustic systems

B The transducer cable is long, and may pick up electric noise from generators, pumps, cooling systems etc.

C The preamplifiers are very sensitive, and they can easily pick up electrical noise from internal and external power supplies. They are also vulnerable for analogue noise created by their own circuitry. Digital noise created by the converter and processing circuitry can also create problems.

D A/D converters transform the analogue echoes to digital format.

E Signal processing circuitry can create digital noise.

Self noise

Any vessel equipped with a hydroacoustic system will produce more or less self noise.

There are many sources of such self noise.

- **Machinery noise**: Main engine, auxiliary engines, gears, pumps, blowers, refrigerator systems, etc.
- **Electric noise**: Electric motors, ground loops, etc
- **Propeller noise**: Propeller blade properties, cavitation, shaft vibrations, static discharges

- **Cavitation**
- **Flow noise**: Laminar flow, turbulent flow, bubbles, etc
- **Rattle noise**: Loose parts
- **Interferences**: Other hydroacoustic systems on your own vessel

We will here go into some details in order to analyse the different sources of self noise on a vessel and how they may influence upon the noise level of the hydroacoustic instruments.

Machinery noise

The main contributor is usually the main engine on board the vessel. The contribution from auxiliary machinery may, however, be considerable, especially if some of it is in poor shape. The machinery noise can be transmitted to the transducer as a:

- Structure-borne noise through the ship structure and the transducer mountings
- Water-borne noise through the hull into the water to the transducer

Electric noise

Modern vessels are normally equipped with a lot of electric instruments such as hydroacoustic systems, radars, navigation systems, and communication equipment. Any electric instruments may in some cause electrical interference and noise.

International regulations and certifications are used to control and reduce this, but even these are limited if the electrical systems are poorly installed and maintained.

Propeller noise

This source is often the main source of noise at higher vessel speeds. Variable pitch propellers or fast moving propellers usually make more noise than fixed propellers or slow moving propellers.

This noise is usually water-borne. In some cases, however, shaft vibrations or vibrations in the hull near the propeller may be structure-borne to the transducer. If a propeller blade is damaged, this may increase the noise considerably.

Propeller cavitation is a severe source of noise. "Singing" propellers might be a source of noise, which interferes at discrete frequencies. In some cases static discharge from the rotating propeller shaft may be quite disturbing.

Cavitation

Cavitation usually occurs more willingly in air filled water and the occurrence is dependent on the hydrostatic pressure. Cavitation is a severe source of noise. The noise is made when the voids implode. Cavitation noise often occurs at the propeller and near extruding objects at higher speeds.

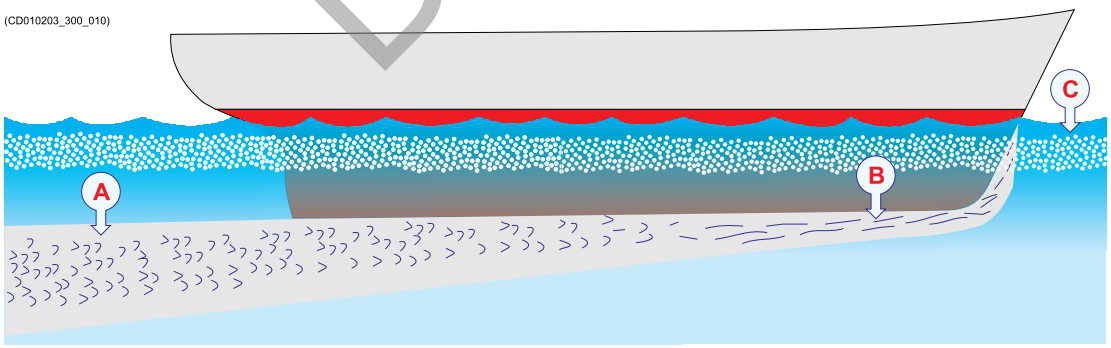
Contributions to the flow noise may also be caused by air bubbles hitting the transducer face, or by the splash caused by the waves set up by the vessel. In some cases a resonant phenomenon is set up in a hole near the hull. This sound will have a discrete frequency, while all other flow noise will have a wide frequency spectrum.

(Image from U. S. Navy in the public domain.)

Flow noise

Every object that moves through water will disturb the medium, and it will cause friction in the water. The friction zone is called the *flow boundary layer*. The flow in this boundary layer may be *laminar* or *turbulent*.

- The laminar flow is a nicely ordered, parallel movement of the water.
- The turbulent flow is a disorderly flow pattern, full of eddies.



A *Turbulent flow*

B *Laminar flow*

C *Air bubbles*

The boundary layer increases in thickness when it becomes turbulent. The boundary layer is thin in the forward part of the vessel hull, and increases as it moves aft. The thickness depends on ships speed and on the roughness of the hull. All objects sticking out from the hull, or dents in the hull, will disturb the flow and will increase the thickness of the boundary layer. When the flow speed is high, the turbulence can be violent enough

to destroy the integrity of the water. Small voids or cavities in the water will occur and this is called cavitation.

Rattle noises

Rattle noise may be caused by loose objects in the vicinity of the transducer, like fixing bolts. The rattle may also come from loose objects inside the hull.

Interference

Interference from other hydroacoustic equipment on board the same vessel may be an annoying source of disturbance. Unless the same frequency is used for more than one piece of equipment only the transmitted pulse will contribute to the interference.

Ambient noise

Ambient noise is usually not a limiting factor to the performance of sonars and echo sounders.

The ambient noise may be split up as follows:

- **Sea noise**: Air bubbles, seismic disturbances, waves, boundary turbulence, etc.
- **Biological noise**: Fish, mammals, etc.
- **Man made noise**: Other vessels, interference
- **Precipitation noise**

In some areas, where many vessels are operating together the engine and propeller noise from other vessels might be disturbing.

Interference from hydroacoustic instruments located in other vessels may also be a limiting factor.

The sea noise is as can be expected dependent on the weather conditions. In bad weather the sea noise can be quite high.

Electrical noise

Electrical or electronic noise is picked up or generated in any other part of the equipment than the transducer.

Hum picked up by the transducer cables or picked up from the voltage supply is usually the most common source of electrical noise.

At higher frequencies – where rather wide bandwidths are necessary – the noise from components, transistors or other analogue electronic may be a limiting factor.

Some means to reduce acoustic noise

Careful planning of the EM 712 installation may reduce the acoustic noise.

Unfortunately, it is impossible to simply provide a number of specific procedures to reduce the noise.

An important factor is the physical location of the transducer. This depends on the vessel's design and construction, how the hull is shaped, and how the water runs along the hull.

Other factors deal with other equipment mounted on board, and this will also be vessel dependant.

At moderate ship speeds the machinery noise is usually dominant. At medium speeds the flow noise increases more rapidly and takes over, while at higher speed the propeller noise will be the main contributor.

Note

The information here must be considered as general advice. Each EM 712 installation must be handled separately depending on the hull design and the other electrical and mechanical systems installed on the vessel.

Reducing flow noise

- The shape of the transducer (or dome around it) must be as streamlined as possible.
- The hull plating in front of the transducer must be as smooth as possible. Be especially aware of bilge keels and zinc alloy anodes. The keel should be rounded off without sharp edges.

  Important

  No extruding objects or any abrupt transitions should appear.

Reducing machinery noise

- The main engine and relevant auxiliary engines and equipment should be fixed to rigid foundations to avoid vibrations. Use of shock absorbers or floating rafts may sometimes reduce this noise.
- Any hull structure that may vibrate should be damped or coated to reduce the vibrations.
- The structure-borne noise may be reduced by isolation, for example by providing vibration clamping between the transducer and the hull structure.

Reducing propeller noise

- Sufficient clearance between the propellers and the hull, the rudder and the keel should be provided.
- Place the zinc alloy anodes in places where the water flow is the least disturbed.
- Ensure that the propellers blades are correctly designed and without damages.

- The use of a baffle between the propellers and the transducer may reduce noise appreciably.
- Static discharges caused by the rotating propeller shaft may be removed by proper grounding or by mounting a coal brush from the shaft to ground.

Reducing rattle noise

Ensure that no parts near the transducer can rattle as a result of water flow or vibrations.

Reducing interference

Interference from the transmission pulses from other hydroacoustic instruments on board the vessel is difficult to avoid.

The problem may be reduced by choosing the working frequencies carefully and to some extent by separating the different transducers.

On vessels with a large number of separate hydroacoustic systems installed and in simultaneous use, a separate synchronizing system (for example the **K-Sync**) should be considered.

Reducing electrical noise

- Make sure that all units are properly grounded, as this is important to avoid electrical noise.
- You must use shielded cables with correct grounding.
- Separate EM 712 cables from other cables with heavy currents or transients.
- Place all high voltage power cables in metal conduits.

Vessel coordinate system

The vessel coordinate system is established to define the relative physical locations of systems and sensors.

When you have several different sensors on your vessel, and you wish each of them to provide accurate data, you need to know their relative physical positions. On larger vessels, each sensor may be located far away from each other.

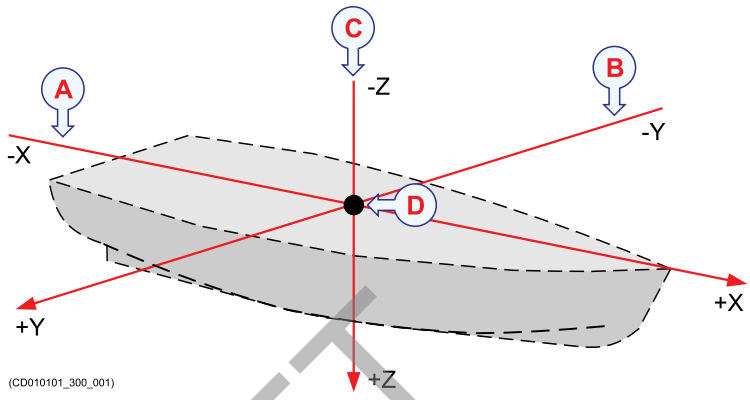
The antenna of a position sensor is typically mounted high above the superstructure, while a motion sensor is located close to the vessel's centre of gravity. Both of these are physically positioned far away from the transducer on a depth sensor, which may be located closer to the bow.

Very often, the information from one sensor depends on data from an other. It is then important that the relevant measurements are compensated for these relative distances.

Example

If you wish to measure the actual water depth, you will need to know the vertical distance from the echo sounder transducer to the water line. Since the vessel's displacement changes with the amount of cargo, fuel etc, the physical location of the water line on the hull must either be measured at a regular basis, or measured with a second sensor.

In order to establish a system to measure the relative distance between sensors, a virtual coordinate system is established. This coordinate system uses three vectors; X, Y and Z.



A *The X-axis is the longitudinal direction of the vessel, and in parallel with the deck. A positive value for X means that a sensor or a reference point is located ahead of the origin (D).*

B *The Y-axis is the transverse direction of the vessel, and in parallel with the deck. A positive value for Y means that a sensor or a reference point is located on the starboard side of the origin (D).*

C *The Z-axis is vertical, and in parallel with the mast. A positive value for Z means that a sensor or a new reference point is located under the origin (D).*

D *Origin*

Coordinate system origin

The *origin* is the common reference point where all three axis in the vessel coordinate system meet. All physical locations of the vessel's sensors (radar and positioning system antennas, echo sounder and sonar transducers, motion reference units etc) are referenced to the origin.

In most cases, the location of the vessel's "official" origin has been defined by the designer or shipyard. This origin is normally identified with a physical marking, and also shown on the vessel drawings.

Frequently used locations are:

- Aft immediately over the rudder (frame 0)
- Vessel's centre of gravity
- The location of the motion reference unit (MRU)

Alternative origins

If necessary, other origin locations may be defined for specific products or purposes. One example is the *Navigation Reference Point* that is frequently used. Whenever a vessel is surveyed to establish accurate offset information, the surveyor may also establish an alternative origin location.

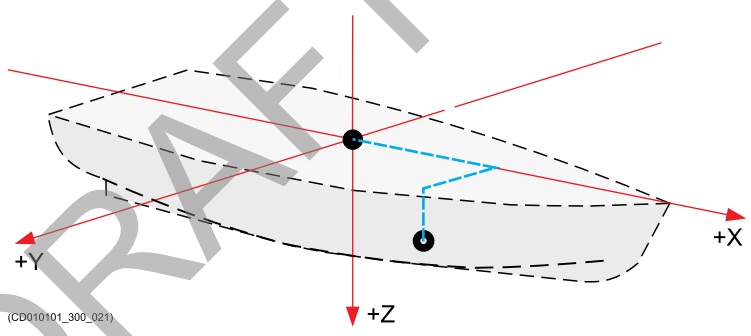
Whenever relevant, any such alternative locations must be defined using offset values to the "official" origin established by the designer or shipyard.

A commonly used alternative origin is the physical location of the vessel's motion reference unit (MRU).

Defining the location of each sensor

By means of the vessel coordinate system, the physical location of every sensor can be defined using three numerical values for X, Y and Z. These values must define the vertical and horizontal distances from a single reference point; the origin. In most cases, the motion reference unit (MRU) is the most important sensor to define.

The accuracy of the three numerical values for X, Y and Z defines the accuracy of the sensor data. If you require a high accuracy, for example for underwater positioning, underwater mapping or scientific measurements, you must have each sensor positioned using professional land surveying. For such use, a good alignment survey is critical for high quality results. Surveys are normally done by qualified and trained surveyors using proven survey equipment and methods.



In this example, a second reference point has been established. It is defined with three positive offset values for X, Y and Z. All values are positive because the new reference point is in front of and below the origin, and on the starboard side.

Installing the transducer

Topics

Transducer installation

Installation of the EM 712 transducers are similar to the EM 710 transducers.

For details about the installation of the EM 712 transducers please refer to the EM 710 Installation Manual document number: 164851.

Installing the EM 712 hardware units

Installing the TX Unit

The EM 712 TX Unit is normally positioned in a dedicated room in the vicinity of the transducer. The physical length of the cables limit the distance between the transducers and the TX Unit.

Prerequisites

Note

The TX Unit is heavy. Make sure that the necessary manpower and lifting equipment are available before you start the installation work.

Free bulkhead space is required to mount the TX Unit cabinet.

The distance between the transducer and the TX Unit is restricted by the length of the transducer cables.

Note

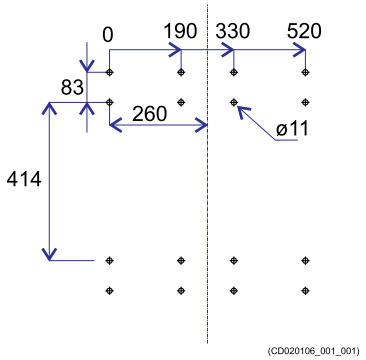
The installation shipyard must provide all necessary installation drawings.

If required, these drawings must be approved by the vessel's national registry and corresponding maritime authority and/or classification society. Such approval must be obtained before the installation can begin. The shipowner and shipyard doing the installation are responsible for obtaining and paying for such approval.

Context

The TX Unit is delivered as a complete cabinet with shock absorbers.

Mounting hole pattern for the TX Unit:



Procedure

1 Prepare the installation site.

   a Observe the general sonar room requirements.

   b Provide ample space around the cabinet to allow for inspection, maintenance and parts replacement.

   c Make sure that the space allows the cabinet door to be fully dismounted for unobstructed access to its internal parts.

   d Verify that the installation does not cause problems with existing cabling, ventilation ducts, piping etc. Check both sides of the bulkhead.

2 Mark the location of the holes for the upper and lower shock absorber on the bulkhead.

3 Drill 11-mm holes, eight (8) for each shock absorber.

Note

Always check on the other side of the bulkhead before drilling holes

4 Mount the cabinet to the bulkhead with sixteen (16) M10 bolts. These bolts must be supplied by the shipyard.

   As the cabinet is heavy, a lifting arrangement (articulated jack or similar) must be used.

   The foundation onto which the cabinet is mounted will determine the correct torque to be applied to the bolts.

   Alternatively, the shock absorbers can be mounted to a pair of specially designed support brackets.

Installing the RX Unit

The EM 712 RX Unit is normally positioned in a dedicated room in the vicinity of the transducer. The physical length of the cables limit the distance between the transducers and the RX Unit.

Prerequisites

Free bulkhead space is required to mount the RX Unit cabinet.

The distance between the transducer and the RX Unit is restricted by the length of the transducer cables.

Note

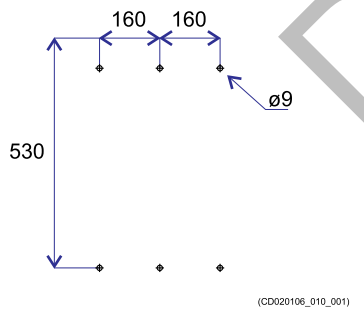
The installation shipyard must provide all necessary installation drawings.

If required, these drawings must be approved by the vessel's national registry and corresponding maritime authority and/or classification society. Such approval must be obtained before the installation can begin. The shipowner and shipyard doing the installation are responsible for obtaining and paying for such approval.

Context

The RX Unit is delivered as a complete cabinet with shock absorbers.

Mounting hole pattern for the RX Unit:



Procedure

1 Prepare the installation site.

   a Observe the general sonar room requirements.

   b Provide ample space around the cabinet to allow for inspection, maintenance and parts replacement.

   c Make sure that the space allows the cabinet door to be fully dismounted for unobstructed access to its internal parts.

   d Verify that the installation does not cause problems with existing cabling, ventilation ducts, piping etc. Check both sides of the bulkhead.

2 Mark the location of the holes for the upper and lower shock absorber on the bulkhead.

3 Drill 9-mm holes, three (3) for each shock absorber.

Note

Always check on the other side of the bulkhead before drilling holes

4 Mount the cabinet to the bulkhead with six (6) M8 bolts. These bolts must be supplied by the shipyard.

The foundation onto which the cabinet is mounted will determine the correct torque to be applied to the bolts.

Alternatively, the shock absorbers can be mounted to a pair of specially designed support brackets.

Cable layout and interconnections

Cabling principles, cable plans and drawings, as well as relevant procedures, are provided.

Topics

Read this first

Detailed information about cable specifications, termination and connectors is provided. Unless otherwise specified, all cables are supplied by Kongsberg Maritime as a part of the EM 712 delivery.

Note

All electronic installations and corresponding wiring must be in accordance with the vessel's national registry and corresponding maritime authority and/or classification society. If no such guidelines exist, we recommend that Det Norske Veritas (DNV GL) Report No. 80-P008 "Guidelines for Installation and Proposal for Test of Equipment" is used as a guide.

Only trained and authorized personnel can install the EM 712 cables.

Kongsberg Maritime will not accept any responsibility for errors, malfunctions or damage to system or personnel caused by improper wiring.

A detailed drawing for each specific cable is provided. Each drawing provides additional information, and may, when applicable, include minimum specifications, connector terminations and the required number of cores.

Drawings are generally not provided for standard commercial cables.

Cables fall into two categories.

1 **System cables**: These cables are provided by Kongsberg Maritime as a part of the EM 712 delivery.

2 **Shipyard cables**: These cables must be provided by the shipyard performing the installation, or the shipowner. It is very important that the cables used meet the minimum specifications provided in this manual.

Kongsberg Maritime accepts no responsibility for damage to the system or reduced operational performance caused by improper wiring.

Note

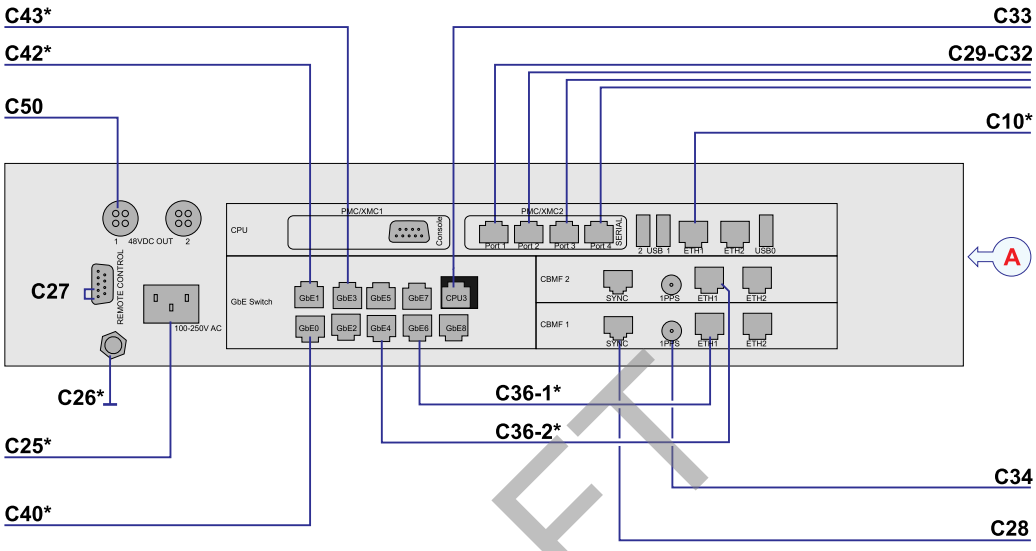
It is very important that all cables are properly installed and correctly terminated. Observe the relevant regulations and work standards. Always leave enough cable slack close to system units and cabinets to allow for maintenance.

Cable plans

Topics

Cable plan, Processing Unit

The processing unit cables include those used to connect the EM 712 processing unit to AC mains power, and to the transmitter and receiver units. One Ethernet cable is used to connect the processing unit to the Hydrographic Work Station.



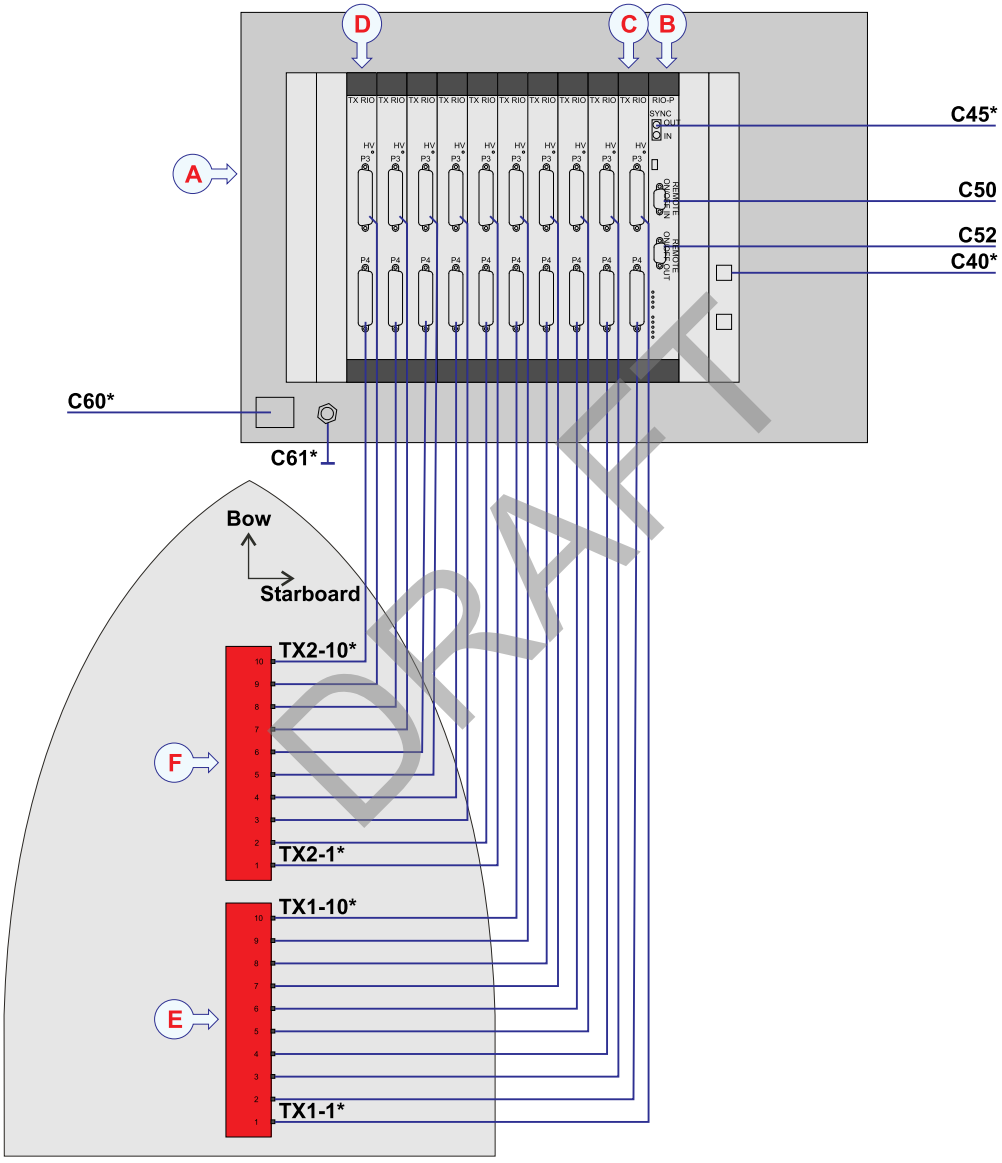
(CD020106_200_002)

A *Processing Unit*

Cables identified with an asterisk (*) are provided with the standard EM 712 delivery.

Cable plan, Transmitter Unit

The transmitter (TX) Unit cables include those used to connect the EM 712 TX Unit(s) to AC mains power, to the receiver (RX) Unit, to the Processing Unit and to the transducers. If there are more than one TX Unit they have to be connected to each other with a fibre optic cable.



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A *Transmitter Unit (TX Unit)*

B *RIO-P*

C *TX RIO 1*

D *TX RIO 10*

E *Transmit Transducer (TX) 1*

F *Transmit Transducer (TX) 2*

Cables identified with an asterisk (*) are provided with the standard EM 712 delivery.

The illustration shows the TX transducer arrays mounted in the default orientation, with the cables pointing towards starboard.

Marking of TX transducer cables

The TX transducer module(s) and its cable is identified as follows:

TX1<m>/<n> or TX2<m>/<n> where <m> is the cable number (a number between 1 and 10) and <nnn> is the module's serial number (a numerical value).

The transducer cables are moulded to the TX array, but connect in the other end to the Transmitter Unit (TXU) with 76–pin D-sub connectors.

Connection of TX transducer cables

Note

During the installation of the TX array, you must fill in the cable identification table(s) below.

For a system with 0.5 degree TX you will need all cables listed in the tables. With a 1 degrees system, you only need the first 10, while the 2 degrees system only requires the first 5 cables.

The 0.5 degree system consists of two TX modules. It is essential to connect all 20 TX cables successively to the TX RIO boards in the Transmitter Unit.

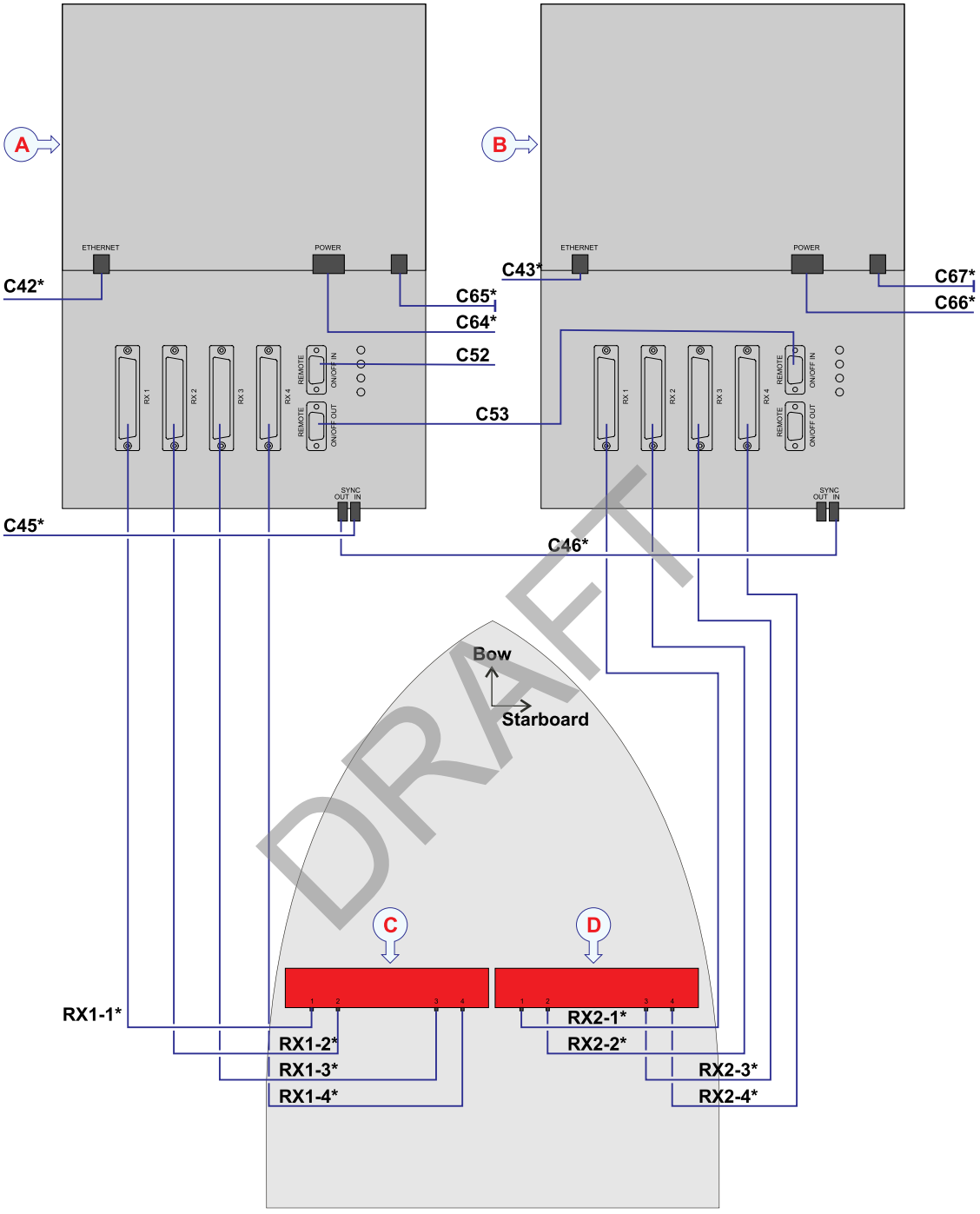
TX array identification TX1		**TX Unit identification**	
Cable no.	Transducer Serial no.:	TX RIO no.	Socket no.
1		1	P3
2		1	P4
3		2	P3
4		2	P4
5		3	P3
6		3	P4
7		4	P3
8		4	P4

TX array identification TX1		TX Unit identification	
9		5	P3
10		5	P4

TX array identification TX 2		TX Unit identification	
Cable no.	Transducer Serial no.:	TX RIO no.	Socket no.
1		6	P3
2		6	P4
3		7	P3
4		7	P4
5		8	P3
6		8	P4
7		9	P3
8		9	P4
9		10	P3
10		10	P4

Cable plan, Receiver Unit, 0.5 degree

The receiver (RX) Unit cables include those used to connect the EM 712 RX Unit(s) to AC mains power, to the transmitter (TX) Unit, to the Processing Unit and to the transducers. If there are more than one RX Unit they have to be connected to each other with a fibre optic cable.



(CD020106_202_002)

A *Receiver Unit (RX Unit) 1*

B *Receiver Unit (RX Unit) 2*

C *Receive Transducer (RX) 1*

D *Receive Transducer (RX) 2*

Cables identified with an asterisk (*) are provided with the standard EM 712 delivery.

The illustration shows the RX transducer arrays mounted in the default orientation, with the cables pointing towards stern.

Marking of RX transducer cables

The RX transducer module(s) and its cable is identified as follows:

RX1<m>/<n> or **RX2<m>/<n>** where <m> is the cable number (a number between 1 and 10) and <nnn> is the module's serial number (a numerical value).

The transducer cables are moulded to the RX array, but connect in the other end to the Receiver Unit (RXU) with 76–pin D-sub connectors.

Connection of RX transducer cables

Note

During the installation of the RX array, you must fill in the cable identification table(s) below.

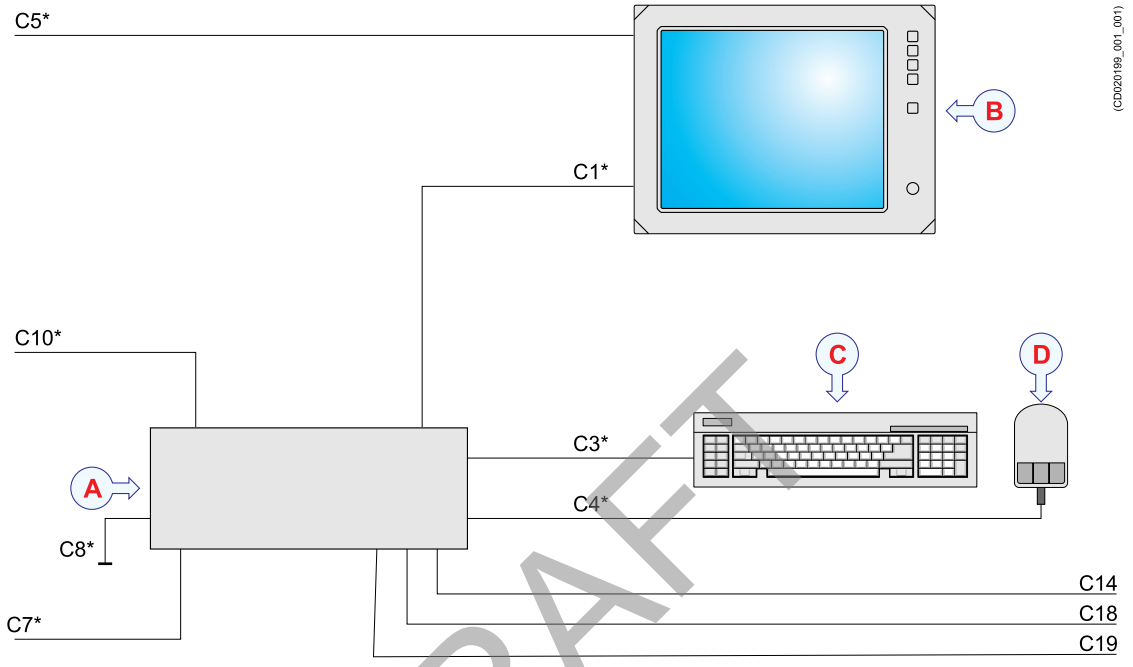
For a system with 0.5 degree RX, you will need all cables listed in the tables. With a 1 degree system, you only need the first 4, while the 2 degrees system only requires the first 2 cables.

RX array identification RX1		TX Unit identification	
Cable no.	Transducer serial no.:	Receiver Unit no.	Socket no.
1		1	RX 1
2		1	RX 2
3		1	RX 3
4		1	RX 4

RX array identification RX2		TX Unit identification	
Cable no.	Transducer serial no.:	Receiver Unit no.	Socket no.
1		2	RX 1
2		2	RX 2
3		2	RX 3
4		2	RX 4

Topside cable plan

The topside cables include those used to connect the EM 712 Hydrographic Work Station and the display to each other, to AC mains power, and to external devices. One Ethernet cable is used to connect the Hydrographic Work Station to the Processing Unit.



A *Hydrographic Work Station*

B *Display*

C *Computer keyboard*

D *Computer mouse or trackball*

Cables identified with an asterisk (*) are provided with the standard EM 712 delivery.

List of EM 712 cables

A set of cables is required to connect the EM 712 system units to each other, to the relevant power source(s), and to peripheral devices.

The following cables are used when the EM 712 is set up.

Cable	Signal	From / To	Min. requirements
C1	Video	Hydrographic Work Station / Display	See comment 1
C3	Keyboard	Computer / Keyboard	See comment 2
C4	Mouse	Computer / Mouse	See comment 3

Cable	Signal	From / To	Min. requirements
C7	AC power	Ship supply / Hydrographic Work Station power supply	
C8	Ground	Ground / Hydrographic Work Station	
C10	Ethernet	Processing Unit / Hydrographic Work Station	See comment 4
C14	Serial	Hydrographic Work Station \ External device	
C18	Serial	Hydrographic Work Station \ Ship's local area network	
C19	Ethernet	Hydrographic Work Station \ External device	
C25	AC power	Ship supply / Processing Unit power supply	See comment 5
C26	Ground	Ground / Processing Unit	
C27	Remote control	Processing Unit \ External device	
C28	External synchronization	Processing Unit \ External device	
C29–C32	Serial	Processing Unit \ External device	
C33	Ethernet Attitude Velocity	Processing Unit	
C34	1 PPS (one pulse per second) clock synchronization	Processing Unit \ External device	
C36	Internal Ethernet connections	Internal on Processing Unit	See comment 6
C40	Ethernet	Processing Unit / Transmitter Unit (TX Unit) 1	See comment 7
C41	Ethernet	Processing Unit / Transmitter Unit (TX Unit) 2	See comment 7
C42	Ethernet	Processing Unit / Receiver Unit (RX Unit) 1	See comment 7
C43	Ethernet	Processing Unit / Receiver Unit (RX Unit) 2	See comment 7
C44	Fiber	Transmitter Unit (TX Unit) 1 / Receiver Unit (RX Unit) 1	See comment 8
C45	Fiber	Last Transmitter Unit (TX Unit) / Receiver Unit (RX Unit) 1	See comment 8
C46	Fiber	Receiver Unit (RX Unit) 1 / Receiver Unit (RX Unit) 2	See comment 8
C50	Remote control	Processing unit / Transmitter Unit (TX Unit) 1	
C51	Remote control	Transmitter Unit (TX Unit) 1 / Transmitter Unit (TX Unit) 2	

Cable	Signal	From / To	Min. requirements
C52	Remote control	Last Transmitter Unit (TX Unit) / Receiver Unit (RX Unit) 1	
C53	Remote control	Receiver Unit (RX Unit) 1 / Receiver Unit (RX Unit) 2	
C60	AC power	Ship supply / Transmitter Unit (TX Unit) 1	See comment 9
C61	Ground	Ground / Transmitter Unit (TX Unit) 1	
C62	AC power	Ship supply / Transmitter Unit (TX Unit) 2	See comment 9
C63	Ground	Ground / Transmitter Unit (TX Unit) 2	
C64	AC power	Ship supply / Receiver Unit (RX Unit) 1	See comment 10
C65	Ground	Ground / Receiver Unit (RX Unit) 1	
C66	AC power	Ship supply / Receiver Unit (RX Unit) 2	See comment 10
C67	Ground	Ground / Receiver Unit (RX Unit) 2	
TX1–1	Transducer	TX Transducer 1 / Transmitter Unit (TX Unit)	See comment 11
TX1–2	Transducer	TX Transducer 1 / Transmitter Unit (TX Unit)	See comment 11
TX1–3	Transducer	TX Transducer 1 / Transmitter Unit (TX Unit)	See comment 11
TX1–4	Transducer	TX Transducer 1 / Transmitter Unit (TX Unit)	See comment 11
TX1–5	Transducer	TX Transducer 1 / Transmitter Unit (TX Unit)	See comment 11
TX1–6	Transducer	TX Transducer 1 / Transmitter Unit (TX Unit)	See comment 11
TX1–7	Transducer	TX Transducer 1 / Transmitter Unit (TX Unit)	See comment 11
TX1–8	Transducer	TX Transducer 1 / Transmitter Unit (TX Unit)	See comment 11
TX1–9	Transducer	TX Transducer 1 / Transmitter Unit (TX Unit)	See comment 11
TX1–10	Transducer	TX Transducer 1 / Transmitter Unit (TX Unit)	See comment 11
TX2–1	Transducer	TX Transducer 2 / Transmitter Unit (TX Unit)	See comment 11
TX2–2	Transducer	TX Transducer 2 / Transmitter Unit (TX Unit)	See comment 11

Cable	Signal	From / To	Min. requirements
TX2–3	Transducer	TX Transducer 2 / Transmitter Unit (TX Unit)	See comment 11
TX2–4	Transducer	TX Transducer 2 / Transmitter Unit (TX Unit)	See comment 11
TX2–5	Transducer	TX Transducer 2 / Transmitter Unit (TX Unit)	See comment 11
TX2–6	Transducer	TX Transducer 2 / Transmitter Unit (TX Unit)	See comment 11
TX2–7	Transducer	TX Transducer 2 / Transmitter Unit (TX Unit)	See comment 11
TX2–8	Transducer	TX Transducer 2 / Transmitter Unit (TX Unit)	See comment 11
TX2–9	Transducer	TX Transducer 2 / Transmitter Unit (TX Unit)	See comment 11
TX2–10	Transducer	TX Transducer 2 / Transmitter Unit (TX Unit)	See comment 11
RX1–1	Transducer	RX Transducer 1 / Receiver Unit (RX Unit) 1	See comment 11
RX1–2	Transducer	RX Transducer 1 / Receiver Unit (RX Unit) 1	See comment 11
RX1–3	Transducer	RX Transducer 1 / Receiver Unit (RX Unit) 1	See comment 11
RX1–4	Transducer	RX Transducer 1 / Receiver Unit (RX Unit) 1	See comment 11
RX2–1	Transducer	RX Transducer 2 / Receiver Unit (RX Unit) 2	See comment 11
RX2–2	Transducer	RX Transducer 2 / Receiver Unit (RX Unit) 2	See comment 11
RX2–3	Transducer	RX Transducer 2 / Receiver Unit (RX Unit) 2	See comment 11
RX2–4	Transducer	RX Transducer 2 / Receiver Unit (RX Unit) 2	See comment 11

Comments

1 This is a commercial cable. It is normally provided with the display.

2 This is a commercial cable. It is normally provided with the keyboard.

3 This is a commercial cable. It is normally provided with the mouse.

4 Ethernet connection between the Processing Unit and the Hydrographic Work Station.

A 4.5 meter long Ethernet cable is provided with the Hydrographic Work Station. If a longer cable is required, this must be provided by the installation shipyard.

Note

It is very important that high quality Ethernet cables are used. You must use CAT-5E STP (Shielded Twisted Pair) quality or better. Cables with lower bandwidth capacity will reduce the EM 712 performance.

5 Power supply to the Processing Unit-

The power cable is delivered with the Processing Unit.

6 Internal Ethernet connections on the Processing Unit. These cables are delivered with the unit.

7 Ethernet connections between the Processing Unit and the Transmitter and Receiver Units.

Note

It is very important that high quality Ethernet cables are used. You must use CAT-5E STP (Shielded Twisted Pair) quality or better. Cables with lower bandwidth capacity will reduce the EM 712 performance.

8 The fiber cables between the Transmitter Units and the Receiver Units are delivered with the units. The standard cable length is 10 meters.

9 Power supply to the Transmitter Units (TXU).

The power cables are delivered with the Transmitter Units.

10 Power supply to the Receiver Units (RXU).

The power cables are delivered with the Receiver Units.

11 The transducer cables are moulded to the TX and RX array and connect in the other end to the Transmitter Unit (TXU) or Receiver Unit (RXU) with 76–pin D-sub connectors.

Standard cable length is 15 meters.

Identifying EM 712 cables on a project cable drawing

The EM 712 is often a part of a project delivery. For such deliveries, project cable drawings are established to show all main cables, and how the various products interconnect. In such project cable drawings, the EM 712 cables are identified as **EM 712/Cx**.

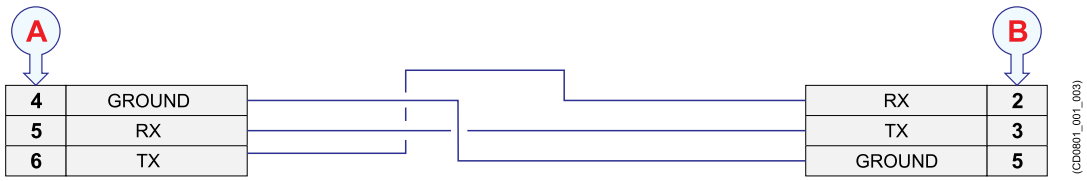
Cable drawings and specifications

Relevant cables and connections required for the EM 712 are described in detail.

Topics

RS–232 serial line using three 3 wires and RJ45 connector

An RS-232 serial line connection using three –3– wires and NMEA telegrams is probably the most common way to connect the EM 712 to external devices.



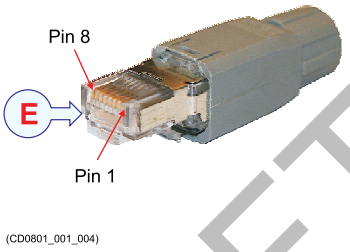
A *Local connection*

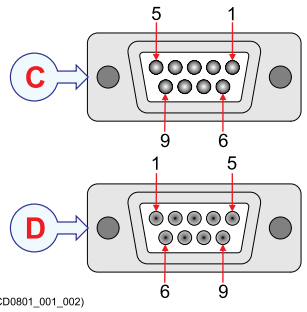
B *Connection on peripheral device*

C *Female 9–pin D-connector*

D *Male 9–pin D-connector*

E *RJ45 connector*





Note that this cable does not support all the signals in the standard RS-232 specification.

Unless otherwise specified, the serial line cable must be provided by the installation shipyard.

Important

When you are using RS-232 serial communication, observe that long runs of unshielded cable will pick up noise easily. This is because the RS-232 signals are not balanced.

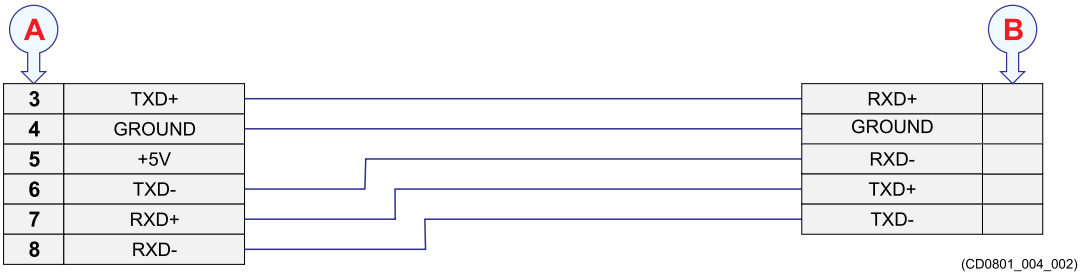
Maximum length is typically 60 meters with 2400 bps data rate, but this depends on the cable quality. Always check the cable manufacturers specifications for the actual "shunt capacitance". A common figure is 47.5 pF/m, which gives a maximum cable length of about 50 meters.

Note

Even though a standard exist for RS-232 pin configuration, certain manufacturer may still choose their own connector pins for the various signals used. In order to make the RS-232 connection to your peripheral device work properly, you must always consult the relevant instructions provided by the device manufacturer.

RS-422 serial line using five wires and RJ45 connector

An RS-422 serial line connection can transmit data at rates as high as 10 million bits per second, and may be sent on cables as long as 1500 meters.



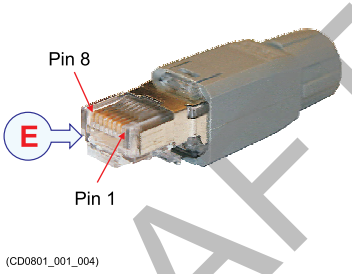
A *Local connection*

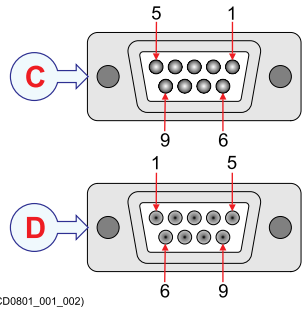
B *Connection on peripheral device*

C *Female 9–pin D-connector*

D *Male 9–pin D-connector*

E *RJ45 connector*





While RS-232 is the most common serial interface for communicating with external devices using the NMEA standard, it only allows for one transmitter and one receiver on each line.

RS-422 provides a mechanism for transmitting data up to 10 Mbits/s. This interface format uses a balanced signal on two wires. This increases both the maximum baud rate and the physical length of the cable, and it reduces the noise. With a high quality cable, you can use RS-422 on distances up to 1500 meters even in noisy environments. RS-422 is also specified for multi-drop applications. This means that one transmitter can send data to up to 10 receivers.

Note

There are no common standard for RS-422 pin configuration. Any manufacturer may choose their own connector pins for the various signals used. In order to make the RS-422 connection to your peripheral device work properly, you must always consult the relevant instructions provided by the device manufacturer.

Minimum cable requirements

- **Conductors**: 2 x 4 x 0.5 mm²
- **Screen**: Overall braided
- **Voltage**: 60 V
- **Maximum outer diameter**: Defined by the plugs

If you need to install a very long serial line cable, increase the cross section.

1PPS (One pulse per second) using a coax cable

The Processing Unit is equipped with a 1PPS signal input for clock synchronization.

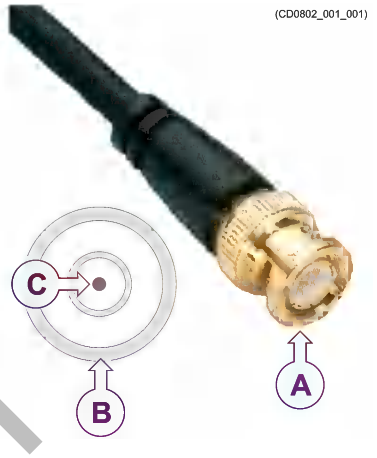
This cable must be provided by the installation shipyard.

1PPS cable

A *Male BNC connector*

B *Ground*

C *1PPS signal*



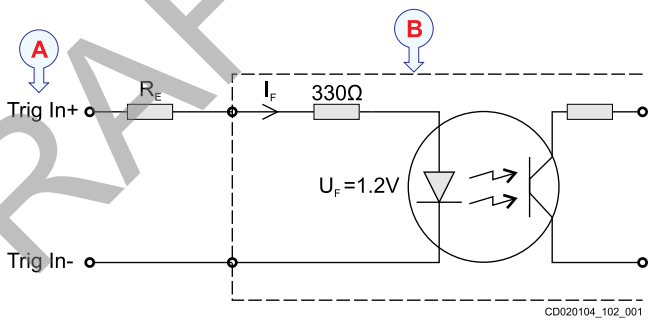
1PPS input

The 1PPS signal is normally provided by a positioning system.

Optical isolated input signals

A *Input from external system*

B *Processing Unit input circuitry*



The input current must be approximately 10 mA. Depending on your input signal additional resistance must be applied to achieve the required input current. Two examples are shown to clarify.

Example:

$$I_F = \frac{4.5V - 1.2V(U_F)}{330} \quad 10mA$$

Using +4.5V input signal the input current will be as required (~10mA). No additional resistance required.

Example:

$$R_{TOT} = \frac{12V - 1.2V(U_F)}{10mA} = \frac{10.8}{0.010} = 1080$$

$$R_E = 1080 - 330 = 750$$

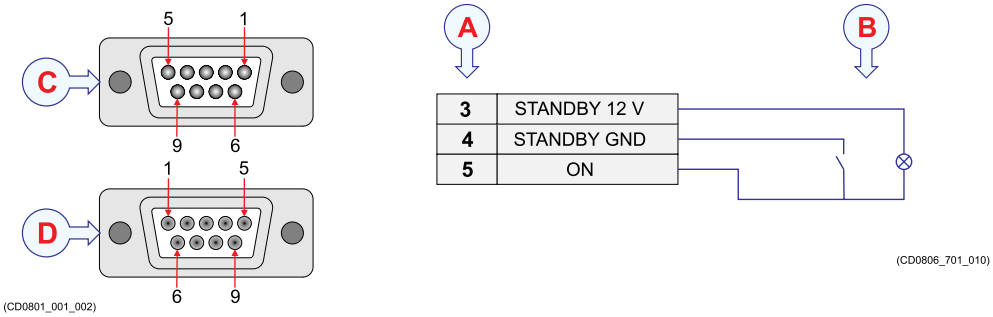
An added resistor of 750Ω and minimum 0.1 Watt must be used.

Note

The input signals must not be negative, i.e. no RS-232 signals can be used for these inputs.

Remote control

The Processing Unit can be switched on/off with a remote switch. This switch is connected to a 9–pin D-connector on the Processing Unit.



A *Local connection, male 9–pin D-connector*

B *Connection to remote lamp and on/off switch*

C *Female 9–pin D-connector*

D *Male 9–pin D-connector*

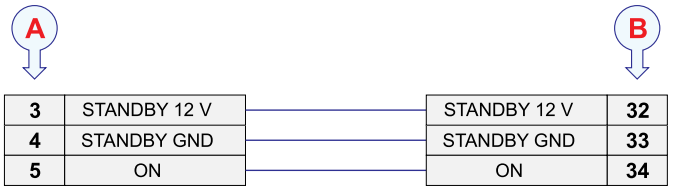
Minimum cable requirements

- **Conductors**: 3 x 0.5 mm²
- **Screen**: Overall braided
- **Voltage**: 60 V
- **Maximum outer diameter**: Defined by the plugs

This cable must be provided by the installation shipyard.

Remote Control using K-Rem

The Processing Unit can be switched on/off with a remote switch. This switch is connected to a 9–pin D-connector on the Processing Unit. A dedicated junction box with on/off switches and light indication has been designed for this purpose (K-Rem).



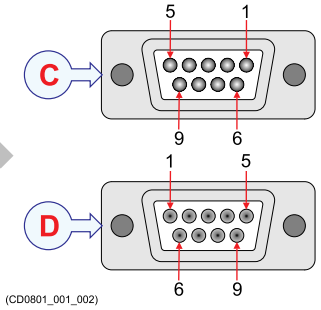
(CD0806_701_011)

A *Local connection, male 9–pin D-connector*

B *Connection at the terminal strip in Remote Control Unit (K-Rem)*

C *Female 9–pin D-connector*

D *Male 9–pin D-connector*



(CD0801_001_002)

Minimum cable requirements

- **Conductors**: 3 x 0.5 mm²
- **Screen**: Overall braided
- **Voltage**: 60 V
- **Maximum outer diameter**: Defined by the plugs

This cable must be provided by the installation shipyard.

Dummy plug for not using remote control

The Processing Unit can be switched on/off with a remote switch. If remote control is not used, the enclosed remote control dummy plug has to be inserted in the **Remote Control** connector in the Processing Unit.

Note

*If remote control is not used, the enclosed remote control dummy plug has to be inserted in the **Remote Control** connector in the Processing Unit. The Processing Unit will not work without this dummy plug.*

External Synchronization

The Processing Unit (PU) is equipped with a connection for interface to an external synchronization system.

External synchronization input/output

When multiple echo sounders are employed on a vessel it is essential to optimize the timing of the transmitting of each system. The Kongsberg Maritime K-Sync Synchronizing Unit provides highly configurable timing.

The EM 712 provides the following synchronization signals:

EM 712 external synchronization signal characteristics		
Signal	**Type**	**Active**
Ready To Transmit (output)	Open collector output from isolation unit	High
Trig out (output)	Open collector output from isolation unit	Low
Trig in (input)	Optical isolated input	High

- **Ready To Transmit**: This is an output signal from the EM 712 to the synchronization system that goes active when the EM is ready to transmit. The signal is inactive when the echo sounder is transmitting, receiving or processing samples.

- **Trig out**: The EM 712 issues a trig out signal. The trig out signal starts before the first transmit pulse and is terminated after the end of the last transmit pulse.
- **Trig in:** The EM 712 can be triggered by an external signal that will cause the echo sounder to ping. The **CBMF** board is equipped with an optocoupler at this input. The input series resistor is tuned for a TTL signal (Low level<0.6 V, High level>3.2 V). There is a delay from the external trig signal is received to the start of the transmit pulse (Trig out). This is caused by signal processing in the TX transducer (pitch stabilization, focus range etc).

  The delay is minimum 1.5 ms and depends on the number of transmit pulses per ping (to optimize pitch stabilization). This means that the delay depends on ping mode (frequency), sector mode and swath mode (single/dual).

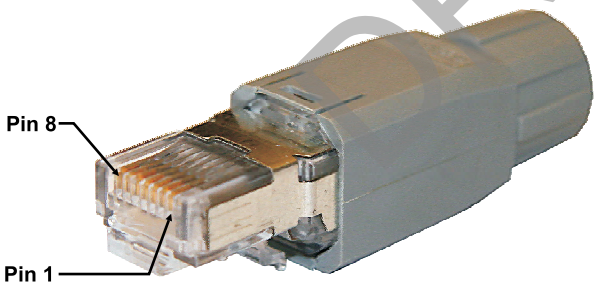
External Synchronization cable

This connection is used for interface to an external synchronization system (for example K-Sync) used when multiple echo sounders are employed on the same vessel. The external synchronization connector is located on the CBMF board of the processing unit.

This is an optically isolated connection that requires ~10mA current. Input power and resistor value must be adjusted accordingly.

The connector is RJ45 type.

This cable must be provided by the installation shipyard.



1	Trig out +
2	Trig out -
3	DGND
4	Trig in +
5	Trig in -
6	DGND
7	RTT +
8	RTT -

(CD0806_701_001)

Pin 3 and 6 is used by Kongsberg Maritime only.

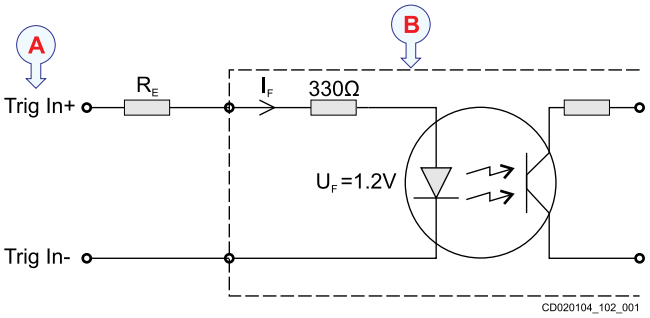
Minimum cable requirements

- **Conductors**: 5 x 2 x 0.5 mm²
- **Screen**: Screened twisted pairs and overall braided
- **Voltage**: 60 V
- **Maximum outer diameter**: Defined by the plugs

Optical isolated input signals

A *Input from external system*

B *Processing Unit input circuitry*



The input current must be approximately 10 mA. Depending on your input signal additional resistance must be applied to achieve the required input current. Two examples are shown to clarify.

Example:

$$I_F = \frac{4.5V - 1.2V(U_F)}{330} \quad 10mA$$

Using +4.5V input signal the input current will be as required (~10mA). No additional resistance required.

Example:

$$R_{TOT} = \frac{12V - 1.2V(U_F)}{10mA} = \frac{10.8}{0.010} = 1080$$

$$R_E = 1080 - 330 = 750$$

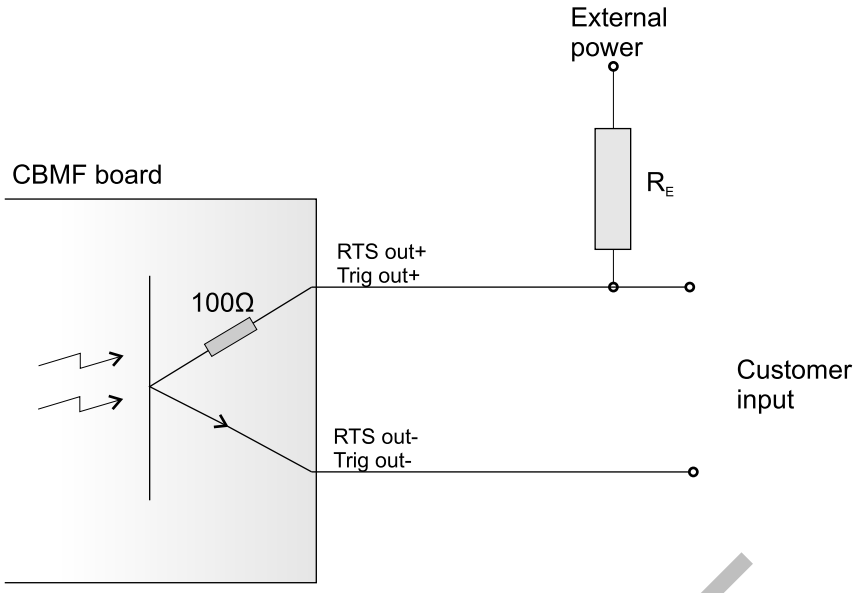
An added resistor of 750Ω and minimum 0.1 Watt must be used.

Note

The input signals must not be negative, i.e. no RS-232 signals can be used for these inputs.

Optical isolated output signals

The collector current must be approximately 10 mA. A resistor must be used to tune the collector current depending on your voltage.



Power	Resistor value	Minimum effect
5 V	0.38 kΩ	0.1 W
12 V	1.08 kΩ	0.15 W
24 V	2.28 kΩ	0.25 W

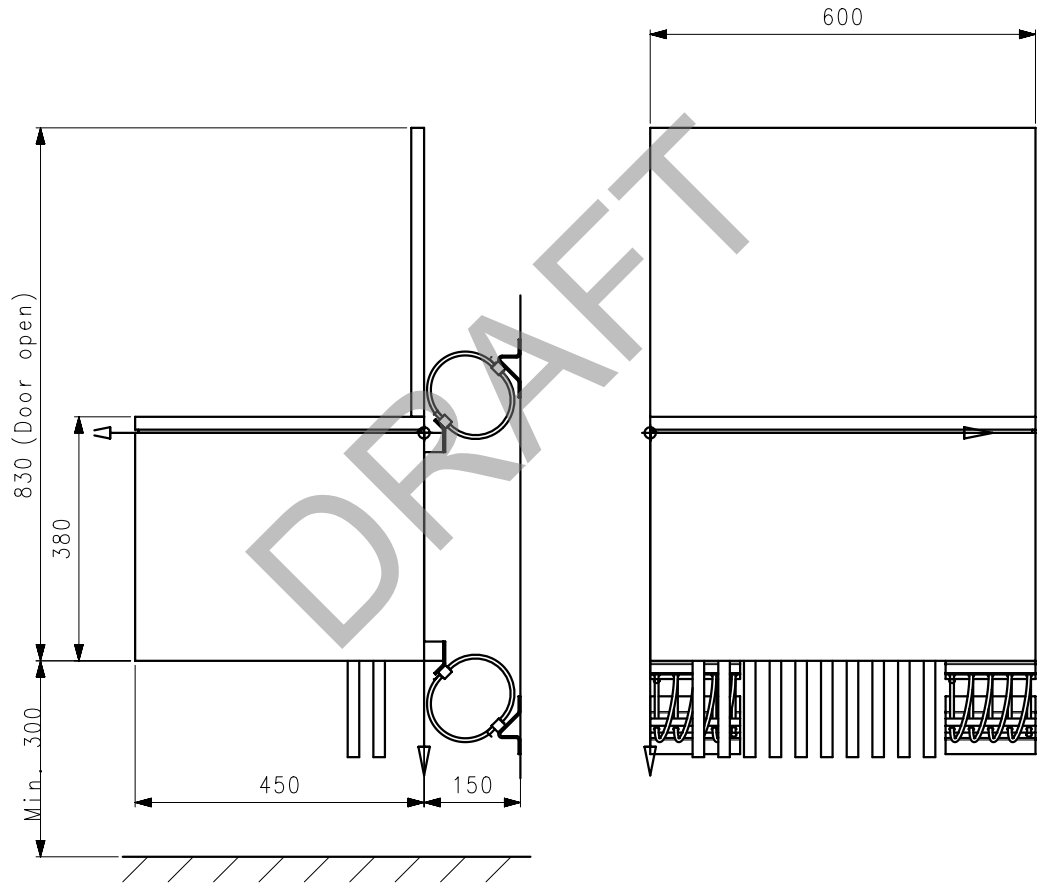
Note

To avoid ground loops and damage of the EM 2040 electronics caused by external connections, all connections are optically isolated.

Drawing file

EM 712 Transmitter Unit outline dimensions

Drawing 396402.

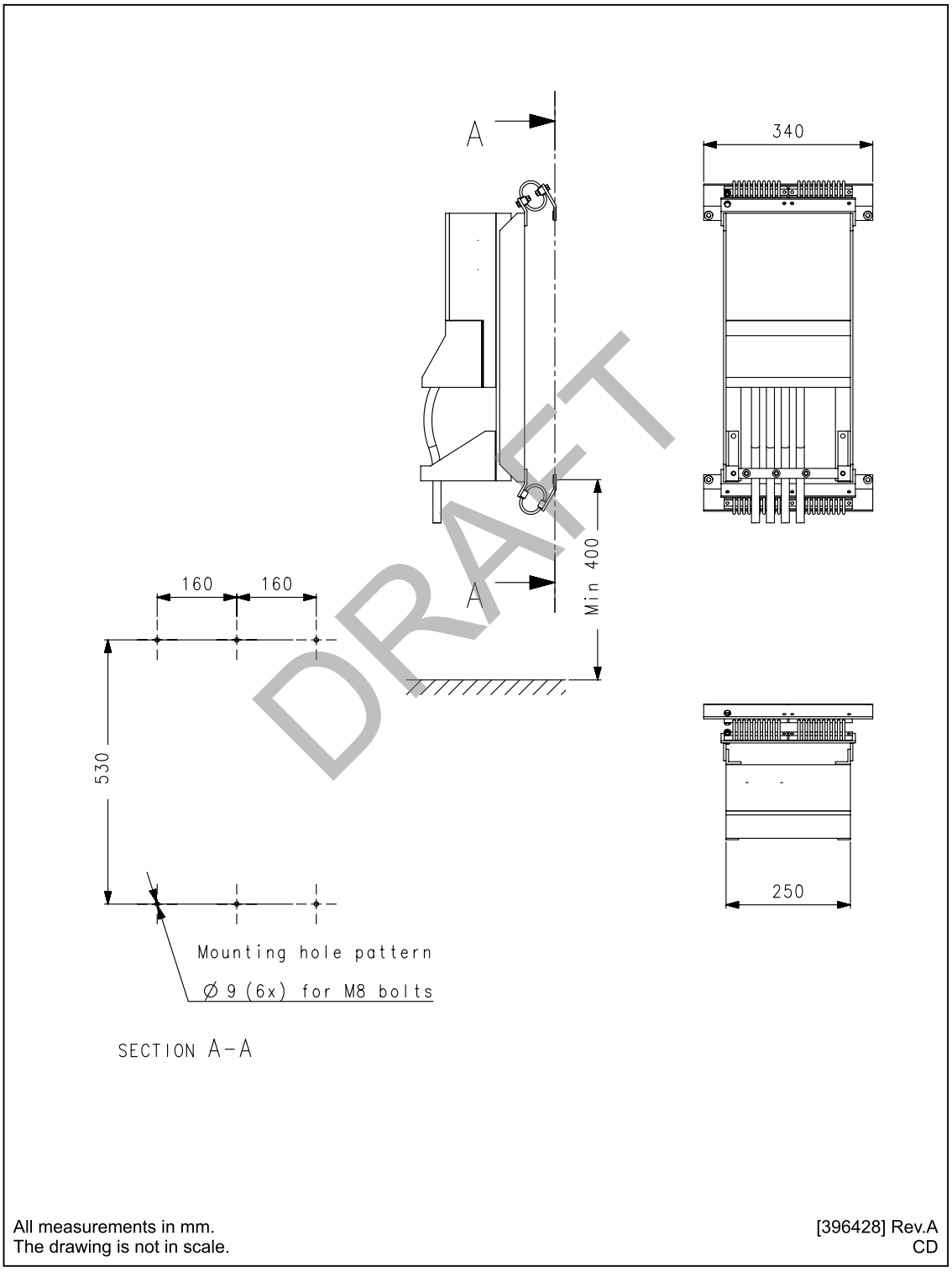


All measurements in mm.
The drawing is not in scale.

[396402] Rev.A
CD

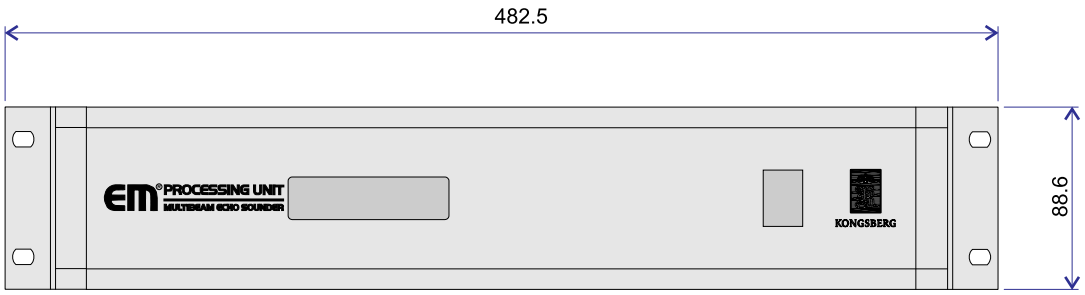
EM 712 Receiver Unit outline dimensions

Drawing 396428.

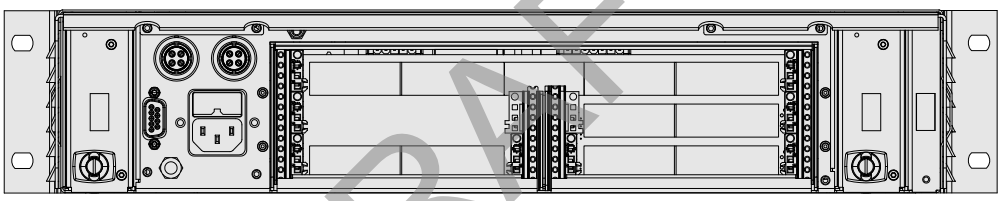


Processing Unit dimensions

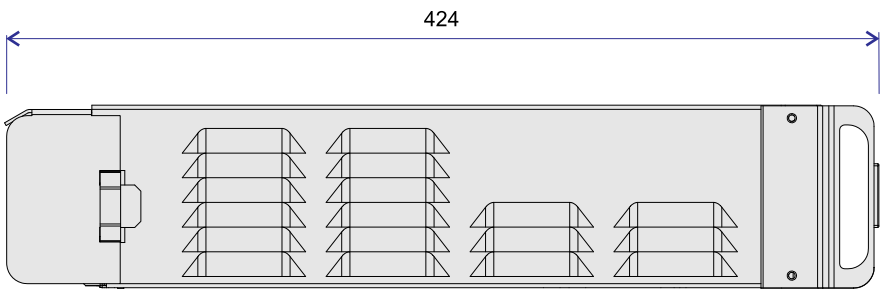
Drawing 385422



Front View



Rear View



Side View

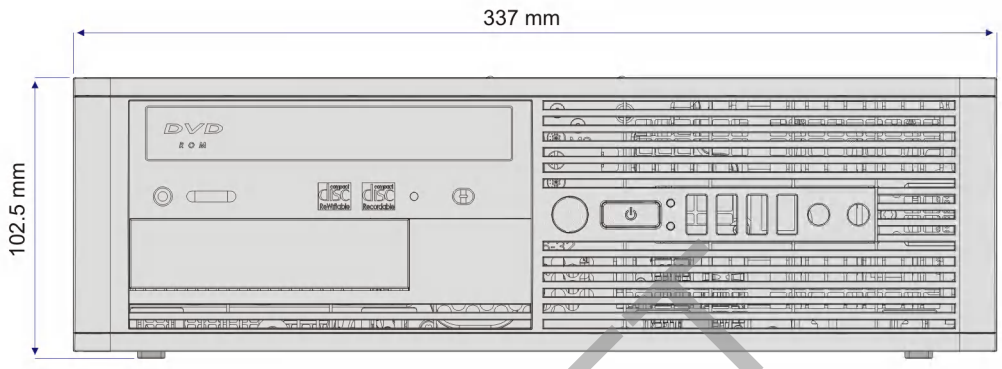
Weight: 10.5 kg

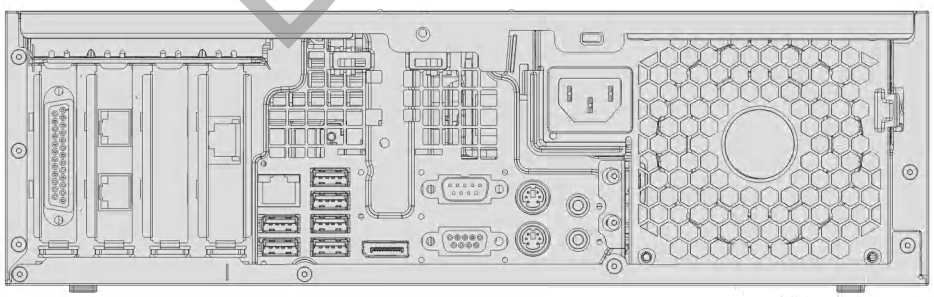
All measurements in mm.
The drawing is not in scale.

[385422] Rev.Pro01
CD12_385422_001_001

Hydrographic Work Station outline dimensions

Drawing 378828 (2 pages)



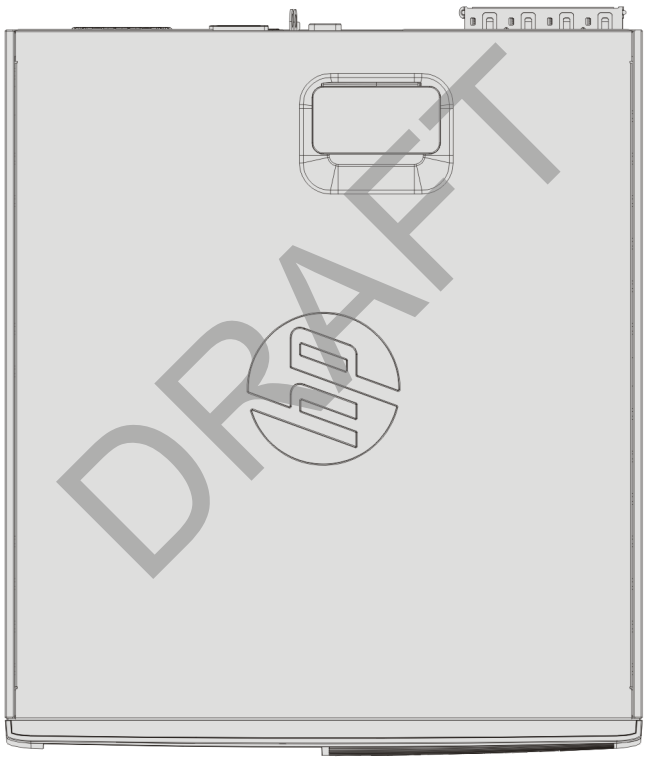


Note that this is a generic drawing. The physical presentation of the computer may not match specific product versions.

All measurements in mm.
The drawing is not in scale.

[378828] Rev.A
CD12_378828_001_001

Page 2



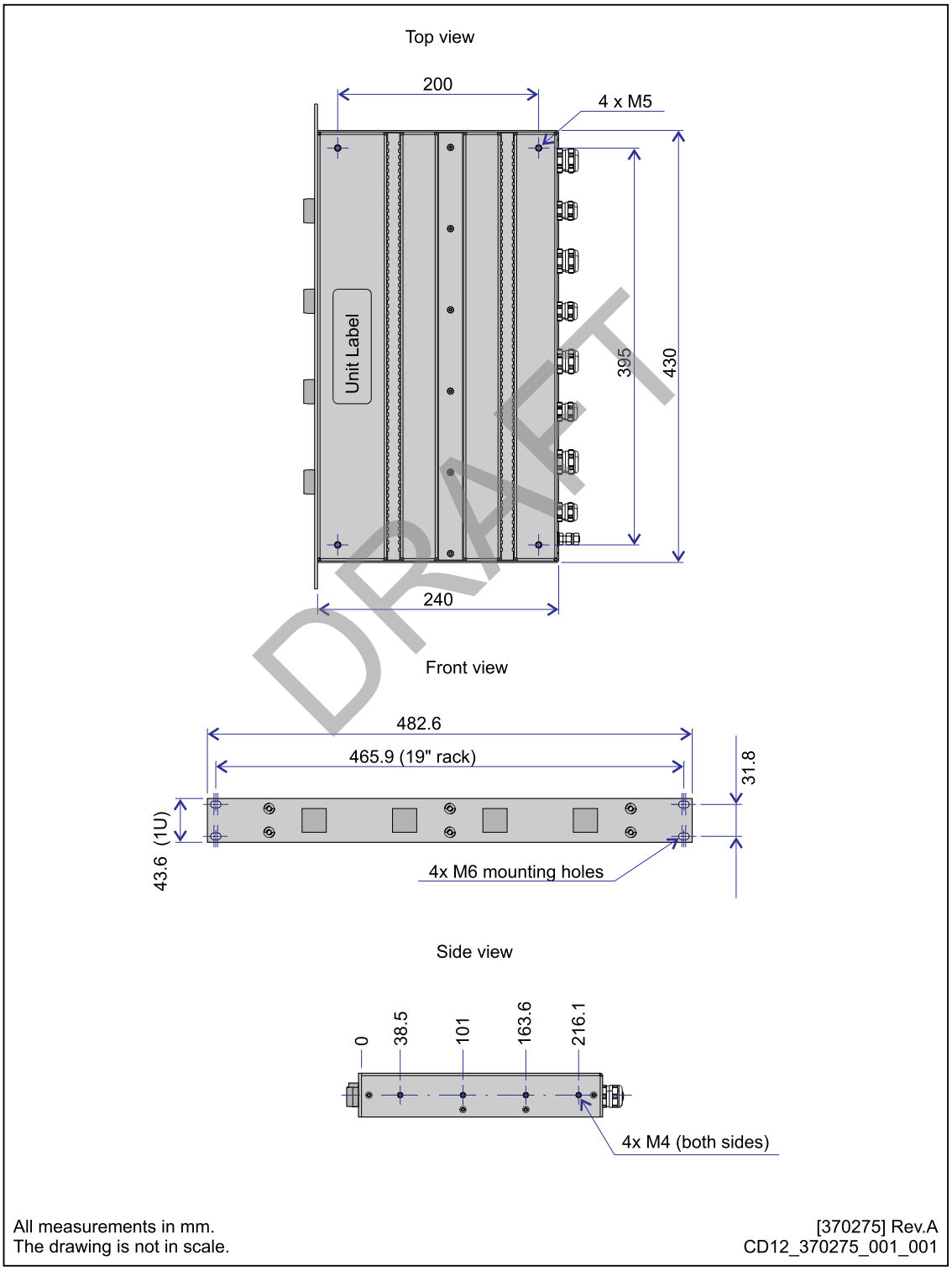
Note that this is a generic drawing. The physical presentation of the computer may not match specific product versions.

All measurements in mm.
The drawing is not in scale.

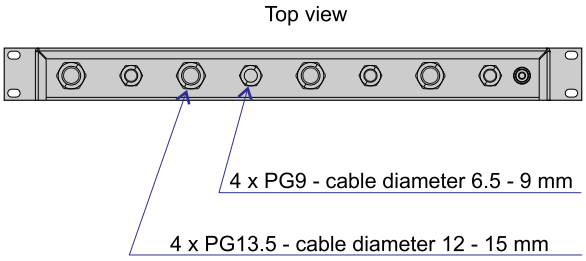
[378828] Rev.A
CD12_378828_001_002

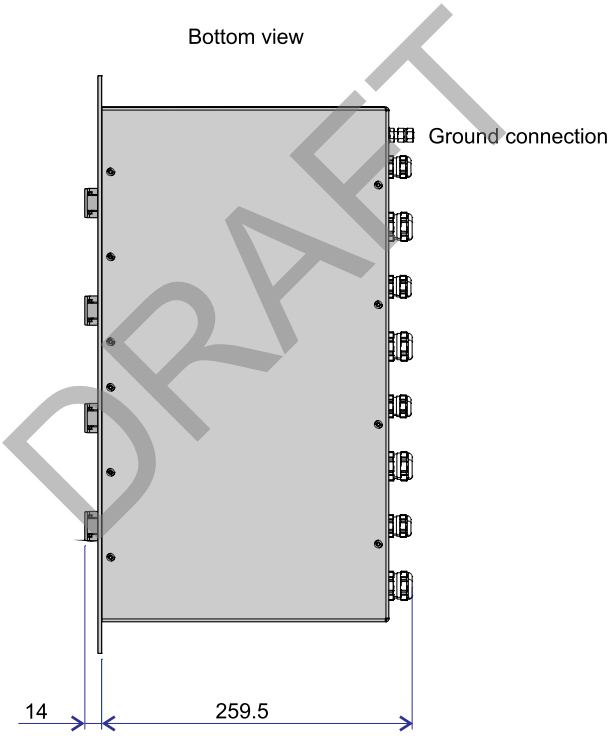
Remote Control Unit (K-REM) outline dimensions

Drawing 370275 (2 pages)



Page 2





All measurements in mm.
The drawing is not in scale.

[370275] Rev.A
CD12_370275_001_002

Technical specifications

The technical specifications summarize the main functional and operational characteristics of the EM 712 system, as well as information related to power requirements, physical properties and environmental conditions.

Note

We are continuously working to improve the quality and performance of our products. Technical specifications may therefore be changed without prior notice.

Topics

Weights and outline dimensions

The weights and outline dimension characteristics summarize the physical properties of the EM 712 system.

Note

For more detailed information about the physical dimensions, see the Drawing file.

Hydrographic Work Station

- **Manufacturer**: Hewlett Packard

  (http://www.hp.com)
- **Model**: HP8300H

  The standard computer from Hewlett Packard has been configured to fit the operational requirements of the EM 712.
- **Outline dimensions**:
  - **Depth**: 384 mm
  - **Width**: 337 mm
  - **Height**: 102.5 mm
- **Weight**: approximately 8 kg

TX Unit

- **Physical dimensions**:
  - **Height**: 380 mm
  - **Width**: 600 mm
  - **Depth**: 600 mm
- **Weight**: –

RX Unit

- **Physical dimensions**:
  - **Height**: 350 mm
  - **Width**: 250 mm
  - **Depth**: 260 mm
- **Weight**: 11 kg

Processing Unit

- **Make and model**: Kongsberg Maritime, Slim PU
- **Outline dimensions**:
  - **Depth**: 424 mm
  - **Width**: 482.5 mm (19” rack)
  - **Height**: 88.6 mm (2U)
- **Weight**: 10.5 kg

Transmit transducer module – TX1 – 1 degree

- **Outline dimensions**:

  - **Length**: 970 mm
  - **Width**: 224 mm
  - **Height**: 118 mm
- **Weight**: 98 kg (with 10 cables)

Transmit transducer module – TX2 – 2 degrees

- **Outline dimensions**:
  - **Length**: 490 mm
  - **Width**: 224 mm
  - **Height**: 118 mm
- **Weight**: 50 kg (with 5 cables)

Receive transducer module – RX1 – 1 degree

- **Outline dimensions**:
  - **Length**: 970 mm
  - **Width**: 224 mm
  - **Height**: 118 mm
- **Weight**: 56 kg (with 4 cables)

Receive transducer module – RX2 – 2 degrees

- **Outline dimensions**:
  - **Length**: 490 mm
  - **Width**: 224 mm
  - **Height**: 118 mm
- **Weight**: 28.5 kg (with 2 cables)

Power requirements

The power specifications summarize the supply power requirements for the EM 712 system.

Note

The use of an uninterrupted power supply (UPS) is highly recommended.

Hydrographic Work Station

- **Manufacturer**: Hewlett Packard

  (http://www.hp.com)
- **Model**: HP8300H

  The standard computer from Hewlett Packard has been configured to fit the operational requirements of the EM 712.
- **Voltage requirement**: 115/230 Vac / 47 to 63 Hz / single phase, selectable (nominal)
- **Maximum voltage deviation**: 15%
- **Maximum transient**: 20% of nominal voltage, recovery time 3 s
- **Power consumption**: Approximately 150 VA

TX Unit

- **Voltage requirement**: 230 Vac/ 50 Hz
- **Power consumption**: Less than 300 W

RX Unit

- **Voltage requirement**: 230 Vac/ 50 Hz
- **Power consumption**: Less than 50 W

Environmental requirements

The environmental specifications summarize the temperature and humidity requirements for the Kongsberg EM 712 system.

Hydrographic Work Station

- **Manufacturer**: Hewlett Packard

  (http://www.hp.com)
- **Model**: HP8300H

  The standard computer from Hewlett Packard has been configured to fit the operational requirements of the EM 712.
- **Operational temperature**: 0 to +50 degrees Celcius
- **Storage temperature**: –20 to +70 degrees Celcius
- **Relative humidity**: 5 to 95% relative non-condensing

Transceiver Unit

TX Unit

- **Operational temperature**: 0 to +50°C
- **Storage temperature**: –30 to +70°C
- **Relative humidity**: 93% relative non-condensing
- **Ingress protection**: IP54
- **Vibration**:
  - **Frequency range**: 5 to 150 Hz
  - **Excitation level**: 1 g
- **Shock**:
  - **Peak accelration**: 15 g
  - **Duration**: 11 ms
  - Half sine pulse
- **Refence standards**:
  - IEC 60945:2002 and CORRIGENDUM 1:2008
  - IACS E10:2006

RX Unit

- **Operational temperature**: 0 to +50°C
- **Storage temperature**: –30 to +70°C
- **Relative humidity**: 93% relative non-condensing
- **Ingress protection**: IP54
- **Vibration**:
  - **Frequency range**: 5 to 150 Hz
  - **Excitation level**: 1 g
- **Shock**:
  - **Peak accelration**: 15 g
  - **Duration**: 11 ms
  - Half sine pulse
- **Refence standards**:
  - IEC 60945:2002 and CORRIGENDUM 1:2008
  - IACS E10:2006

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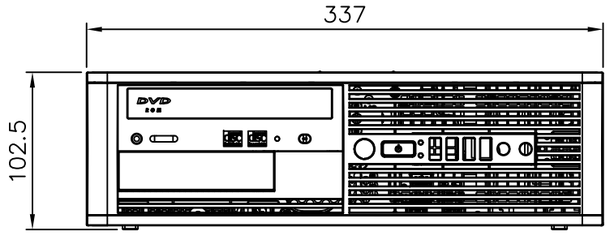
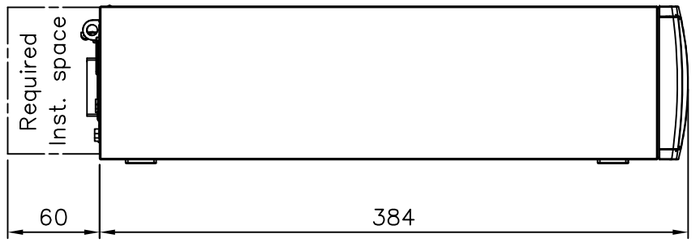
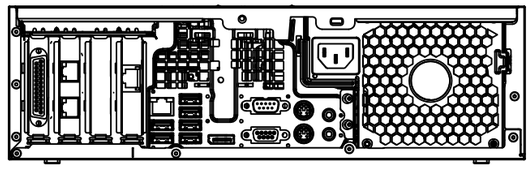
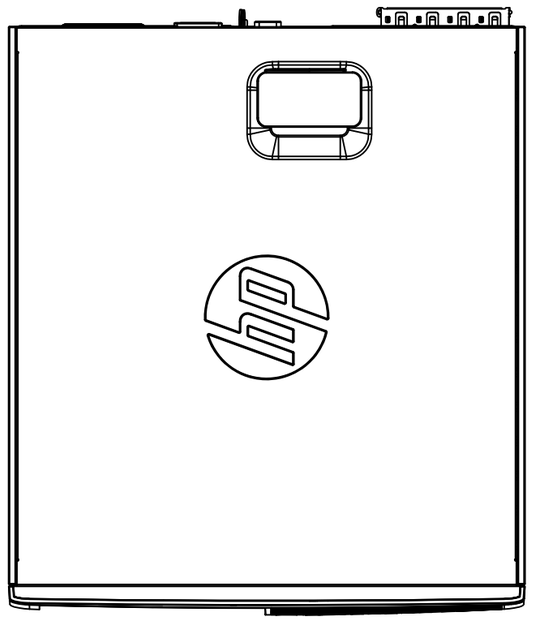
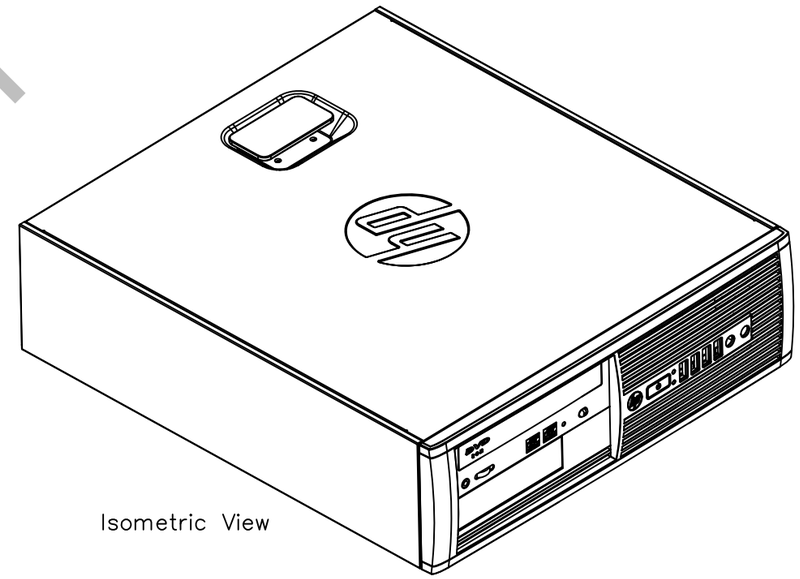










Isometric View

Weight approx. 8Kg

Reference documentation:

Outline Desk Mounting:	366001
Outline Rack Unit:	371591
Rail Kit Rack Unit:	375288
Instruction Manual Rack Unit:	372140
Outline KM1000 Mounting Kit:	365290
Outline Mariner Mounting Kit:	327993

REV.	DATE	DESCRIPTION	Designed by	Checked by	Approved by
A	2012.12.19	First Issue	HF	LK	TP

Material: –
Surface Treatment: –

Unless Otherwise Stated, Tolerances:
DIM.: ISO 2768–mK Threads: 6g/6H Surface: Ra6.3

Class. Code: 100416

KONGSBERG

Kongsberg Maritime AS
Subsea Division
Horten - Norway

Title: Outline Dimensions MP8200H HWS

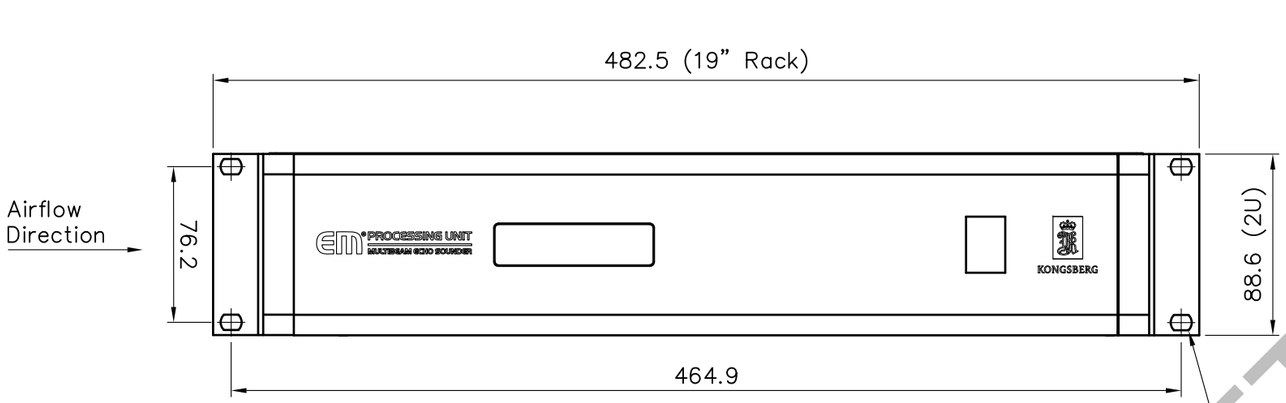
Sheet: 1/1
Size: A3
Scale: 1:4

Project / Product name: EMx
Project number: –

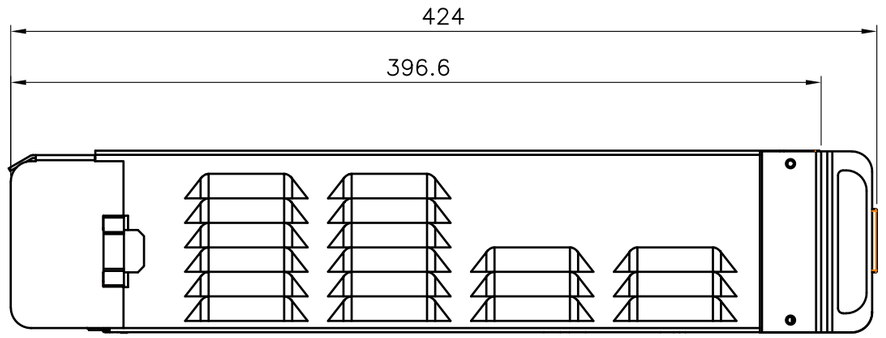
Drawing type: Outline

Document ID: 378828

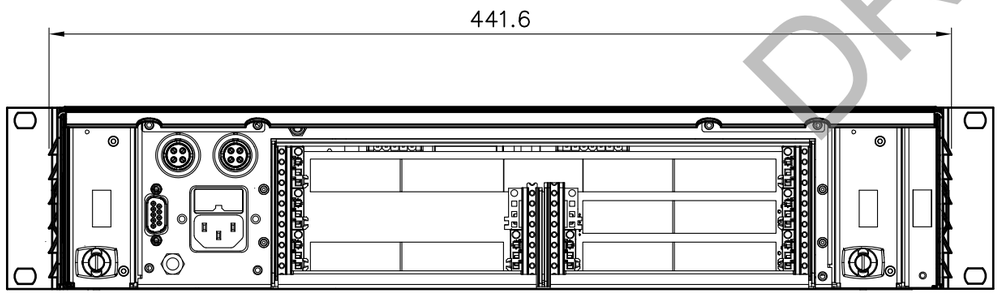
Revision/Version: A



Front View



Side View



Rear View

Weight: 10,5kg

REV.	DATE	DESCRIPTION	Designed by	Checked by	Approved by
B	2017.06.09	Upd. holepattern acc. to 2U unit spec. Effective from Q3 2017	HF	BH	KJ
Pro01	2013.08.05	First Prototype Release	HF	–	–

Material: –
Surface Treatment: –

Unless Otherwise Stated, Tolerances:
DIM.: ISO 2768–mK Threads: 6g/6H Surface: Ra6.3

Class. Code: –

KONGSBERG

Kongsberg Maritime AS
Subsea Division
Horten - Norway

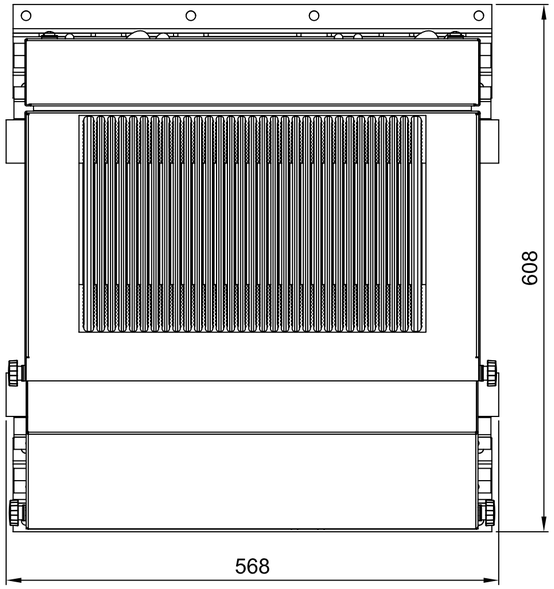
Title: Outline Dimensions Processing Unit –

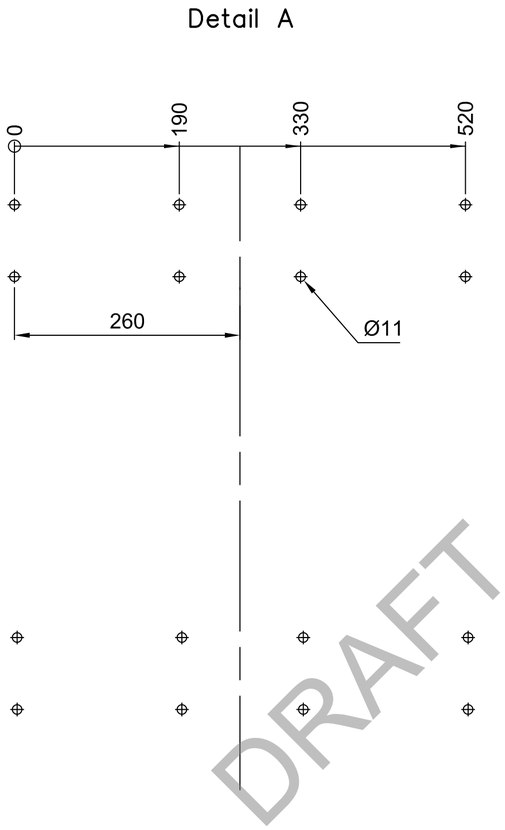
Sheet: 1/1
Size: A3
Scale: 1:3

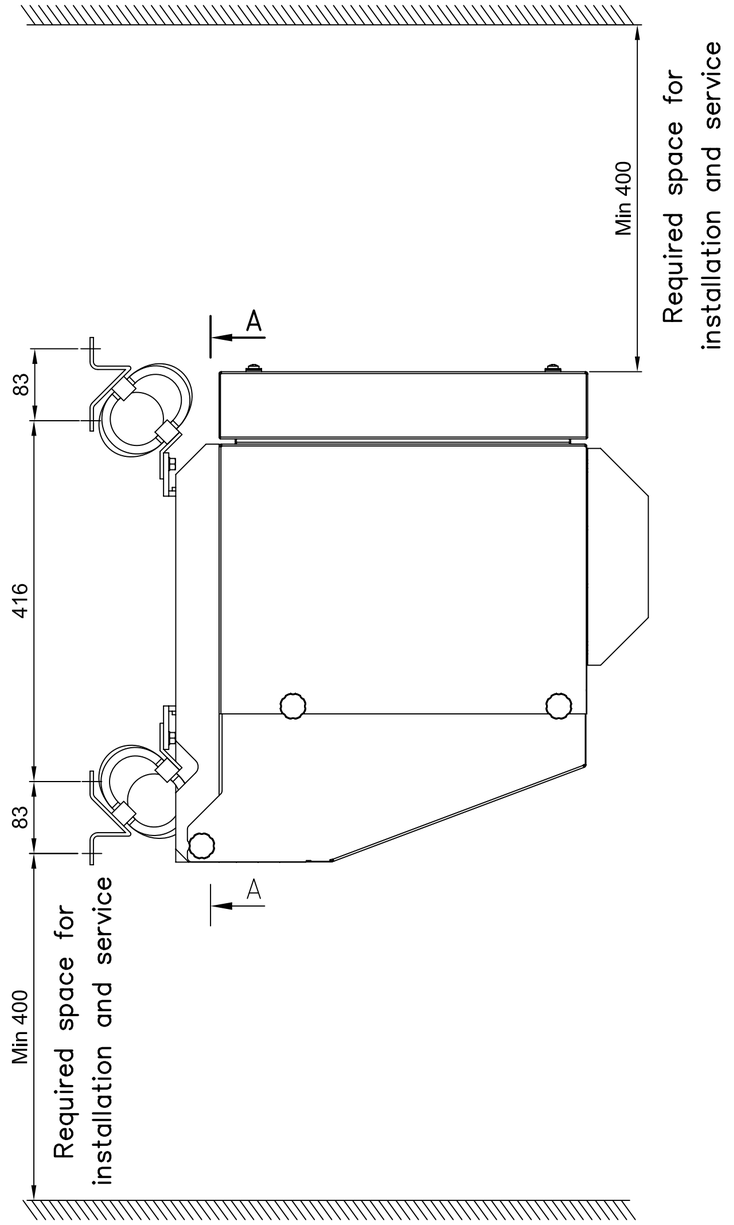
Project / Product name: EMx
Project number: –
Drawing type: –

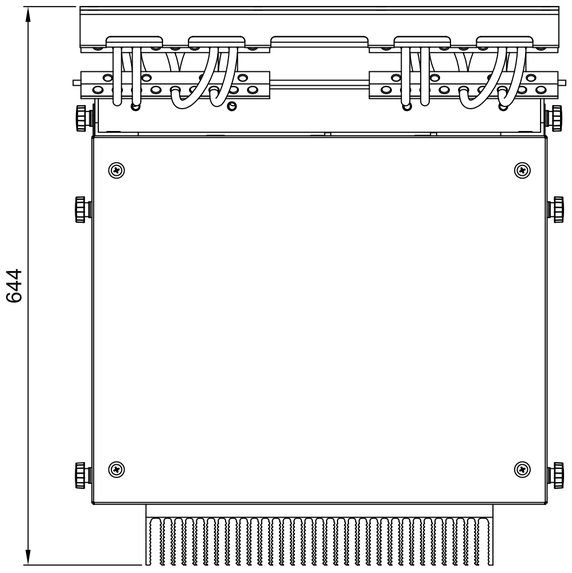
Document ID: 385422

Revision/Version: B









Rev.	Date	Description	Designed by	Checked by	Approved by
A					
A	2016.10.24	First official release	HF	ES	KEN

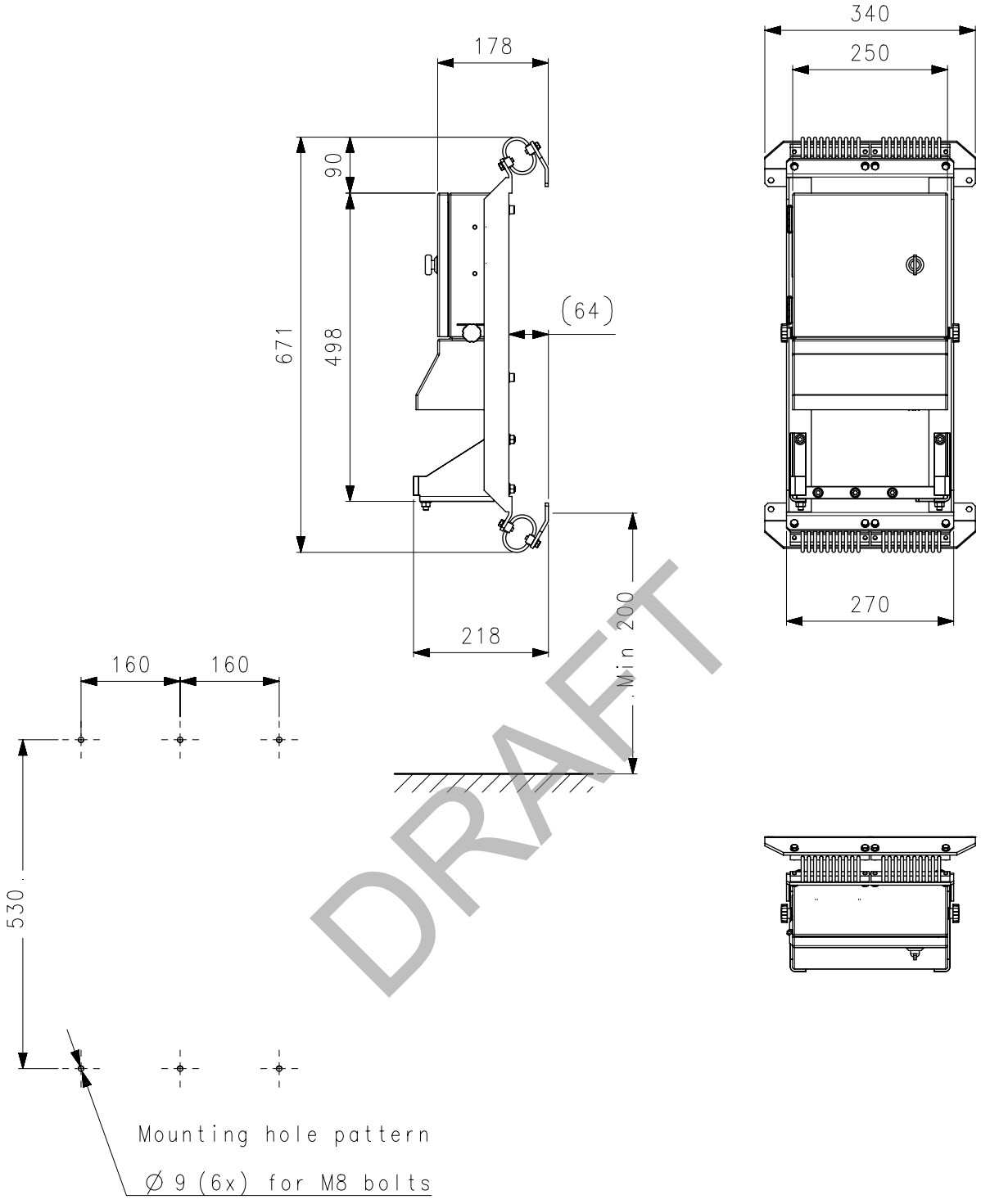
Material: -
Surface treatment: -
Tolerances unless otherwise stated: ISO2768-mK
Surface: Ra 6.3
Threads: 6g/6H
Broken edges: 0,1-0,5 x 45°

KONGSBERG

Kongsberg Maritime AS
Subsea Division
Horten

Title: Outline Dimensions TX Unit
Sheet: 1/1
Size: A2
Scale: 1:5

Project / Product name: EM712
Project number / Item ID:
Drawing type: 100416
Document ID: 396402
Revision: A



Weight complete unit: 10,9 kg

REV.	DATE	DESCRIPTION	Designed by	Checked by	Approved by
A	2016.02.29	First Issue	ES	HF	KEN

Material: –
Surface Treatment: –

Unless Otherwise Stated, Tolerances:
DIM.: ISO 2768-mK Threads: 6g/6H Surface: Ra 3.2

Class. Code

KONGSBERG

Kongsberg Maritime AS
Subsea Division
Horten – Norway

Title
OUTLINE DIMENSIONS
RX UNIT 1 DEGREE / 2 DEGREE
EM712

Sheet 1/1
Size A4
Scale 1:10

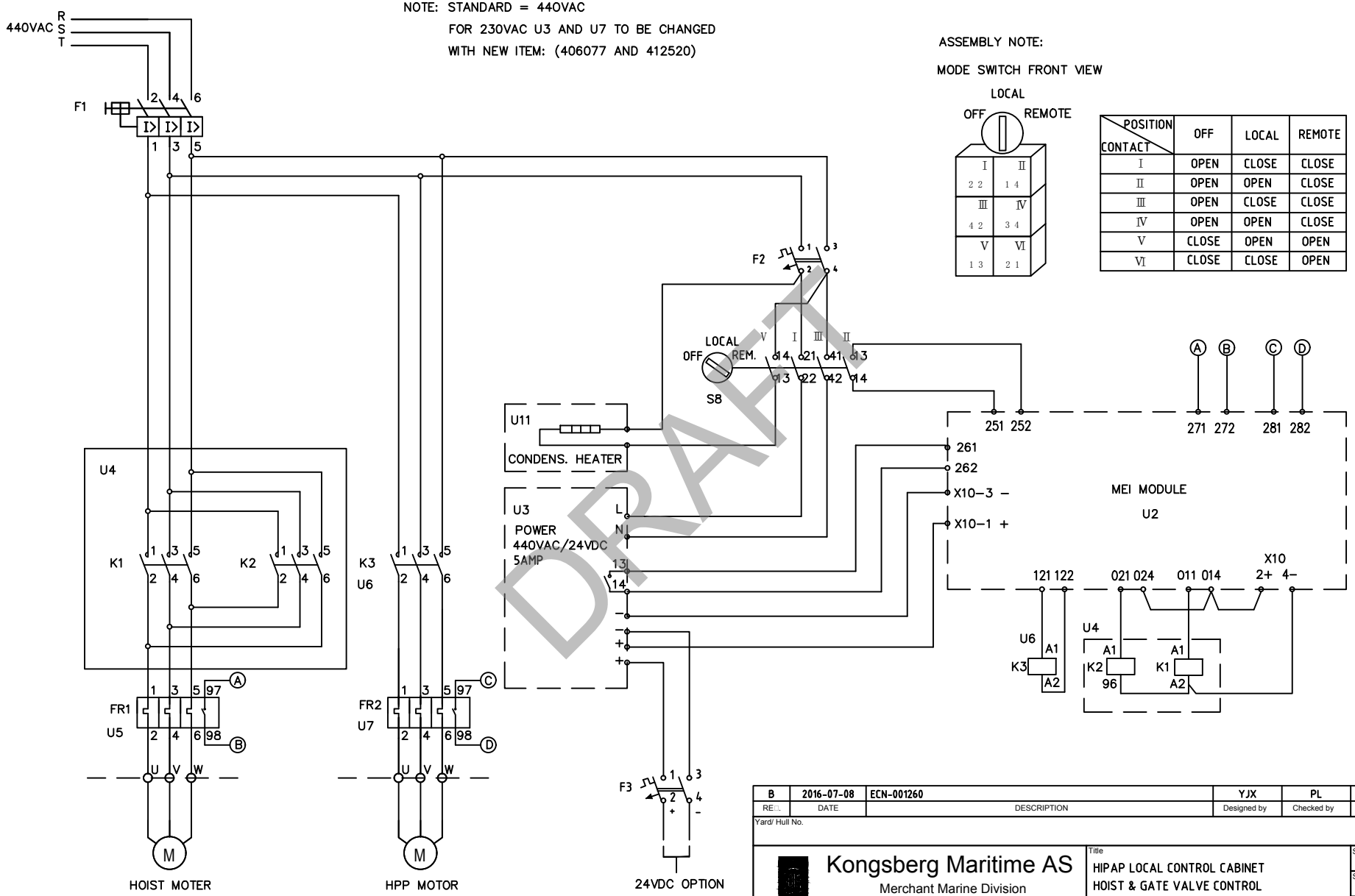
Project / Product name

Project number

Drawing type
Mechanical Drawing

Document ID
396428

Revision/Version
A



B	2016-07-08	ECN-001260	YJX	PL	VU
REV.	DATE	DESCRIPTION	Designed by	Checked by	Approved by

Yard/ Hull No.

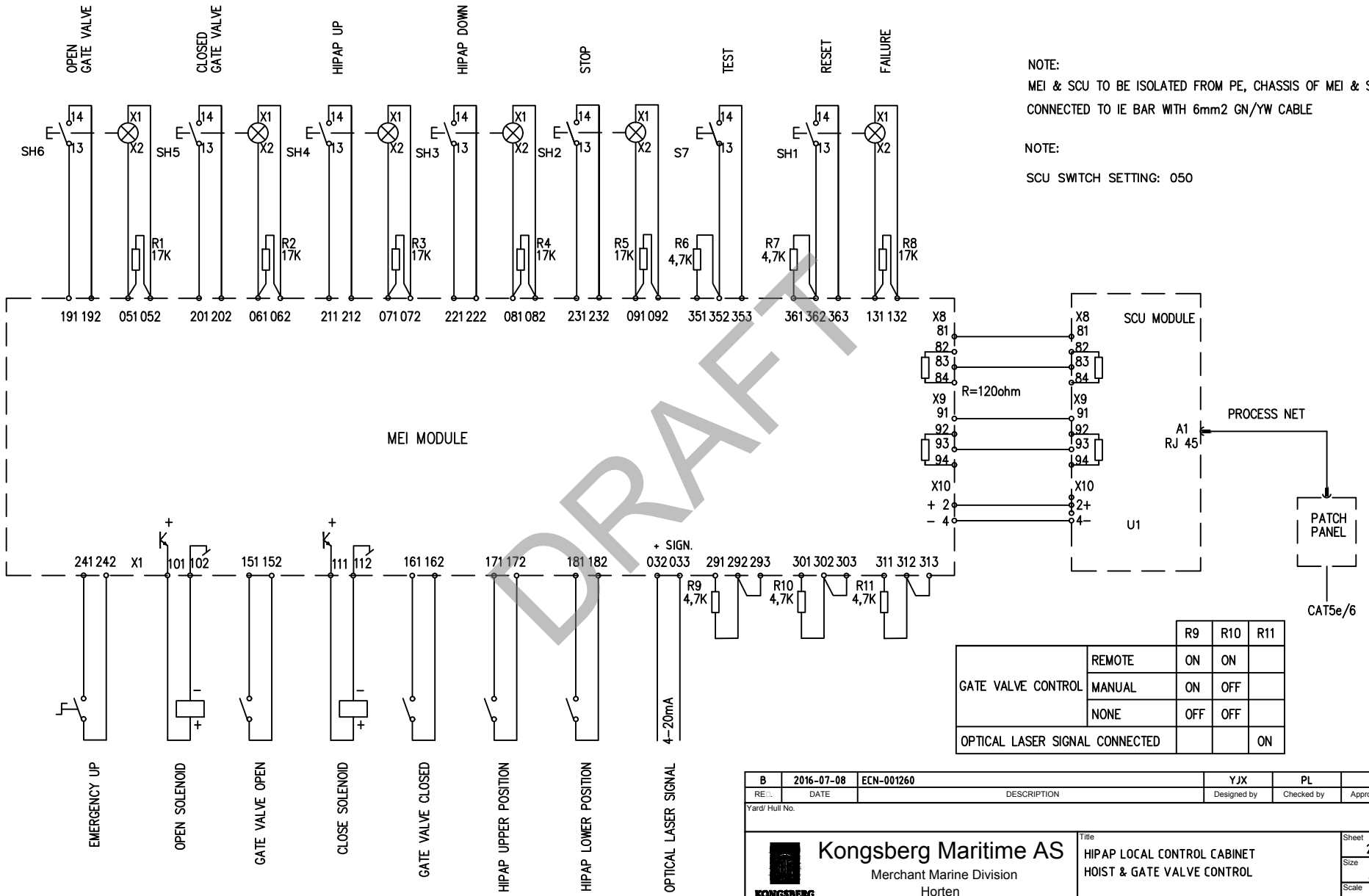
Kongsberg Maritime AS
Merchant Marine Division
Horten

Title: HIPAP LOCAL CONTROL CABINET
HOIST & GATE VALVE CONTROL

Sheet: 1/2
Size: A4
Scale:

Project / Product name: K-CHIEF 600
Project number:
Drawing type: CONNECTION DRAWING

Document ID: 406276
Revision/ Version: B



NOTE:
MEI & SCU TO BE ISOLATED FROM PE, CHASSIS OF MEI & SCU CONNECTED TO IE BAR WITH 6mm2 GN/YW CABLE

NOTE:
SCU SWITCH SETTING: 050

		R9	R10	R11
GATE VALVE CONTROL	REMOTE	ON	ON	
	MANUAL	ON	OFF	
	NONE	OFF	OFF	
OPTICAL LASER SIGNAL CONNECTED				ON

RE:	DATE	DESCRIPTION	Designed by	Checked by	Approved by
B	2016-07-08	ECN-001260	YJX	PL	VU

Yard/ Hull No.

Kongsberg Maritime AS
Merchant Marine Division
Horten

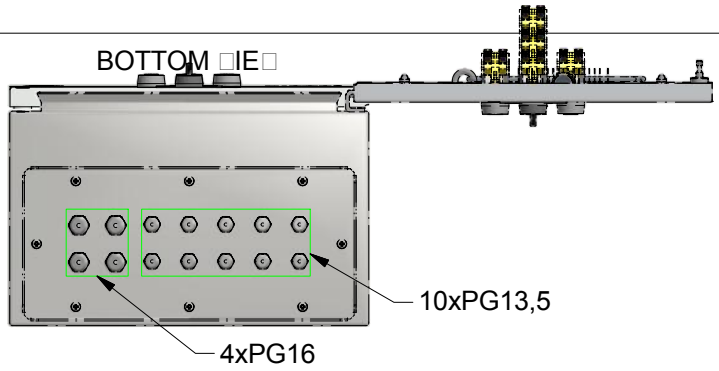
Title: HIPAP LOCAL CONTROL CABINET
HOIST & GATE VALVE CONTROL

Sheet: 2/2
Size: A4
Scale:

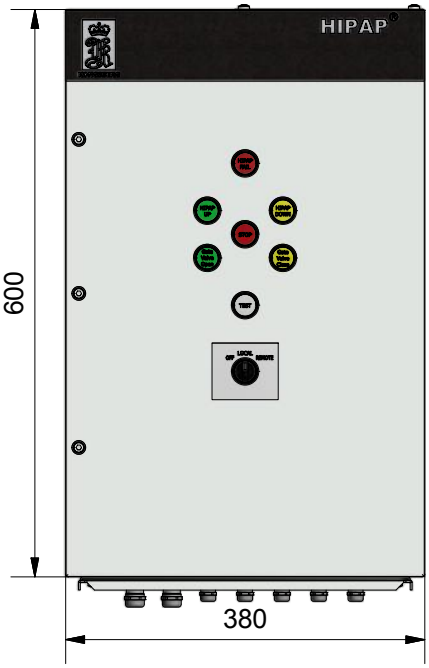
Project / Product name: K-CHIEF 600
Project number:
Drawing type: CONNECTION DRAWING

Document ID: 406276
Revision/ Version: B

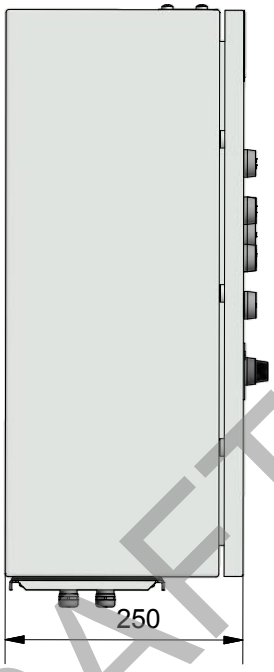
BOTTOM □IE□



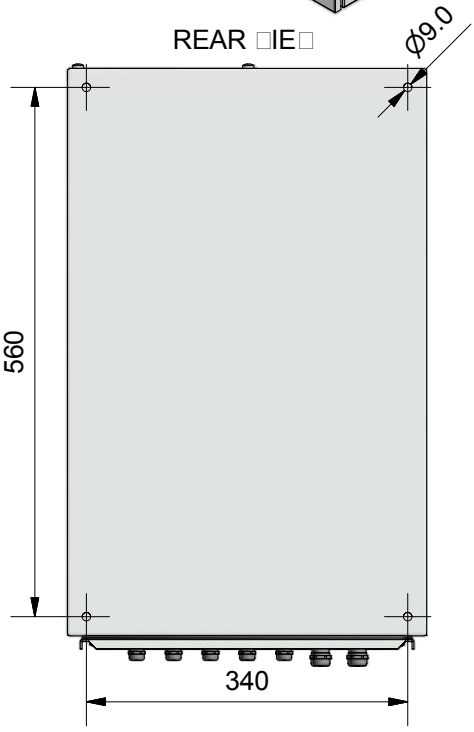
FRONT □IE□



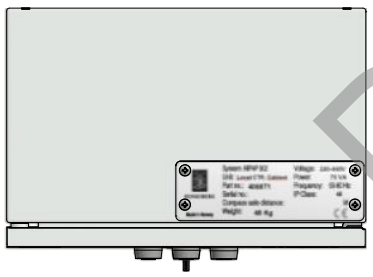
SIDE □IE□



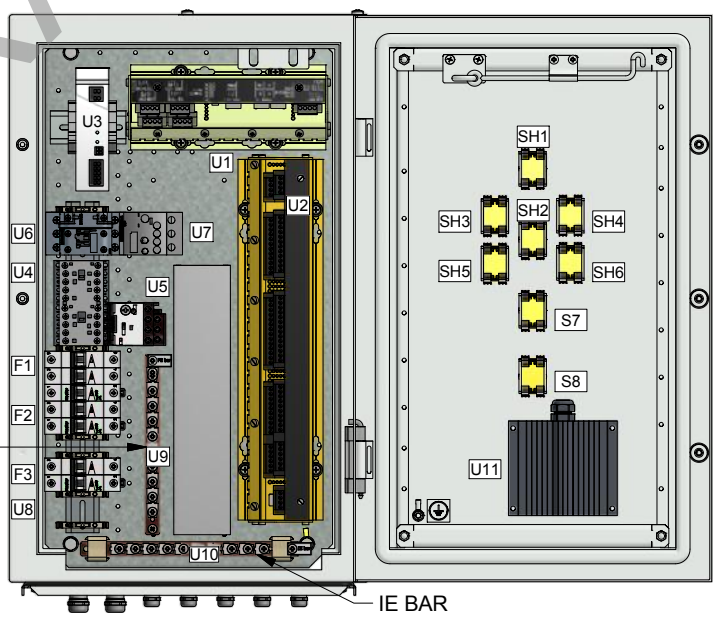
REAR □IE□



TOP □IE□



INSIDE □IE□



INDE□ OF PROTECTION: IP65

MATERIAL: STEEL METAL □235

CABINET COLOUR: RAL 9005

□ EIGHT: APPRO□ 25KG

□IBERATION CODE: 4G, FRE□UENCY 2-100H□

RE□.	DATE	DESCRIPTION	Designed by	Checked by	Approved by
B	02.02.2017	ECN-003207	TFM	PL	□U

Yard/Hull No.

KONGSBERG

Kongsberg Maritime AS

Merchant Marine Division
Horten

Title: HIPAP local control cabinet
hoisth gate valve control

Sheet: 1 of 1

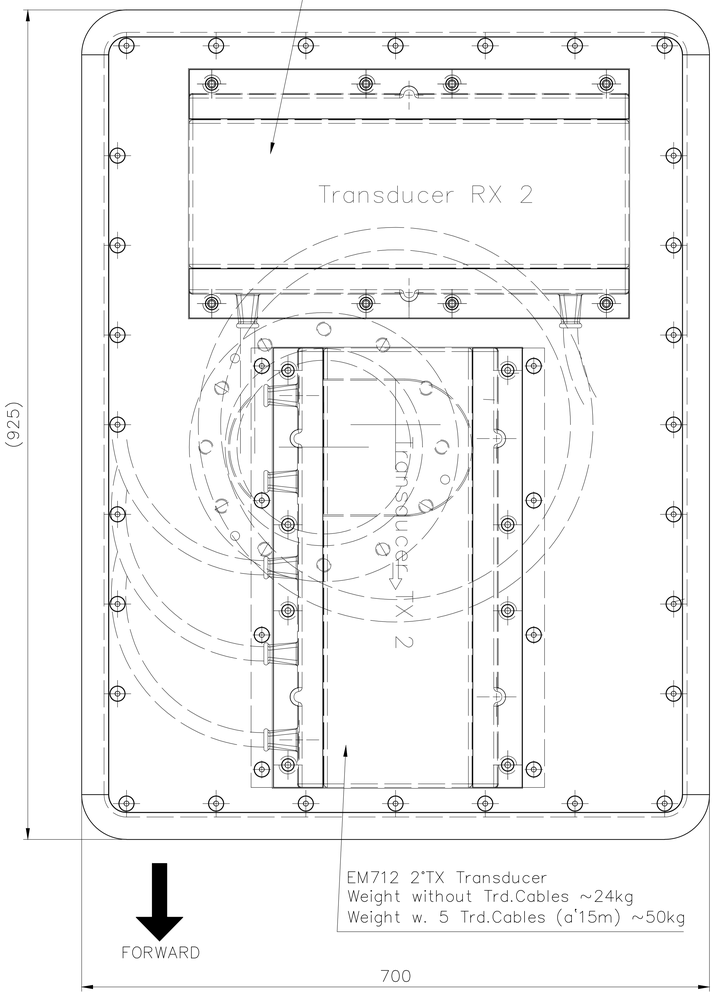
Size: A4

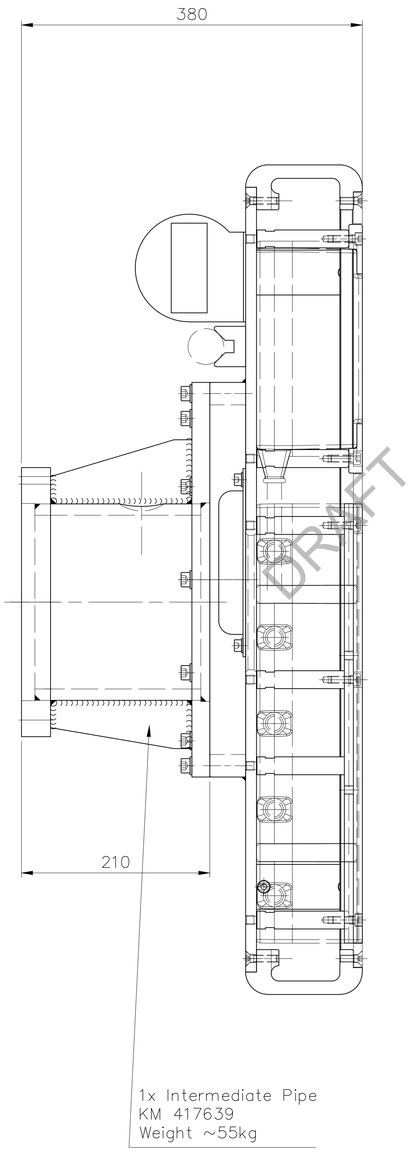
Scale: 1 : 8

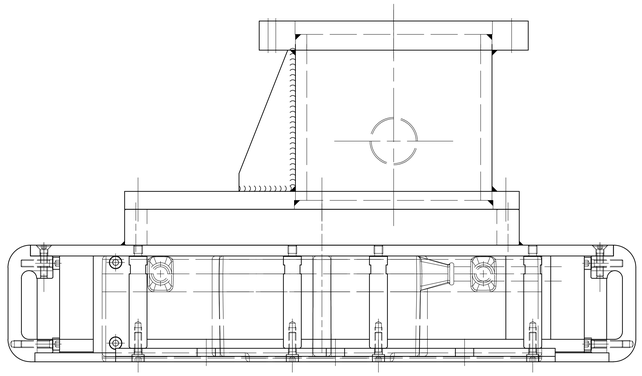
Project / Product name	Project number / Item ID	Drawing type
	406071	Outline Drawing

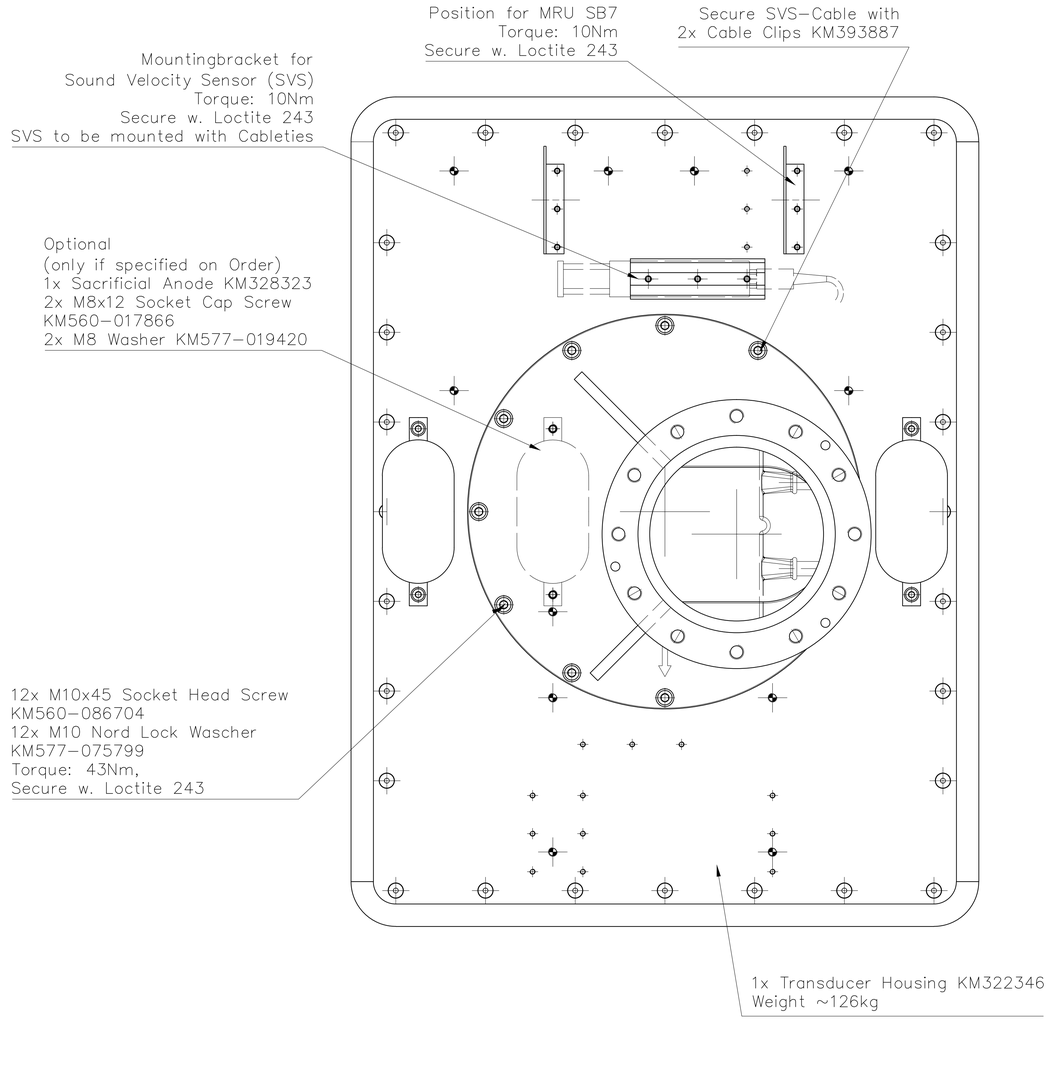
Document ID: 407161

Revision: B

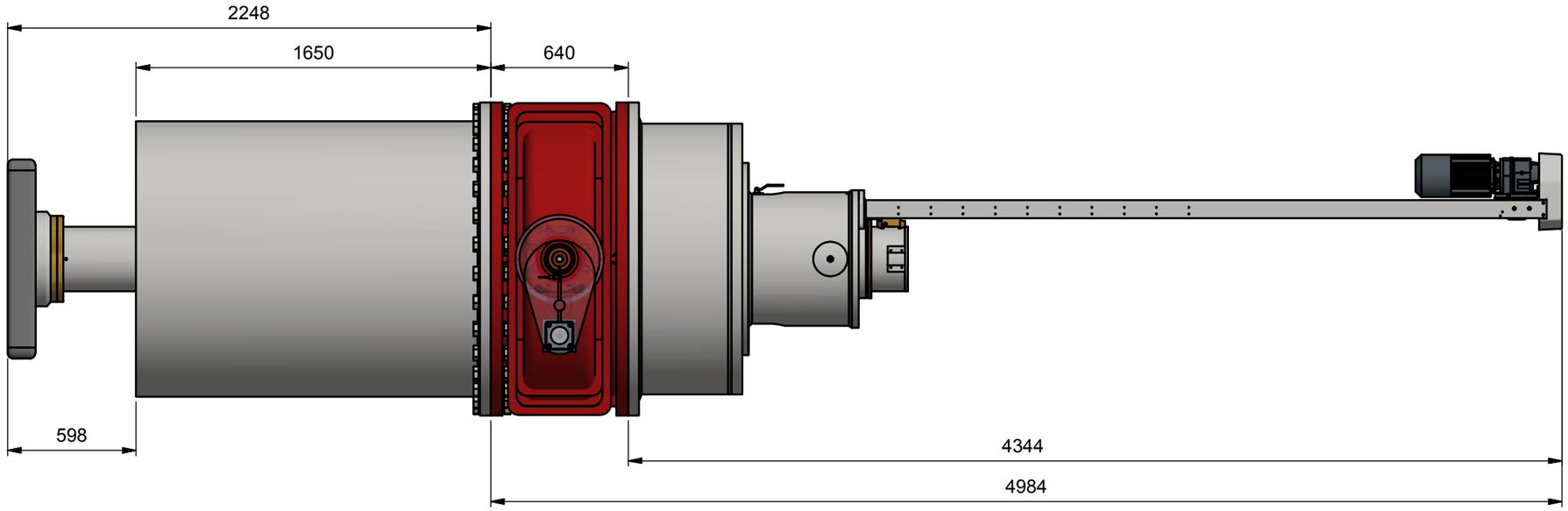


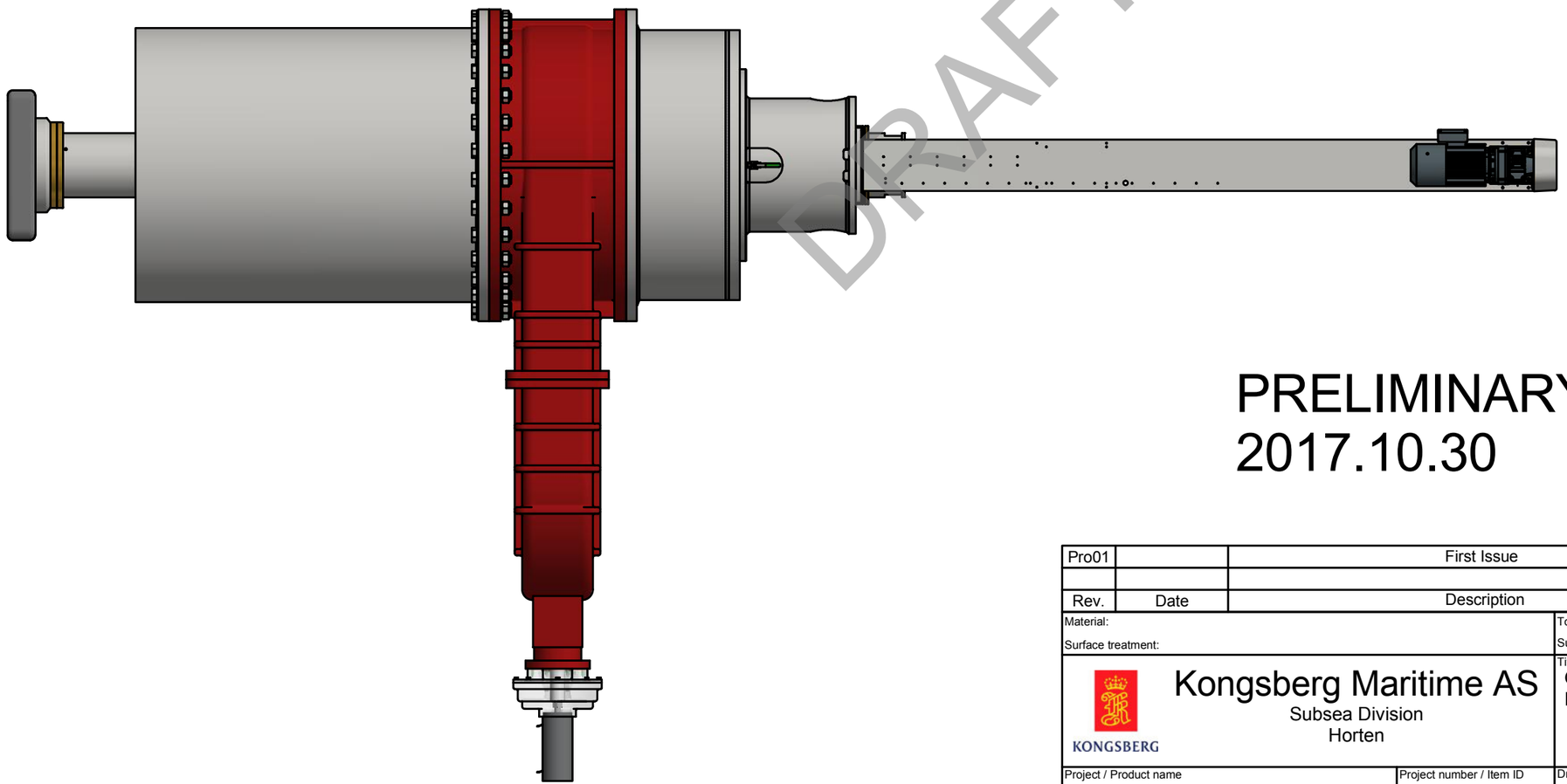






MATERIAL: -			UNLESS OTHERWISE STATED, TOLERANCES:		PROJ. METHODE
SURFACE TREATMENT: -			DIM.: ISO 2768-mK THREADS: 6g/6H SURFACE: Ro6.3		
ASSEMBLY DRAWING TRANSDUCER HOUSING WITH INTERMEDIATE PIPE EM710/712			SCALE 1:5 ALTERNATIVE SCALE N.A.	Kongsberg Maritime AS KONGSBERG	
			CLASS. CODE 120950	ITEM ID 417715	REV. A
ORIGIN DATE 2016.08.29	DESIGNED LK	APPROVED SVEINT	SIZE A2	SHEET 1 OF 1	REV. DATE. 2016.08.29





PRELIMINARY
2017.10.30

Rev.	Date	Description	Designed by	Checked by	Approved by
Pro01		First Issue	haa		

Material:
Surface treatment:

Tolerances unless otherwise stated: ISO 2768-mK
Surface: Ra 3,2 µm
Broken edges: 0,1 - 0,5 x 45°
Threads: 6g/6H

KONGSBERG

Kongsberg Maritime AS
Subsea Division
Horten

Title: General Arrangement HL3200 EM712 Ice Breaker

Sheet: 1 of 1
Size: A3
Scale: 1 : 25

Project / Product name: Underwater Mapping
Project number / Item ID: 424455
Drawing type: General Arrangement (100409)

Document ID: 424455
Revision: Pro01

4.2 Hydraulic system (Power pack)

4.2.1 System drawing

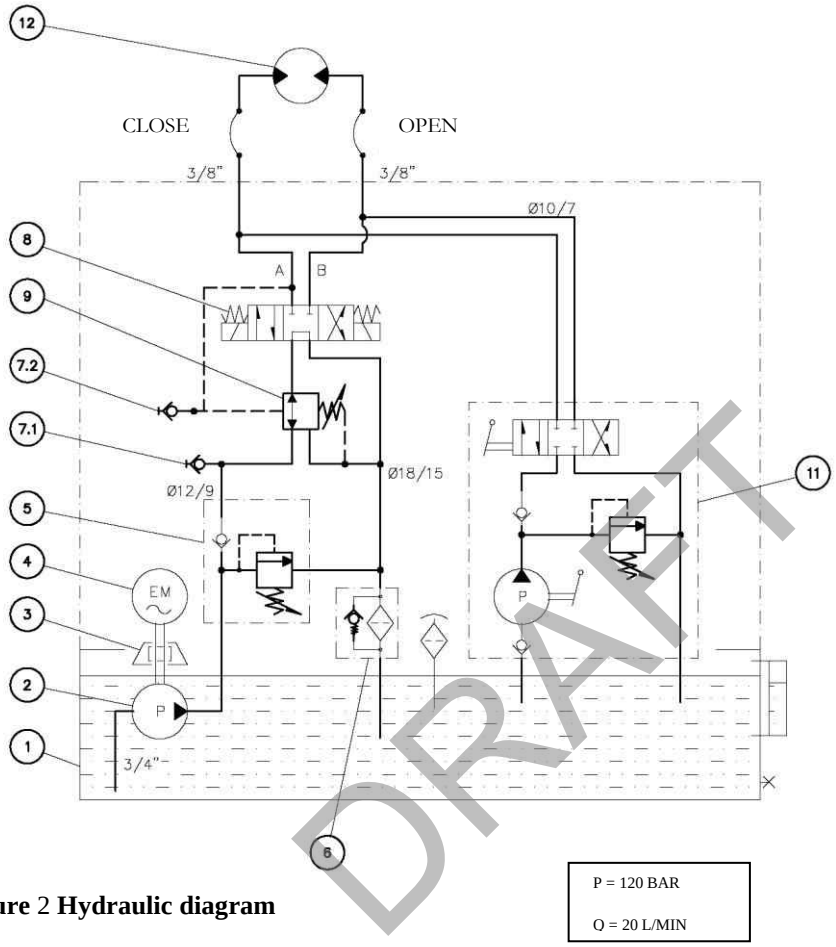
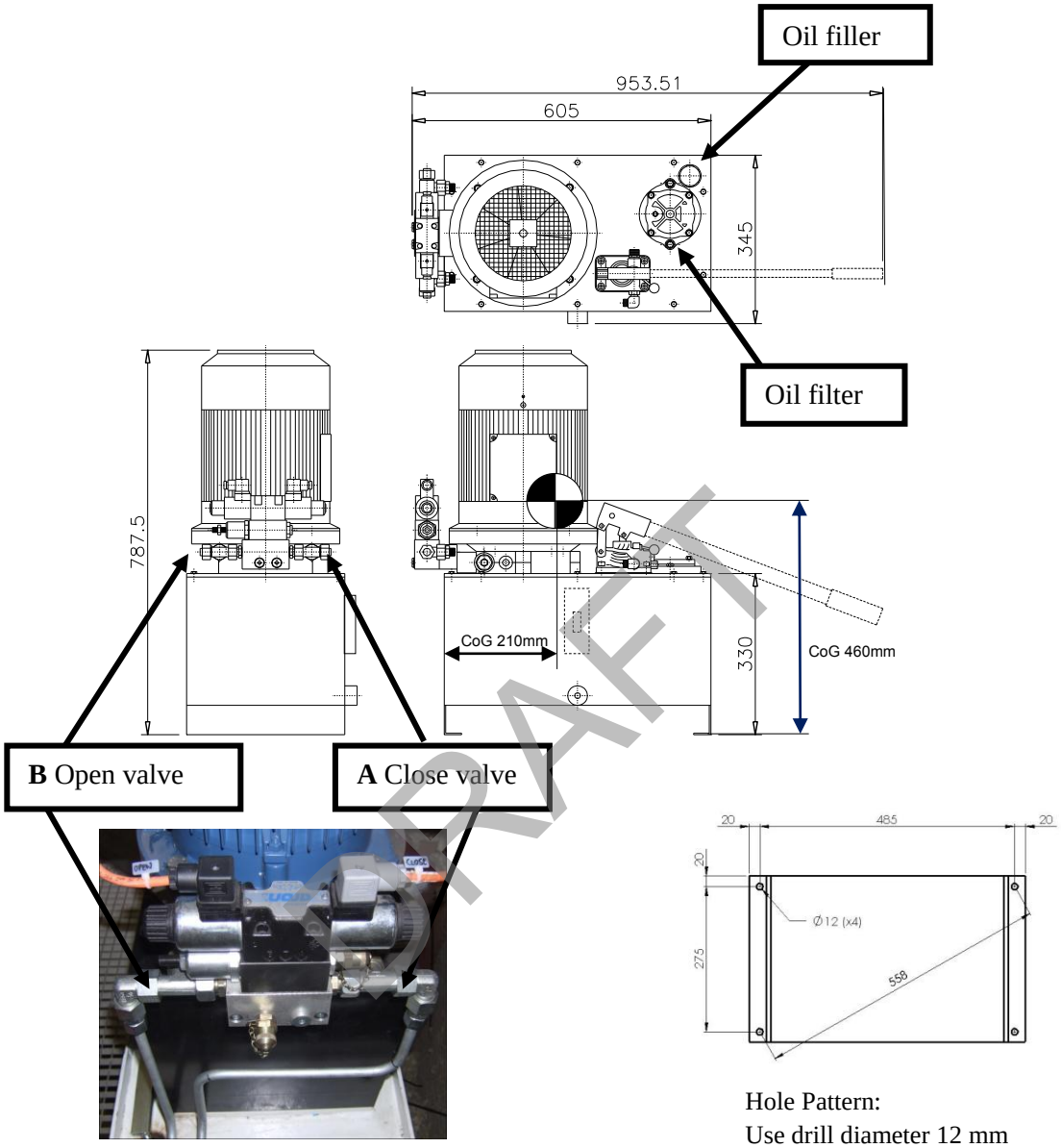


Figure 2 **Hydraulic diagram**

Position	Description	LK no:
	Complete Power Pack	90743
Single Components		
1	Tank type S114-ZL-45 Liter	
2	2SPA-11D-10N Pump	
3	F67/ZL Junction element	
4	MS132L4-B5-3/6 5,5KW	
5	01Y/ZL Manifold 50-220 Bar	
6	FBO Return filterFIR 60/1-10M	92362
7	20.10.66-01 1/4" Test connector	
8	Aron Valve AD 3E 04C M	
9	Aron Valve AM3 RD/A1 C2	
11	OMFB hand pump PMISS 45 + VS	
12	OMR 250 151-0416 HY-Motor	90744

Table 2 Parts for Power Pack

4.2.2 Arrangement drawing



Hole Pattern:
Use drill diameter 12 mm
for M10 bolts.

Figure 3 Power Pack Layout and dimensions

Powerpack	
Issue	**Description**
Power Supply	440V - 60Hz 5.5kW
Opt. Power Supply	On request
Tank Capacity	45 L
Usable Capacity	30 L
Weight (empty)	53 Kg
Code	114
Fittings	Conex GE15L
Recommended Hoses	1/2", (13mm) for 30.0 Mpa
Rec. Oil quality	ISO VG 32

Table 3 Power Pack Technical data

Observe: No hoses or fittings between valve actuator motor and Power pack are included.

4.2.3 Hand pump

Emergency opening of gate valve.

When operating the lever manually, you have 3 functions. Note that these functions corresponds to recommended solenoid function:

1. Open valve manually
2. Normal operation
3. Close valve manually

Figure 4 Selector for manual pumping

4.2.4 Oil quality

Recommended oil quality: According to ISO VG 32 specifications.

4.5 Electronic control

4.5.1 Electric system drawing

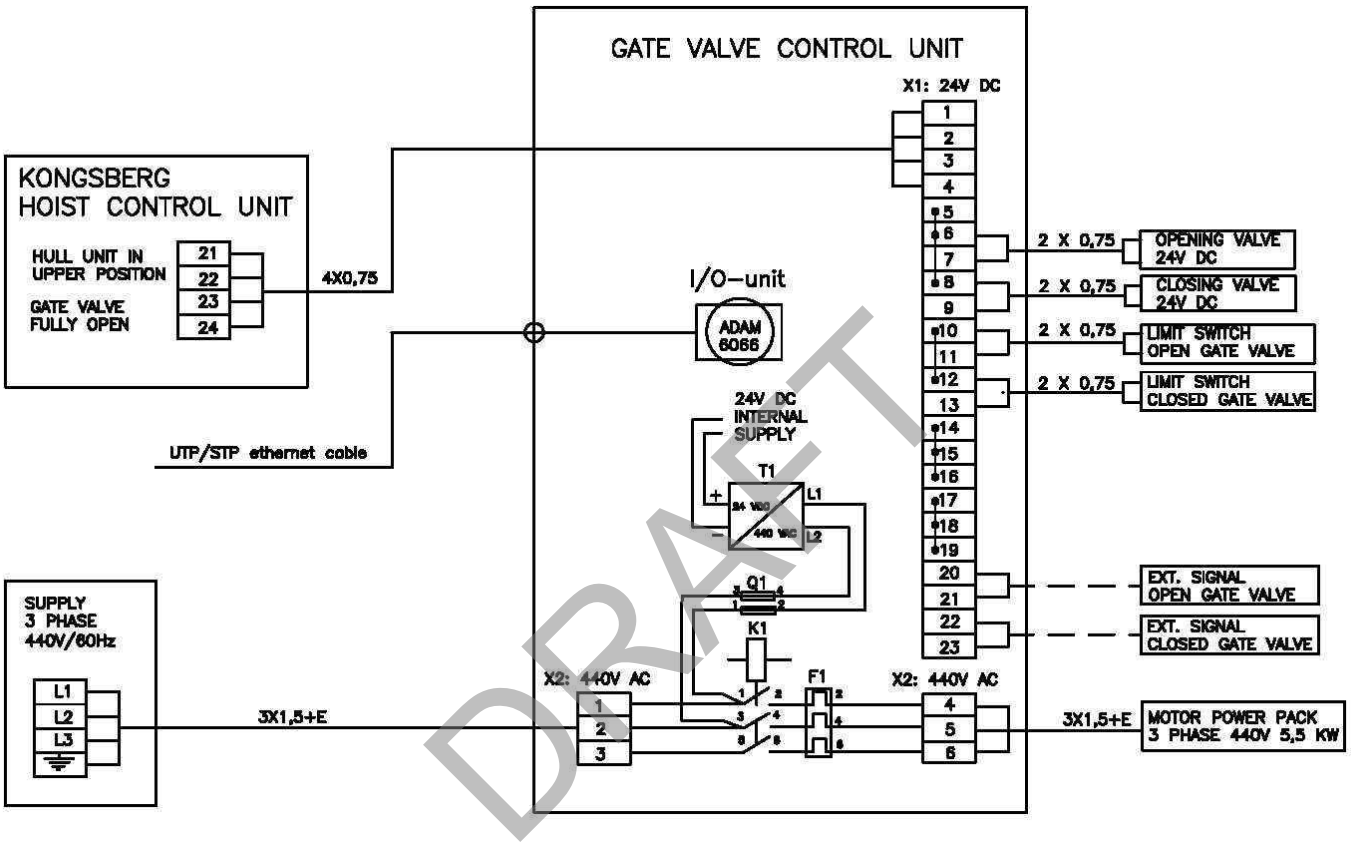


Figure 8 Electric system drawing

miniSVS Sound Velocity Sensor

Our unique digital time of flight technology gives unmatched performance figures, with signal noise an order of magnitude better than any other sensor. The miniSVS is available in a selection of configurations and with optional pressure or temperature sensors. There are a variety of sizes to suit many applications.

miniSVS - still the most accurate sound velocity sensor in the world. Nothing else comes close.

Sound Velocity Measurement

Each sound velocity measurement is made using a single pulse of sound travelling over a known distance, so is independent of the inherent calculation errors present in all CTDs. Our unique digital signal processing technique virtually eliminates signal noise, and gives almost instantaneous response; the digital measurement is also entirely linear, giving predictable performance under all conditions.

Range:	1375 - 1900m/s	
Resolution:	0.001m/s	
Accuracy:	Dependent on sensor size	
100mm	Random noise (point to point)	±0.002m/s
	Max systematic calibration error	±0.013m/s
	Max systematic clock error	±0.002m/s
	Total max theoretical error	**±0.017m/s**
50mm	Total max theoretical error	±0.019m/s
25mm	Total max theoretical error	±0.020m/s

Acoustic Frequency: 2.5MHz

Sample Rate: Selectable, dependent on configuration

Rate	SV	SV+P	SV+T
Single Sample	•	•	•
1Hz	•	•	•
2Hz	•	•	•
4Hz	•	•	•
8Hz	•	•	•
16Hz	•	•	•
32Hz	•	•	
60Hz	•		

Optional Sensors

The miniSVS may be optionally supplied with either a pressure or temperature sensor (but not both). Data is sampled at the rates shown above

Sensor	**Pressure**	**Temperature**
Type	Strain Gauge	PRT
Range	5, 10, 50, 100 or 600 Bar	-5°C to +35°C
Resolution	0.001% range	0.001°C
Accuracy	±0.05% range	±0.01°C

Data Output

Unit has RS232 & RS485 output, selected by command code. RS232 data may be taken directly into a PC over cables up to 200m long, whereas RS485 is suitable for longer cables (up to 1000m) and allows for multiple addressed units on a single cable.

Baud Rate: 2400 - 115200 (NB. Low baud rates may limit data rate)
Protocol: 8 data bits, 1 stop bit, No parity, No flow control

Electrical

Voltage: 8 - 30vDC
Power: 0.25W (SV only), 0.35W (SV + Pressure)
Connector: Subconn MCBH6F (alternatives on request)

Data Format

Examples of data formats are:
<space>{sound_velocity}<cr><lf>
<space>{pressure}<space>{sound_velocity}<cr><lf>
<space>{temperature}<space>{sound_velocity}<cr><lf>

SV: Choose from mm/s (1510123), m/s to 3 decimal places (1510.123), or m/s to 2 decimal places (1510.12)

Pressure: If fitted, pressure is always output in dBar with 5 digits, with a decimal point, including leading zeroes if necessary. Position of the point is dependent on sensor range, e.g.

50dBar	47.123
100dBar	047.12
1000dBar	0047.1

Temperature: If fitted, temperature is output as a 5 digit number with 3 decimal places and leading zeroes, signed if negative, e.g. 21.456, 02.298, -03.174

Physical

Please refer to factory for detailed dimensions if required.

Depth Rating: 6000m (Titanium), 500m (acetal)
Weight: 1kg (housed type)
Housing & Bulkhead: Titanium or acetal, as selected
Transducer Window: Polycarbonate
Sensor Legs: Carbon Composite
Reflector Plate: Titanium.

Ordering

All systems supplied with operating manual and carry case. OEM units come with a test lead, housed units with a 0.5m pigtail.

Configuration	100mm	50mm	25mm
Titanium Housed	0652004	0652005	0652006
Acetal Housed	0652045	0652046	0652047
Bulkhead OEM	0652001	0652002	0652003
Remote OEM	0652007	0652008	0652009
Titanium + Pressure	0652004-P	0652005-P	0652006-P
Titanium +Temperature	0652004-T	0652005-T	0652006-T

Datasheet Reference: miniSVS version 2b, June 2013

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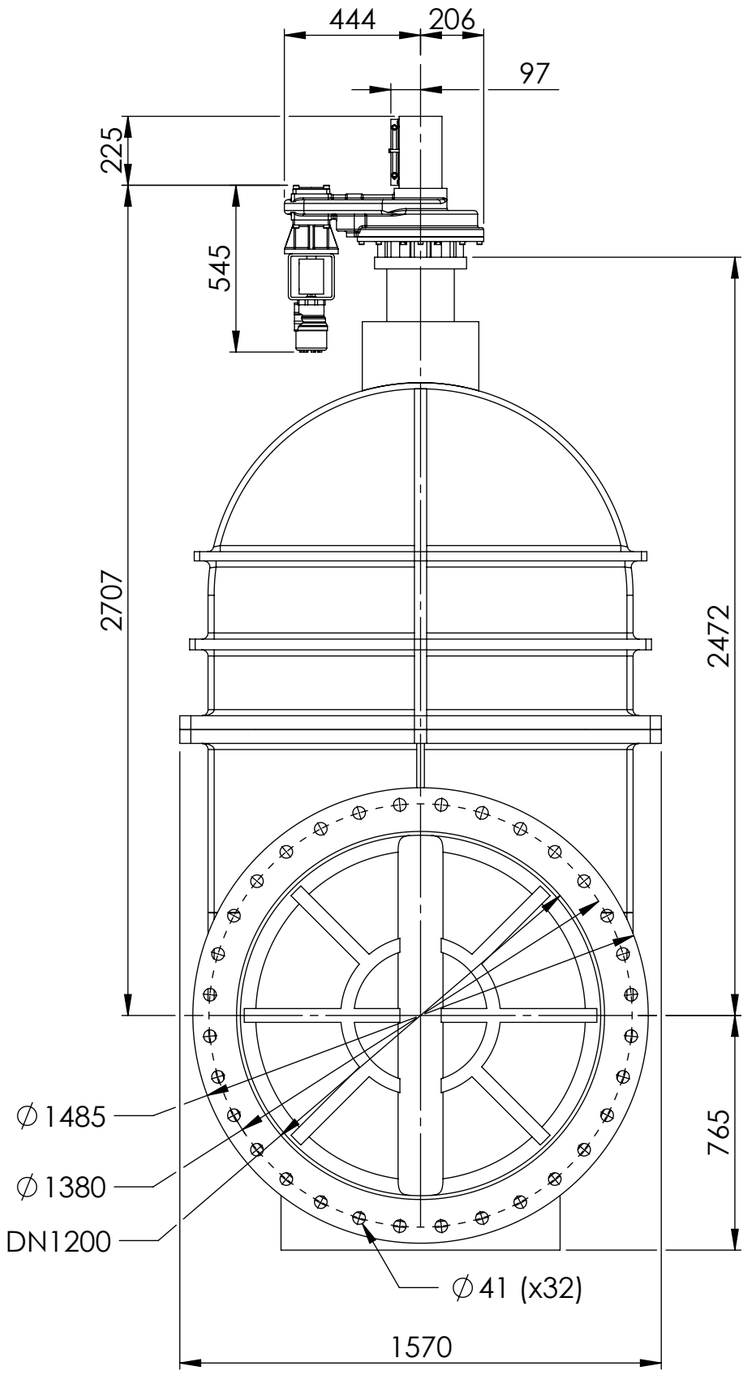
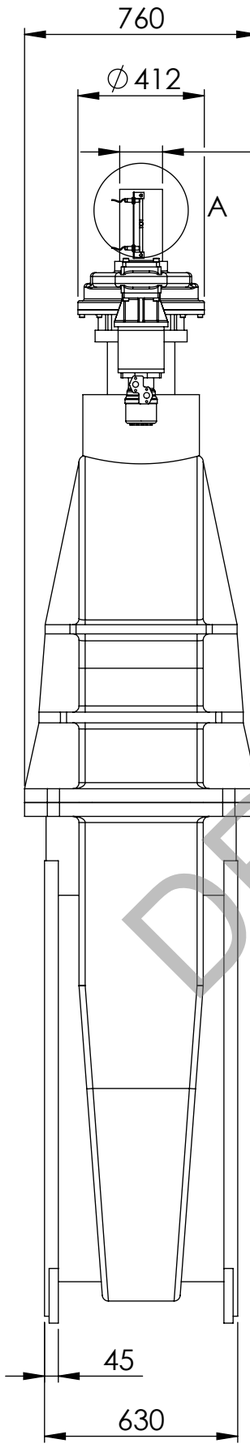
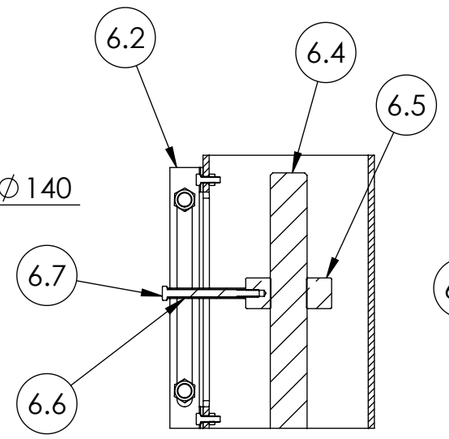
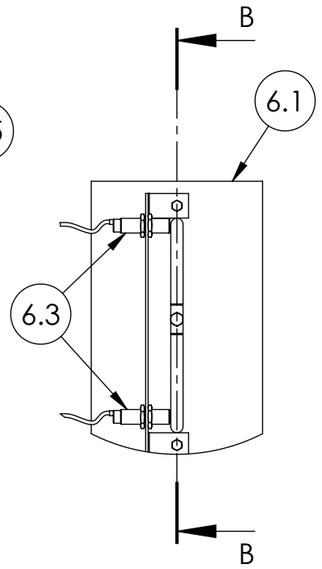


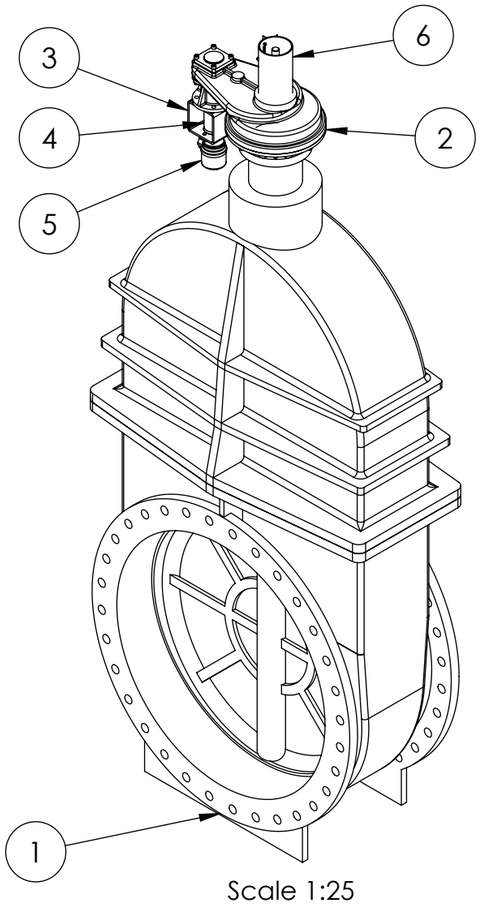




SECTION B-B
SCALE 1 : 5



DETAIL A
SCALE 1 : 5



Scale 1:25

Pos	Part	Material	Note
6.7	Hex bolt	-	
6.6	Spacer	AISI 304	
6.5	Indicator collar	Bronze RG5	
6.4	Indicator shaft	AISI 304	
6.3	Inductive sensors	-	XS612B1PAL2 IP67
6.2	Sensor bracket	AISI 304	
6.1	Cover tube	EN 10 219-S355 J2H	
6	Indicator assembly	-	
5	Hydraulic motor	-	OMR250
4	Shaft coupling	-	
3	Motor adapter	EN 10 025-S235 JRG2	
2	Gearbox	GGG40 (Gearcase)	Rotork IS10
1.5	Stem	AISI 316L	
1.4	Seats	Al-Bronze CuAl8	
1.3	Disc	Ductile Iron GGG50	
1.2	Bonnet	Ductile Iron GGG50	
1.1	Body	Ductile Iron GGG50	
1	Gate Valve	-	Full bore

Approximate weight: 4200 kg

Designed by	Checked by	App. Market	App. Production	App. Purchase	DRW STD: ISO 8015 & 1302 Gen.tolerance:	Scale	Format
FHE						1:20	A3

LK Valves

Title: **Gate Valve DN1200 PN4/PN10**
Gearbox + hydraulic actuator
Inductive sensors

Sheet 1/1 | Introduced Date 2017-10-21
Drawing No. Q-37317 | Revision D

Q-37317