- 15 - Private sanitary rooms (exhaust)
- 30 - Public sanitary rooms (exhaust)
- 60 - Extract for Galley
- 30 - Supply for Galley
- 20 - Laundries
- 5 - Stores (supply and exhaust)
- 6 - Cargo hold
- 8 - Scientific hold
- 8 - Heli Hangar

6.6.5 Means of Cooling & Heating

R6.293 .The general Cooling Medium used shall be chilled water. The flow temperature for the chilled water system shall be 6^{o}C and the return temperature shall be 12^{o}C. The same system shall be able to distribute heated water for heating purposes. The hot water shall have an inlet temperature of 70^{o}C and return temperature of 50^{o}C. For heat supply, the system shall be connected:

- to boiler/thermal oil heater via heat exchanger
- via heat exchanger to HT Circuit of main diesel engine

The system shall have two circulating pump of appropriate capacity and an expansion tank etc.

Some compartments may have standalone direct expansion package air conditioning units.

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6.6.6 Air Conditioning General Arrangements

R6.294 Air conditioning and ventilation system shall be based on principle of zonal segregation using separate systems for meeting fire safety requirements. The accommodation space shall be assumed to be located in at least two fire zones. There shall be two chilled water plant for the vessel. The air handling units (AHUs) shall be located in the same fire zone as the served rooms. There shall be separate system as follows;

- A dedicated AHU for serving cabins and wheel house.
- A dedicated AHU for serving ECR, corridors, stairs and recreation rooms.
- A dedicated AHU for serving mess, recreation, workshops and technical rooms, server rooms, winch room, electrical equipment room, science hangar.
- A dedicated AHU serving the galley and scullery.
- A dedicated AHU serving helicopter hangar and cargo area.
- A dedicated AHU serving the laboratories

The air handling units shall be manufactured with twin skin panels, trapping solid mineral wool between. All components should be mounted on an integral base frame and be designed to prevent condensation on the exterior skin. Fan and motor assemblies shall be mounted on anti-vibration mounts to prevent noise/vibration transmission.

Each AHU shall be equipped with dedicated return / exhaust fans and sorption recovery wheel.

Independent air extraction shall be provided from hospital, galley, pantries, scullery, laundry and toilets. The exhaust outlets from these spaces shall located away from any fresh air intakes.

The overall air conditioning airflows shall be the same for all climatic conditions. Recirculation shall be ideally limited to a normal value of 25% with a maximum of 50%. The systems should be capable of full fresh air in moderate climates.

6.6.7 Air Handling Unit (AHU) Serving Cabins and Wheelhouse

R6.295 The cabins shall be served from the AHU located in the same fire zone as the served cabins.

A drop separator shall be used at the air inlets to restrict the passage of moisture, salt spray and rainwater into HVAC systems. The fresh air shall be heated by a preheater (fluid: e.g. thermal oil) at the drop separator. The fresh air temperature behind the preheater should be about +15°C.

- Each Cabin shall get the minimum fresh air rate from the AHU. The air shall be distributed into the rooms by a single Spiro-duct system. The primary fresh air will get a constant airflow controller and is distributed direct to the Cabin Fan Coil Unit (CFU) where it is mixed with the return air of the cabin.

The air out let temperature from CFU in cooling mode shall be 12°C and in heating mode it is about 35°C. In cooling mode the CFU is served by chilled water (supply=6°C / return=12°C) and by warm water (supply 70°C / return 50°C) in heating mode. The CFU shall be equipped with a 4-way-valve changing over from chilled water to warm water.

The exhaust air is exhaust via an exhaust nozzle and a constant air flow controller at the toilet. The air is routed vie the sorption recovery wheel at the AHU into the outside.

The corridors shall be supplied with air from the AHU. The supply air shall be heated by electrical duct reheater or by warm water zone reheaters. Electrical heaters shall cut out on detection of no air flow in the ducts.

The AHU shall have the below items;

- Bag filter class M6 (supply and exhaust side)
- Sorption Recovery Wheel (supply and exhaust side)
- Two cooling coil (water inlet 6°C, water outlet 12°C), each with a capacity of 50%
- Anti freeze protection
- Two electrical steam humidifier, each with a capacity of 50% with drop eliminator
- Two direct driven supply fans, each with an air volume of 50%

- Two direct driven exhaust fans, each with an air volume of 50%

For sufficient fresh air for the maximum number of persons expected the Wheelhouse shall be supplied from AHU serving the cabins. Wheelhouse to meet a minimum air change rate of 6 per hour.

In addition, free standing or deck head mounted fan coil units shall be fitted in wheel house to deal with particularly onerous climatic conditions. These might be cooled expansion units mounted locally to the Wheelhouse. If deck head units are used, careful consideration and avoidance of condensation and drainage must be observed.

In the Wheelhouse there shall be a ducted demist supply of hot air for the windows for winter operations. . This duct shall be fitted with electric heaters and shut off damper.

6.6.8 Air Handling Unit (AHU) Serving Mess, Recreation, Workshops and Other Technical Rooms, Server Rooms, Winch Room, Electrical Equipment Room, Science Hangar

R6.296 Rooms such as ECR, switchboard rooms, server rooms, winch room, electrical equipment room, propulsion switchboard rooms, science hangar, corridors, stairs and recreation rooms shall be served from the dedicated AHU. Rooms such as mess, gymnasium, conference suite, corridors, laundry, offices and workshops shall be served from another AHU. The AHUs shall be located in the same fire zone as the served rooms.

The AHUs shall be equipped with dedicated return/exhaust fans and sorption recovery wheel. The laundry spaces have a separate exhaust fan.

A drop separator shall be used at the air inlets to restrict the passage of moisture, salt spray and rainwater into HVAC systems. The fresh air shall be heated by a preheater (fluid: e.g. thermal oil) at the drop separator. The fresh air temperature behind the preheater should be about +15°C.

The heating of the rooms to be realized by corresponding warm water reheater zones in the supply duct of the AHU.

The supply air temperature in cooling mode shall be 12°C and in heating mode it shall be 35°C.

The air shall be supplied into the rooms by rainfall principal or by supply boxes with diffuser. The air shall be exhausted by exhaust boxes with diffuser. Alternatively rooms like Switchboard Rooms shall be supplied by supply air via raised floor.

The airflow shall be controlled by electrical driven dampers. The dampers raise the airflow in cooling mode up to 100% and reduce the airflow in heating mode down to about 70% of maximum airflow. The speed of the supply and exhaust fan in the AHU is controlled by the pressure measurement inside the AHU.

The AHU shall have the below items;

- Bag filter class M6 (supply and exhaust side)
- Sorption Recovery Wheel (supply and exhaust side)
- Two cooling coils (water inlet 6°C, water outlet 12°C), each with a capacity of 50%
- Anti freeze protection
- Two electrical steam humidifiers, each with a capacity of 50% with drop eliminator

- Two direct driven supply fans, each with an air volume of 50%
- One warm water reheater (70°C/50°C) for 70 % of maximum airflow.
- Two direct driven exhaust fans, each with an air volume of 50%

The ECR shall have two fan coil cooler connected to the main chilled water plant. Both units with capacity: approx 100% of total need with fresh air from the main AHU serving this deck.

All switch board rooms shall have two fan coil cooler connected to the main chilled water. Both units approx 100% of total capacity.

Fresh air from the main AHU serving this deck. The cooling capacity shall be determined after final decision of equipment and dissipated "wild heat"

6.6.9 Air Handling Unit (AHU) Serving the Galley

R6.297 The galley shall be served by a s eparate dedicated the AHU. The air is exhausted via the funnel to the outside.

A drop separator shall be used at the air inlets to restrict the passage of moisture, salt spray and rainwater into HVAC systems. The fresh air shall be heated by a preheater (fluid: e.g. thermal oil) at the drop separator. The fresh air temperature behind the preheater should be about t=+15°C.

The AHU shall have the below items:

- Bag filter class M6 (supply and exhaust side)
- Sorption Recovery Wheel (supply and exhaust side)
- One cooling coil (water inlet 6°C, water outlet 12°C), each with a capacity of 50 %
- One warm water reheater (70°C/50°C) for 100% of maximum airflow.
- Anti freeze protection
- One direct driven supply fans, each with an air volume of 100%
- One direct driven exhaust fans, each with an air volume of 100%

The air shall be distributed into the galley by duct system with electrical duct reheater.

The constant supply temperature for the galley shall be 20°C to avoid any condensation inside the galley.

The air shall be supplied by supply boxes with diffuser into the galley and it shall be exhausted by grease hoods.

The airflow shall be controlled with VFD drives both for supply and of the exhaust fans. Full speed mode shall be selected during heavy cooking and half speed is regarded as normal ventilation.

The AHUs fans shall have remote start/stop facilities both inside and outside the space. One bulkhead-mounted remote control panel shall be arranged in the Galley for control of supply and exhaust fan.

In order to prevent smells, the Galley shall be designed to maintain an under pressure with regards to the rest of the vessel.

The exhaust air shall be carried through stainless steel hoods above the cooking equipments and these shall be fitted with easily demountable and washable stainless steel grease filters. The filters shall be easy to clean and capacity shall be coordinated with the capacity of the Galley exhaust fan.

A stainless steel hood shall be installed above dishwashing machines complete with extract fans

Galley exhaust ducts shall have bolted access hatches arranged to facilitate cleaning of the complete length of the duct. All bends shall have inner and outer radius of minimum 100mm, and the inside of the duct shall be smooth with no stiffeners etc.

All duct work shall be accessible for internal degreasing and cleaning.

6.6.10 Air Handling Unit(AHU) Serving the Laboratories

R6.298 The room temperature and the temperature accuracy (e.g. +/- 1 K) for different laboratories shall be defined during the detailed design. The controlled environmental laboratories shall be controlled with a temperature range shall be between 0ºC and 30ºC with a tolerance of ± 2ºC and humidity 35% RH and 60%RH. In addition, the humidity control accuracy to be +/- 5%RH.. In addition, the humidity control accuracy to be +/- 5%RH. They shall be served by dedicated air handling units. The air shall be exhausted to the outside.

The AHU shall have the below items;

- Bag filter class M6 (supply and exhaust side)
- Sorption Recovery Wheel (supply and exhaust side)
- One cooling coil (water inlet 6°C, water outlet 12°C), each with a capacity of 50 %
- One warm water reheater (70°C/50°C) for 100 % of maximum airflow.
- Anti freeze protection
- One direct driven supply fans, each with an air volume of 100%
- One direct driven exhaust fans, each with an air volume of 100%

The airflow shall be controlled with VFD drives both for supply and of the exhaust fans.

Several air supply diffuser shall disperse air over a large area in order to minimize drafts and must provide uniformity of temperature throughout the space (one large air diffuser is NOT acceptable).

If any laboratory which requires a room temperature of 18°C or less, fan coil coolers supplied by chilled water plant directly to be considered for such laboratories. The spaces shall be kept within 1.5°C of the set point.

6.6.11 HVAC System Serving Helicopter Hangar, Cargo Holds and Scientific Hold

R6.299 The Helicopter hangar, Cargo holds and Scientific Hold shall be ventilated by supply and exhaust fan providing the room with necessary fresh air. In addition the rooms to get a fan coil unit with heating and cooling coil to maintain a temperature of 18°C. The temperature of 18°C shall be achieved when measured at a height of 1.5m above deck level with the hangar door closed and exterior temperatures down to -20°C.

The system shall be able to prevent any accumulation of explosive or combustible gases within the hangar. The air supply shall be distributed in such a way that, during hot weather, the effective hangar temperature shall not exceed 36.5°C.

The air of the hangar shall be supplied and exhausted by supply / exhaust boxes with diffusor.

The supply and exhaust air fan shall be frequency controlled.

The equipment need to be explosion proof rated.

Hangar air temperature shall not vary more than 5°C between deck level and five metres above deck level.

Hot air from the heating system shall not be directed onto the aircraft and provision shall be made to reduce condensation in the hangar area.

The exhaust system shall provide at least six complete air changes per hour.

6.6.12 Chilled Water System

R6.300 All AHU's, as mentioned above shall be fed by means of two independent chilled water systems to be installed, both serving accommodation and machinery technical rooms.

Two skid mounted chillers plants to be provided. Each pump shall be fed from different switchboard.

Each chilled water plant shall be mounted upon suitable anti-vibration mounts designed to limit the vibration levels transmitted to / from the ships structure. Anti-vibration mounts shall also be provided for the chilled water and seawater pumps and each starter panel.

The final required chiller cooling capacity is 1 x 100% of the total required cooling capacity.

Each chiller plant shall be installed as an independent "stand alone system/loop" including required isolation valves, non-return valves, balance valves, temperature indicators, pressure gauges, etc.

A sequence shall be programmed to ensure all chillers will make the same running hours.

Chiller plants shall include compressors of the screw type and having a minimum of two circuits, each rated at 60% of design duty.) and shell & tube sea water cooled condensers constructed with suitable materials.

Evaporation temperature shall not lower be as +3°C.

Complete system shall be designed for minimum 30% Glycol & 70% water.

Since the main ship's machinery relies upon air conditioning of the switchboard rooms each main refrigerating machinery plant shall be designed for indirect cooling of chilled water with R134a as refrigerant and as the heat transfer coolant.

Both plants will maintain the required temperatures automatically (manually starting) and be mounted on anti-vibration mounts compatible with the requirements for Underwater Radiated Noise.

The compressor unit, evaporator and condenser shall be built together to form a condensing unit. Compressors with automatic capacity control and condenser seawater systems shall be fitted with pressure controlled water regulators. Noise attenuation shall be specially addressed.

Refrigerant gas shall be vented to atmosphere above atmosphere science sensors via suitable pipework.

Systems shall be so designed such that the entire charge of refrigerant gas can be pumped down to the condensers before maintenance is carried out.

6.6.13 Chilled Water Pumps

R6.301 Each chiller plant, two chilled water pump each of 100% (total of 4 for the vessel) of the required flow capacity are required. The pumps shall be installed parallel, so if one them fails, it can be isolated and repaired or overhauled, although the system is still running.
Both pumps shall be positioned on a common skid frame with a drip tray installed underneath, which is connected to a scupper, or drain line.

It shall be possible to service the pumps without dismantling.

Each pump shall be fed from different switchboard.

All pumps & belonging electric motors shall be selected with +10% margin

6.6.14 Chilled Water Piping & Insulation

R6.302 All chilled water piping exceeding 4" shall be terminated with flanges.

The maximum design velocity for the chilled water system is 3m/seconds.

All Chilled water piping shall be insulated with flexible, waterproof, closed cell foam pipe insulation.

Pipe insulation shall not be interrupted at hanger or support locations; supporting must be around the insulation. The insulation shall be protected with aluminium sheet metal cladding, also between the supports and the insulation.

6.6.15 Ducting System

R6.303 All duct elements shall be of aerodynamic design. The ductwork system may be a low or medium velocity, insulated double skinned duct system with preset control of volume for cabins, wheelhouse, electronic equipment rooms, laboratories and offices.

The system chosen shall be compatible with the requirements for Underwater Radiated Noise and Internal Noise limits such that the vessel will achieve a DNV Silent (R) notation.

The majority of ductwork shall be double walled spiro ducts pre-insulated type with 15mm insulation between inner and outer duct. The inner duct shall be with double lip sealing. However, should rectangular ductwork be used this should be to DW141 standard.

Exhaust ducts shall be of same quality as supply ducts.
All fireproof ductwork to be a minimum of 5mm thick and insulated on the outside.

No insulation shall be fitted inside any ductwork with-out prior agreement.

Special attention shall be paid to ductwork connections to fan inlets and outlets in order to maximise the fan performance. Flexible ducting shall be kept to a minimum and be used only for vibration damping or thermal expansion purposes.

The room unit diffusers shall be of high pressure drop design complete with sound attenuation.

All duct mounted electric heaters shall be interlocked with the fan so that if there is no airflow the heaters are isolated.

Inspection doors should be as large as possible. All inspection doors in heavy gauge ductwork shall be h inged. Access for cleaning of ductwork shall be pr ovided. The extract ducts from areas exposed for pollution, such as galley hood, tumble drier etc. shall be fitted with inspection doors, suitable for complete clean out of the ducting.

6.6.16 Fans

R6.304 The fans for fresh air and exhaust air shall be either of the axial type, with balanced impeller and the junction box of the electrical motor on the casing, or of the centrifugal type.

Each of these fan types shall be mounted on anti-vibration mounts and connected to air ducts with flexible connections. Electrical connections shall be flexible. Dampers shall be installed for each fan.

Fan motors are to have a maximum rotating speed of 1800 rpm.

All fans are protected against corrosion by galvanizing and exposed casings shall be made of galvanised steel plate. of minimum 5mm thickness. Fans inside air handling unit casings shall be a minimum of 1mm thick galvanised sheet steel.

Exposed casings shall be of galvanised steel.

Alloy impellers can be used if special care is taken against corrosion.

All machinery space fans are to have a maximum speed of 1800 rpm for axial and big centrifugal fans or 3600 rpm for small centrifugal fans and high pressure fans (motors shall be 1800 rpm).

Where possible fans shall be variable speed so that a reduced duty may be achieved for quiet running.

6.6.17 Fire Dampers

R6.305 All necessary fire dampers required, whether according to Rule or not, shall be of electric controlled type with operation switches and lights on both sides of bulkhead or deck, automatic closure means are also to be fitted. Central closing of all, or by zones, shall be achieved from the Wheelhouse.

6.6.18 Not Used

R6.306

6.6.19 Heating of Other Spaces

R6.307 Air-conditioned working areas shall be heated as necessary by the air conditioning system. The thermal system shall be used, as far as practicable, for heating coils inside air handling units and electric re-heaters at the outlet diffusers

shall be fitted. The re-heaters shall be controlled locally manually or by individual space thermostats.
All other spaces, including any unmanned spaces, without air conditioning, shall be fitted with fan driven electric heaters to prevent unacceptably low temperatures in winter ambient conditions.

Control spaces with large window areas (Wheelhouse, Winch Control Cabin) shall be fitted additionally with black electric convector heaters for localised control of temperatures.

6.6.20 Ventilation and Heating of Specific Machinery Spaces General

R6.308 The ventilation of the various machinery rooms shall be carried out generally as follows:

- Main Engine Room: Forced supply & natural exhaust
- Propulsion/Thruster Rooms: Forced & natural supply plus forced exhaust.
- Auxiliary Machinery rooms: Natural supply plus forced exhaust,
- Switchboard rooms: Air conditioning with fresh air inlet and exhaust.
- Fresh water cooling of primary heat generators (drives) to be provided
- Engine Room Stores: Natural supply plus forced exhaust
- Engine control room: Conditioned air, supply, and exhaust and make-up air.
- Workshops: Forced exhaust. A hood exhaust fan is installed above any welding stand fitted.

Bearing in mind the requirements with regard to noise and vibration care must be taken in the choice of fan sizes and speeds.

6.6.21 Main Engine Rooms

R6.309 The system shall be able to operate both in heating and cooling mode. The freezing of the Engine Rooms is avoided by using preheater.

The total required air flow for engine rooms shall account for combustion air and air required for heat evacuation. Calculations carried out as per EN ISO 8861 shall be submitted for owners review.

In cooling mode the the maximum engine room temperature shall be 52.5°C when the outside supply temperature is 40°C.

A drop separator shall be used at the air inlets to restrict the passage of moisture, salt spray and rainwater into the supply fan system. In heating mode, the fresh air shall be heated by a preheater (fluid: e.g. thermal oil) at the drop separator. The fresh air temperature behind the preheater should be about 15°C.

Each engine room shall be mechanically ventilated by two frequency controlled axial flow fans. The two fans shall supply each engine through a common supply duct system, each fan providing 50% of the airflow.

The fan flows shall be designed in order to produce a temperature of exhaust air not greater than 47.5^{o}C (with fresh air inlet temperature of 35^{o}C) in all areas of the compartment. In addition the fans must be r ated to provide sufficient engine

combustion air with all machinery working at its maximum output at the most extreme outside ambient air temperatures.
There shall be two type of supply fans “comfort supply fan” and “normal supply fans” for the engine rooms .The engine room shall be supplied with a “comfort supply fan” with silencer at the suction side and outlet side while in harbour mode. The “normal supply fan” with a silencer only at the suction side shall be used in other times.

The fresh air shall be distributed by a duct network. Exhaust air shall be led out through the casing aft of the funnel in the upper part. Exhaust fans are to draw exhaust air from the engine room space and also from below floor plate level (CO_2 evacuation).

Fans shall be easily accessible and easily removable for maintenance

The airflow of the both fan shall corresponds to the combustion air volume of the main engines.

The speed control of supply fans using VFD shall be based on pressure measurement in the engine room and control of the exhaust dampers shall be based on the engine room temperature.

The closing dampers shall be fitted with electric actuators with end-position switches.

The fan shall automatically be prevented to start until the damper is positive open by signal from end-position switch, and the damper shall automatically close when the fan is stopped.

The dampers of the supply air shall be connected to the UPS and are always open, only exception is the manual stop in case of emergency.

If the engine room temperature rises and needs more outside air the exhaust damper are to open. If the pressure in the engine room decreases due to engine air demand, the supply fan shall increase the speed.

The control system shall provide 50 Pa overpressure in the Engine Room. For a stable control of the Engine Room, all doors of the Engine Room shall be shut.

An effective supply duct distribution system shall be fitted in order to cool down equipment as found necessary, to avoid hot spots and to provide combustion air directly to the air inlet of the engines.

6.6.22 Propulsion Motor Rooms

R6.310 All electronic equipment susceptible to high temperature should be located within the switchboard rooms.

The propulsion motor rooms shall have two independent cooling systems, so that cooling is still available in the event of one system failure. Some reduction in total air flow may be acceptable in case of failure. One standalone package air handling unit and a separate fan coil coolers supplied by chilled water plant directly shall be arranged inside each room for cooling purposes.

Automatic temperature regulation shall keep propulsion motor room temperature at maximum 27°C.

Mechanical ventilation and ducting shall be provided by separate supply fan for changing the air at least 10 times an hour.

6.6.23 Auxiliary Machinery Rooms

R6.311 The fresh air inlet shall be through either a goose-neck duct or ventilator housing with a hinged watertight cover and fitted with a spray eliminating Jalousie located on an open deck.

The outside air for the auxiliary machinery rooms shall be heated by preheater (fluid: e.g. thermal oil) and the drops in the outside air shall be eliminated by a drop separator. The fresh air temperature behind the preheater should be about t=+15°C.

Ventilation of these spaces shall be carried out through exhaust axial fans with natural inlets. Particulars of these fans shall be primarily designed to dissipate heat from motors and other heat sources.

The use of fan coils supplied from the chilled water plant may be c onsidered, to reducing the amount of air required.

Where redundancy is required, two independent means of cooling shall be considered, so that cooling is still available in the event of one system failure e.g. one fan coil cooler connected to the main chilled water plant and one self-contained package unit.

Where the space contains large motors or heat sources it is to remain working at least 15 minutes after the motor(s)/heat sources are shut down. An electrical heater shall be installed in these spaces.

Typical basic air changes required would be:

- Winch Room 20 changes per hour
- CO_2 room 20 changes per hour
- Hydraulic equipment 20 changes per hour
- AC-compressor spaces 20 changes per hour
- AVTUR pump room 20 changes per hour
- Boat garage 20 changes per hour

6.6.24 Bow and Stern Thruster Rooms

R6.312 One air package handling unit or fan coil unit served by the nearest chilled water plant shall be arranged inside each thruster room for cooling purposes if cooling is essential for the correct operation of the thruster or its frequency drives if located in the bow thruster room.

Automatic temperature regulation shall keep room temperature at maximum 27°C.

Mechanical ventilation shall be provided by separate supply fan and necessary ducting for changing the air in accordance with table above.

6.6.25 Emergency Generator Room

R6.313 Engine shall be provided with radiator fan for cooling. In addition, mechanical ventilation shall be provided by separate supply fan, necessary ducting and weather tight closing device /fire dampers in accordance with relevant regulations, both for outlet and inlet.

Heating shall be provided to prevent condensation. Natural supply air louvers shall also be arranged to cover emergency generator fan when the above supply fan is not operating.

Separate ducting for direct supply of combustion air to the engine shall be considered. Capacity and arrangement shall be in accordance with recommendations from maker of generator.

Inlet and outlet ducts/openings must be ample size allow small pressure drop enabling the built-on radiator fan on the generator set to ventilate the radiator sufficiently.

A separate fan for normal operation shall be provided to remove wild heat from emergency switchboard and for general ventilation of the room according to ISO 8861.

6.6.26 Engine Room Stores

R6.314 The store shall be ventilated with one exhaust fan to create 20 air changes.

6.6.27 Incinerator / Boiler Room

R6.315 The total required flow shall account for combustion air and air required for heat evacuation. Calculations carried out as per EN ISO 8861 shall be submitted for owners review.

Mechanical ventilation (under pressure) shall be provided by separate extraction and supply fan, necessary ducting and watertight closing device in accordance with relevant regulations, both for outlet and inlet. Capacity and arrangement shall be in accordance with maker of incinerators and boiler recommendations

An exhaust fan for normal operation shall be provided for ventilation and cooling purposes in accordance with instructions from the supplier. This fan shall be interlocked with the Incinerator/boiler so that it will automatically start when the Incinerator/boiler is running.

6.6.28 Paint and Chemical Stores

R6,316 Mechanical ventilation (under pressure) shall be pr ovided by separate extraction fan (explosion proof) with necessary ducting and watertight closing device in accordance with relevant regulations, both for outlet and inlet.

Capacity, with regard to air changes per hour, shall be at least as stated in table above.

6.6.29 Engineering Workshop

R6.317 The workshop shall be ventilated and cooled with one independent air-conditioner. Separate fresh air supply shall be provided.. One exhaust fan shall be fitted with a hood for the welding station and a dedicated exhaust.

6.6.30 Deck and Rough Workshop

R6.318 These spaces shall be open to atmosphere under normal operating circumstances. They will however be fitted with suitable forced supply ventilation and electric fan heating to provide a reasonably habitable environment for the extremes of ambient temperature.

6.6.31 UIC Room

R6.319 This shall be air conditioned by a free standing or deck head mounted local unit augmented by electric heating for cold climes.

For demisting UIC room windows for winter operation, ducted supply of hot air shall be available. The duct shall be fitted with electric heaters and shut off damper.

6.6.32 Scientific Stores

R6.320 This shall be fitted with natural ventilation plus a forced air inlet fan or fans to achieve at least 12 air changes per hour under normal conditions of storage.

6.6.33 Air Intakes / Discharges

R6.321 The fresh air intakes and discharges in both the engine room and accommodation shall be made through openings in the ships structure.

These openings shall be provided with an efficient baffle against possible rainwater ingress and green water (air speed to be about 6 m/s in the box inlets), as well as a gutter-overhang at the upper part of the openings in vertical bulkheads to avoid as far as possible ingress of running water.

Water removal shall be at least 99.9% at 6 m/sec air inlet velocity for droplets of 4-6 microns.
EXEMPLAR, Premaberg two stage separator type P35.

6.6.34 Natural Ventilation

R6.322 The spaces served by natural climate controlled ventilation shall be provided with top and bottom ventilation pipes.

The air inlets and outlets shall have covers or goosenecks, with shutters, of watertight design where necessary.

Spaces served:

- Oxygen and Acetylene lockers
- Deck stores
- Battery lockers

Other Spaces without mechanical ventilation shall be fitted with natural ventilation.

6.6.35 Cold Room Details

R6.323 For the cold rooms, the following shall be installed as a minimum:

- Fan shut-down when opening the door of the rooms
- Defrosting pilot lamp above each door of each room and repeated in the Galley.
- Alarm lamp in the galley if the installation shuts down.
- Central system alarm is also to be fitted for shut down or high temperature.
- The rooms shall be fitted with marine type fan air coolers. Trays are to receive the defrosting water and condensates which shall be led to the nearest scupper. T ubes and fins of these air coolers are of tinned copper.
- Electric heaters shall be installed: for the defrosting of the air coolers in the frozen rooms, also trays and drain-pipes.
- Air coolers in the cool rooms are defrosted with forced ventilation.
- Isolating transformers are provided for the defrosting heaters.
- The door frame in the freezer rooms is fitted with an anti-frosting cord.
- Outside conditions for machinery capacity: air temperature +45^{o}C, seawater +35^{o}C.

- Remote thermometers outside the rooms with a digital display showing the temperature of each cold room located in the provision area close to the entrance or in the galley.

6.6.36 Refrigeration Machinery for Provision Rooms & Garbage Room

R6.324 Combined refrigeration plant shall be installed to serve both provisions stores and garbage room. The system shall be served by two compressors, one running and, one standby, each with a design capacity of 110% of the maximum system requirements and maintain specified to temperatures with 12 hours running per day.

The plant shall be automatically controlled by a control panel including necessary push buttons and indicators for plant operation and head pressure control valves on the fresh water cooling lines.

All spaces are to have fan assisted evaporators, defrost timers and trace heating.

6.6.37 Not Used

R6.325

6.6.38 Refrigeration Machinery for Scientific Chill Room

R6.326 The chill room shall be served by two compressors, one running and one standby.

The compressor shall be designed to maintain the specified temperatures with 12 hours running per day.

The plant shall be automatically controlled by a control panel including necessary push buttons and indicators for plant operation and head pressure control valves on the seawater cooling lines.

The space is to have a fan assisted evaporator, defrost timer and trace heating.

The system is to have run/stand-by sea water cooling pumps.

6.6.39 Control and Automation

R6,327 Local / Remote System

All systems shall be able to run in local and remote control.

In normal mode all systems shall be are running in remote control. A separate working station (“stand alone”) for the HVAC system shall be considered in the Engine Control Room.

The HVAC-Control system shall be connected to the VMS system.

6.6.40 Remote Maintenance

R6.328 A system of remote data transfer to assist maintenance (e.g. Air Handling Units and Chiller) shall be arranged

6,6.41 ECO Notation Requirements

R6.329 The vessel shall be able to achieve ECO(R) notation.

Systems shall be arranged with suitable means of isolation so that maintenance, servicing or repair work may be undertaken without releasing the refrigerant charge into the atmosphere.

For the purposes of refrigerant recovery, the compressors shall be capable of evacuating a system charge into a liquid receiver. Additionally, recovery units shall be provided to evacuate a system either into the existing liquid receiver or into cylinders dedicated for this purpose. The number of cylinders shall be sufficient to contain the complete charge between points of isolation in the system.

A leak detection system appropriate to the refrigerant shall be provided to monitor continuously the spaces into which the refrigerant could leak. An alarm shall be activated to give warning in a permanently manned location when the concentration of refrigerant in the space exceeds a pr edetermined limit (300 p.p.m for halogenated fluorocarbons).

6.7 SHIP'S CCTV SYSTEM

6.7.1 Ship's CCTV System

R6.330 The Contractor shall supply and install a high quality digital CCTV system based on a central HE400-500 system or alternative brand of similar quality with special attention to ensure speed and quality are maintained during use and recording functions. Control shall be installed for operational assistance, safety, security (ISPS) and engineering space monitoring. The system should be designed and manufactured by a company with a certified (Lloyd's Register (or DNV) product that has a proven track record for use under the extreme conditions of the Polar marine environment and the tropics.

The system shall have analogue cameras with cabling to a matrix(ces) and a server.

Views shall be provided throughout the vessel both on open decks and internally in the machinery spaces. IMO Requirements with regard to Marine Security (ISPS) shall be incorporated. Cameras shall be able to view points of access (gangways) to the vessel when alongside the quay and motion recognition software shall be provided coupled to an alarm at control station and watchman locations.

Viewing monitors and camera controls shall be provided in the Wheelhouse (x2), the Engine Control Room, Watchman position (to be nominated), Main Laboratory (x2), and UIC Room.

Wheelhouse monitors shall be located in the head-up displays above the control positions. The Main Laboratory monitors should be within the display/operation consoles

A remote viewing monitor shall be provided in the Recreation Room and Coffee Area.

Monitors should be configurable to show split screen views (4 per screen) from a family (8 families) of pre-grouped selections. This is essential for the monitoring of winch and wire operations where different sections of the activity should be covered. For example it should be possible to view the scrolling & wire lay, top side diverter sheave and outboard deployment associated with a wire operation on a single monitor display.

Allowance shall be made for 60 cameras of which 16 have pan and tilt switchable controls and allowance shall be made for one spare of each type of camera.

Thermal cameras are applied to rooms with high risk, e.g. Category A Machinery spaces and other spaces with a high fire risk, such as aviation fuel pump room, helicopter fuel handling, helicopter hangar (which may house a helicopter with fuel in its tanks) and steering gear rooms boiler & incinerator room, hydraulic power pack room, garbage room., hot fuel and lub oil rooms or equipment areas and external decks

Reference should be made to Table of Camera Locations & Types below for a proposed outfit based on the Concept General Arrangement.

Table of Camera Locations & Types

No.	Type	Lens	Location And View
1	Fixed	Wide Angle (WA)	Deck 5 Port Life Boat Station Overlooking Muster Area
2	Fixed	WA	Deck 5 Deck Starboard Life Boat Station Overlooking Muster Area
3	P&T	Zoom	Deck 5 On Swinging Arm Port to Overlook CargoTernder, Rescue Boat Launching and Small Boat Access
4	P&T	Zoom	Deck 5 On Swinging Arm Starboard to Overlook Cargo Tender, Rescue Boat Launching and Small Boat Access
5	P&T	Zoom	Deck 5 Overlooking Starboard Side “A” Frame Top Viewing Wires, Sheaves.
6	Fixed	WA	Navigation Bridge Deck Viewing Heli Deck
7	P&T	IR	Wheelhouse Top Viewing Forward (Horizon)
8	P&T	WA	Deck 5 Port Viewing Aft
9	P&T	WA	Deck 5 Starboard Viewing Aft
10	P&T	Zoom	Inside Science Hangar Viewing Forward
11	P&T	Zoom	Top of UIC Room Viewing Aft Working Deck Operations
12	P&T	Zoom	Top of UIC Room Viewing Side Working Deck Operations
13	Fixed	WA	Deck 5 Top Overlooking Side Deck Viewing Starboard Side Working Deck
14	Fixed		At Top of Moonpool Looking Down on the Moonpool
15	P&T	Zoom	Deck 3 Port to View Gangway
16	Fixed		Deck 3 Starboard to View Gangway
17	Fixed		To View Spooling on the Winch Drums (Trawl)
18	Fixed		To View Spooling on the Winch Drums (Deep Tow)
19	Fixed		To View Spooling on the Winch Drums (Coring)
20	Fixed		To View Spooling on the Winch Drums (Deep Coring)
21	Fixed		To View Spooling on the Winch Drums (CTD 1)
22	Fixed		To View Spooling on the Winch Drums (CTD 2)
23	Fixed		To View Traction Winch (CTCU)
24	Fixed		To View Traction Winch (Trawl)
25	Fixed		To View Traction Winch (CTD)
26	Fixed		To View Wire Routes
27	Fixed		To View Wire Routes
28	Fixed		To View Wire Routes
29	Fixed		Spare
30	P& T	WA	Winch Room Overview
31	P& T	WA	Winch Room Overview

Table of Camera Locations & Types contd.

No.	Type	Lens	Location And View
32	P&T	WA	Cargo Hold Upper Overview
33	P&T	WA	Cargo Hold Upper Overview
34	P&T	WA	Scientific Hold Overview
35	P&T	WA(Intrinsic Safe)	AVTUR Pump Room
36	Fixed	WA	Aft Port Thruster Room Overview
37	Fixed	WA	Aft Starboard Thruster Room Overview
38	Fixed	WA	Forward Tunnel Thruster Room Overview
39	Fixed	WA	Forward Thruster Room Overview
40	Fixed	WA	AC Room Overview x 2
41	Fixed	WA	Domestic Systems and Clean Seawater Rooms Overview
42	Fixed	WA	Engineers Store and Workshop Overview
43	Fixed	WA	Purifier Room Overview
44	Fixed	WA	Port Side Upper Engine Room Over View
45	Fixed	WA	Starboard Side Upper Engine Room Overview
46	Fixed	WA	Engine Control Room Overview
47	Fixed	WA	Port Switchboard Room Overview
48	Fixed	WA	Starboard Transformer Room Overview
49	Fixed	WA	Switchboard Room Overview
50	Fixed	WA	Starboard Side Lower Engine Room Overview
51	Fixed	WA	Port Side Lower Engine Room Over View
52	Fixed	WA	Lower Auxiliary Machinery Room Overview
53	Portable		Mounted on Hanging Block to Provide a View of the Hanging Load
54	Portable		Portable Unit on Flying Lead Available to View Special Activities/Equipment (Fitted with Clamp)
55	Portable		Portable Unit on Flying Lead Available to View Special Activities/Equipment (Fitted with Clamp)
56	Portable		Portable Unit on Flying Lead Available to View Special Activities/Equipment (Fitted with Clamp)
57	Fixed		Portable Unit on Flying Lead Available to View Special Activities/Equipment (Fitted with Clamp)
58	Fixed	Underwater	Underwater Camera Mounted in the Moonpool Looking Downward
59	Fixed	WA	To View Spooling on the Clean CTD Winch
60	Fixed	WA	To View Storage Drum on Clean CTD Winch
61			One Spare of Each Type

Each external and machinery space camera station should include 316L stainless steel camera housings, internal cabling and integral telemetry receivers to eliminate external flying leads. Each camera station will also incorporate a junction box for easy multi-cable connection. An exception to this is a c amera within the moonpool described below.

Cameras within the accommodation may be suitable for the use with dome housings.

The system should be capable (and configured to) of providing real-time images for selected cameras to the ships network. The system should be interfaced to displays within the Integrated Bridge System.

The system should be integrated with the fire detection system utilising thermal imagery.

An underwater black and white camera (e.g. 4mm wide angle lens, resolution 420 lines, 0.3 Lux) with led lighting shall be incorporated within the leading edge, towards the base of the moonpool. The camera shall be integrated with the CCTV system and shall be used for viewing of retrieval of underwater deployed scientific equipment and evaluating any surge of aeration below the vessel.

A distribution point should be provided within the Hangar to feed 4 m obile cameras which shall be positioned by the NERC according to the operational requirement. The cameras shall be connected via plug and socket connections, the cameras should be provided with a clamping arrangement suitable for attaching to a handrail.

Two external points should be provided one at an aft pedestal and a s econd at the midship deployment position for the connection of a monitor in an external housing.

A recording system should be pr ovided in compliance with ISPS, the system should have recording capacity for 50 da ys for 8 c ameras (to be agr eed) utilising exchangeable hard disc drives (5) with a capacity of 10 days each.

The complete system must also be fully protected against shipboard EMC.

6.7.2 Networked Maritime Surveillance System

R6.331 The contractor shall supply and correctly install a high specification Electro Optical (EO) surveillance system for; operational situational awareness Navigational,/ Research, Logistics Operations etc as stated in SoR 6.7.2 and is not relevant to the cameras in the machinery spaces with the exception of the winch room(s)which are to be included in the Networked Maritime Surveillance System. including, ice navigation, search and rescue, mammal detection, monitoring helicopter operations, monitoring cargo tender/landing operations, working deck observation, port security, detection of oil spills, and general maritime surveillance.

The system supplied should be commercially available and be proven to operate reliably in Polar environments.

The sensor unit payload package should provide; search light and cameras with sensors for visible light and infrared stabilized in relation to the vessel's movement in six degrees of freedom, and provide pan, tilt and zoom capability to the payloads.

The Sensor unit is to provide long range performance. Using the IR Sensor another vessel is to be detected and recognisable at 10NM, and a person in the water is to be detectable at 1.5NM.

The system is to be provided with position and movement data from the ship's GPS, Gyro and MRU. This information is to provide data for the advanced stabilization of the sensor unit. Additionally data connections to the ship's ARPA radar and AIS will provide an unparalleled level of situational awareness with the ability to lock onto, and track, ARPA and AIS targets.

Images and video from the sensor unit are to be presented in a touch screen user interface, featuring a maritime chart. The geographic location of the centre of the cameras field of view is to be marked on the chart. This will provide geo referencing of the video and still images captured by the sensors. Geo referencing will allow for the video images to be projected as a layer onto the chart to show the actual position of the object being viewed

Significant capacity for recording images and video is to be provided in the system.

Recorded images will be tagged with time, date and geographic location of the vessel and geographic location object being recorded.

A touch screen user interface is to be installed in the Wheelhouse, at or near the main helm station. Additionally, a second slave user interface should be provided in the UIC and the main laboratory for use of the EO system for scientific purposes (e.g. Mammal detection).

Video and position data from ROV operated from the vessel are to be connected to the user interface. This will provide live images and position of ROV to the Wheelhouse to assist the bridge crew with vessel navigation during ROV operations.

A computer server and associated user interface are to be supplied for installation onshore at a location to be determined. The server will allow for images and videos, including those from ROV, both live and recorded, to be shared from the vessel to shore. The server will also enable the images and videos to be viewed from any web browser via a secure log in.

All suitable spare parts are to be included in the delivery to enable continuous operation of the EO Surveillance System during the vessels extended deployments.

6.8 COMMUNICATIONS

6.8.1 Internal Communications

R6.332 The vessel shall be equipped with a telephone system fitted in all spaces throughout and fitted with acoustic hoods or booths where necessary. The telephone system shall be interfaced with the external communication systems R6.336 using an E1 interface.

Full VOIP (Voice Over IP) to cabins and workspaces.

CISCO phone system shall be integrated into the ships LAN.

Components:
CISCO Routers, switches and Voip phones (gigabit network speeds or better shall be required for all network devices).

The vessel shall be equipped with a PA and Talkback system throughout all spaces. This may be utilised for general alarm systems. The open decks shall be liberally fitted with loudspeakers so that all areas are properly covered and talkback points provided at key positions, e.g. mooring and s cientific operational positions. The Scientific communications system (R7.25) may be integrated with this but should also be capable of independent operation. Secure conversations shall be possible on a one-to-one and conference basis.

6.8.2 Internal LAN

R6.333 Internal LAN equipment shall consist of:

- Gigabit routers to serve external communications
- Gigabit switches or better will be required for all decks

6.8.3 Business Computer Outfit

R6.334 The Contractor shall purchase and install networked computer equipment as follows:

Captain, Chief Officer, Chief Engineer, 2nd Engineer, 7 x Officers, 4 x Petty Officers,, Cadet, Medic, Safety Control Room, Purser's Office, 2 x Ship's Office, 1 x IT Workshop, 1x Science Electronic Room, 1 x Electronics Workshop, 1 x Electronics Workshop(Below Wheelhouse), 2 x Science Office, 3 x Research Room and 2 x Engine Control Room, Total 32

A "Business Desktop" PC with a specification equivalent or better than 1 x Core 2 Duo E6550 / 2.33 GHz - RAM 2 GB - HDD 1 x 160 GB - DVD - GMA 3100 Dynamic Video Memory Technology 4.0 - Gigabit Ethernet – MS Win XP Pro and PC Monitor: Flat panel display - TFT - 17" - 1280 x 1024 VGA. Pre-loaded with latest version of MS Office. Printer: Colour-printer/scanner.

In addition to the above the Ship's Office, Engine Control Room, Science Office, Research Room, Science Office and Purser's Office shall be supplied and fitted with high output A3 capable combination colour printers, photo copiers and scanners.
Totals 6

Two A0 plotters shall be installed with one in Data Suite and one in Research Room

Owner shall be consulted over equipment selection.

All items shall be securely fitted in an aesthetic manner.

6.8.4 External Communications

R6.338 The vessel shall be fitted with an integrated suite of satellite communications equipment. The system will include a stabilised V-Sat C band Terminal and an Inmarsat Fleet 77 Terminal.

The V-Sat C band Terminal will have the following characteristics:

- Latest generation systems have smaller (2.2m) dish and (2.7m) radome Exemplar: Orbit TRX-7
- The Radome should include an Air Conditioning Unit.
- An initial data transfer rate of 512kbps is required
- The data transfer rate shall be expandable to higher data rates (max. 1440kbps) with the hardware provided at outfit without further upgrade. [60 Watt RF maximum carrier probably required]
- Below deck equipment is to include interfaces for telephone and to the vessels data network (R7.25)
- The telephone interface arrangements with the ships internal telephone system shall be digital. 5 telephone / facsimile lines required via E1.
- Telephone connections shall be landed & broken out from a UK facility (Service Provider) to the local PSTN
- Data connections shall be landed at a UK facility (Service Provider) and connected to the British Antarctic Survey, Cambridge, UK via a VPN solution.
- To achieve the telephone and VPN connections above, any modem/router/firewall hardware required shall be purchased with the vessels equipment.
- A switching arrangement (integrator) with the Inmarsat Fleet77 Terminal shall be implemented to provide a backup in event of failure of the V-Sat C band for data transfer.
- Isolation Transformer and UPS

The Fleet77 Terminal will have the following characteristics:

- Be part of the vessels GMDSS requirement
- Be provided with a Facsimile Machine
- Be configured as a back-up to the V-Sat C band system for email and data transfer. The data transfer rate shall be 128kbps
- Be interfaced to the ship's internal telephone system

Since the above equipment will require a Service Provider and segment allocation through the life of the vessel NERC are to approve the solutions.

The Service Provider must be UK based with billing elsewhere.

6.9 SCIENTIFIC WINCH SYSTEM

6.9.1 Scientific Winch System

R6.337 The Contractor will be responsible for correctly purchasing, installing and testing the equipment. The choice of *Manufacturer* shall be approved by NERC as will be the final designs.

Winches and ropes / wires shall be installed as indicated in the following table and further detailed in subsequent sections.

The arrangement of winches and wires shall offer flexibility to deploy a wide range of scientific equipment through the scientific moonpool, over the starboard side or over the stern of the vessel. Additional portable equipment shall also be mobilised, including ROVs, piston corers, seabed drills etc. As far as practical ship's winches and handling systems shall be used, avoiding duplication of launch and recovery systems and making optimum use of the available space and deadweight.

Handling systems may be multi-functional. However science winch wires shall not be used for general handling of equipment around the deck. Separate and independent crane hoist wires shall be used for this purpose.

The scientific winch installation requires wire ropes, synthetic ropes and electro-optical cables. Detailed guidance is also provided on the winch systems required to handle them. In terms of general application these may be described as follows:

- General purpose - Steel Wire Rope
- Deep Tow - Steel Armoured Electro-optical Cable
- Deep Water Coring - Synthetic Rope
- Standard CTD - Steel Armoured Electro-mechanical Cable
- Biological Wire - Steel Armoured Electro-optical Cable
- Hydrographic Wire - Steel Wire Rope
- Metal Free CTD Wire - Kevlar (or equivalent) with copper core

In general scientific winches shall incorporate spooling systems appropriate to the type of wire being handled. Where traction winches are proposed they may be multi-functional, service two or more wires. However some redundancy shall be provided to avoid failure of any multi-functional winch preventing deployment of equipment over the side (or through the moonpool).

SUMMARY OF SCIENTIFIC WIRES & WINCHES									
	Wire description	**Purpose**	**Winch**	**Winch Type**	**Winch Location**	**Deployment**			
						Moonpool	**Starboard Side**		**Stern via "A" Frame**
							In line with Moonpool	**Starboard side aft of moonpool**	
	CTD wire 1 off x 10,000m x 11.4mm (0.45")	CTD	5t CTD winch	Traction	Main Winch Room	X	X		
	Kevlar 8,000m	CTD Metal Free	5t CTD winch	Direct Pull-winch (independent system)	Main Winch Room	X		X	
	General Purpose wire (12,000m x 18.0mm (9/16")	Trawling, towing, Coring & dredging	20t trawl/towing winch	Traction	Main Winch Room	X		X	X
	Synthetic rope (Dynema) 10,000 x 28mm (66.5t)	Towing/trawling Piston coring	30t trawl/towing winch?	Traction winch	Main Winch Room			X	X
	Electro-optical deep tow cable 10,000m of 17.3mm fibre optic A302351 trefoil cable	Vehicle / Net Vertical & Trawling	20t trawl/towing winch	Traction winch	Main Winch Room	X		X	X
	Hydrographic 5,000m x 6mm	Bongo Nets etc	1t winch	Drum Winch	Main Winch Room	X	X		-
	Hydrographic 5,000m x 6mm	Bongo Nets etc	1t winch	Drum Winch	Main Winch Room			X	X
	Biological 5,000m x 13.5mm conductive wire, or electro optical	Biological/Nets	5t winch	Lead from top of the Winch Room via diverter block(s)	Port Aft Winch Room				X
	200m for mooring deployments, stopper wire SS 12 -14mm	General purpose	2t Gilson winch	Drum Winch	Port Aft Winch Room				X
	200m for General Purpose	Multi-purpose portable winch ~ 1t SWL	Located & secured down matrix. Moveable using a pallet truck						

Notes:

- Main Winch Room located above/aft of the science hangar.
- Auxiliary Winch Room located on Main Deck, port aft.

Locations shall be nominated for their positioning along with the necessary diverter sheave system to the appropriate over-side handling equipment. Each wire and cable path shall be fitted with load dynamometer sheaves, line out encoders and outhauler units to feed the ropes, wires and cables and to maintain sufficient outboard tension on the winch system under all conditions.

In the case of the Metal Free CTD system all sheaves (including dynamometer) to each of the specified overboarding points shall be manufactured of a non-metallic material e.g. Nylatron or equivalent and shall be mounted such that they are not in close proximity to any sheaves carrying steel wires or cables. Hanging blocks (2 in total) fitted with non-metallic sheaves shall be provided at each overboarding point.

The ropes and cables nominated in the above table will be stored and winched by a permanent system shall be purchased and installed on the vessel by the Contractor.

Scientific Winch System Statement of Requirements

6.9.1.0 General Requirements

The complete system, including ropes and cables as specified, shall be purchased, installed and tested by the Contractor.

The winching system shall be installed in or on the vessel in a protected environment.

Wire and cable runs from the winches to the various over-boarding points shall be as direct as possible with the minimum of diverter sheave requirements. All diverter sheave diameters shall be at least 40 times the maximum rope or wire diameter being handled with significantly higher requirements for some systems.

A Winch Room shall be provided to accommodate the scientific winch system

A Winch Drive Room shall be provided to accommodate the electrical and electronic systems for the Scientific Winches. This room shall be air conditioned to meet the range of ambient conditions specified in section 4.6 of this SoR.

It shall be electrically driven and controlled using AC frequency converter drive systems.

The system shall be provided complete with all necessary diverter, jumping and overboarding sheaves, such that the respective ropes and cables can be led over the required over-side lifting equipment positions. Each wire and cable path shall be fitted with load dynamometer sheaves, line out encoders and outhauler units to feed the ropes, wires and cables and to maintain sufficient outboard tension on the winch system under all conditions.

Arrangements by which the operating length of each rope or cable can be thoroughly washed with fresh water, blown dry in an environmentally friendly manner.

The winches and available leads should be colour coded to assist with the correct rigging of science wires.

Sufficient power shall be available to permit the two of the science winches with the highest rated load to be operated simultaneously at that rated load.

6.9.1.1 System Specifications

1.1.1 Winches & Wire Leads

The following are requirements in common to the winches and wires identified above, except as indicated.

1.1.2 The ratio between the diameter of the winch drum, any sheave throughout the entire wire line to overboard and the wire diameter (D:d) shall be 40: 1 or better. For tapered wire, diameter 'd' shall be taken to be the maximum wire diameter.

1.1.3 The maximum line speed of the winch shall be 120m/min. In the case of a live winch this requirement shall apply at the mid layer.

1.1.4 The winch drum shall be fitted with grooved steel shells of original Lebus manufacture and accurately matched to the wire rope specification and level wind design.

1.1.5 Speed control shall be infinitely variable between zero and maximum speed throughout the wire length.

1.1.6 The facility for the operator to set an automatic render capability is required. This is to be capable of manual adjustment to enable rendering at any tension between 10% and 100% of maximum pull capacity.

1.1.7 Sheaves shall be self-aligning to accommodate the various combination of overboard deployment positions. Low maintenance bearing arrangements shall be provided.

1.1.8 Changes of wires and their deployment positions shall be specially considered to allow safe operation at sea.

6.9.1.2 Motors and Drives

1.2.1 All traction winches, live winches and storage drums shall be driven by AC motors. In order to ensure that space requirements and noise levels are minimised these motors should be of a liquid cooled design.

1.3,2 The winch motors should be driven by frequency converters connected to a common DC bus maintained by inverters. The system is to possess the ability to accept regenerated power produced by the winches under lowering / paying out conditions. The inverters provided to maintain the common DC bus must be tolerant of transient supply voltage drops caused by the connection of large loads elsewhere in the vessel.

6.9.1.3 Cooling Services

1.3.1 Winch motor cooling requirements shall be provided by suitable connections.

1.3,2 Hydraulic power unit cooling requirements shall be provided by suitable connections to the main engine room low temperature cooling circuit.

1.3,3 All gearboxes shall be fitted with oil cooling systems. Cooling of gearbox oil and any other auxiliary equipment shall utilise cooling circuits and heat exchangers local to the equipment. Heat exchangers shall be of the package plate design manufactured in a material appropriate for the marine environment. Primary coolant shall be derived from the main engine room low temperature cooling circuit.

6.9.1.4 Control Arrangements

1.4.1 All winch systems shall be capable of individual selection and operation from the same suite of winch controls.

1.4.2 All winch and over-side handling (Stern (A-Frame), Midships (A-Frame) & Midships Gantry system controls shall be integrated into and capable of individual selection and operation from each winch control unit.

1.4.3 It shall be possible to operate the CTD winch system and any one other winch system.

1.4.4 All winch systems carrying electro-optical or electro-mechanical cables shall be equipped to accept an external speed control signal to provide the option to control winches via signals from user equipment in the range +/- zero to maximum speed. The interface specifications for this connection shall be described in the operating manual.

1.4.5 Two permanently fixed winch system control desks shall be situated in the UIC Room. One desk is to face forward such that the operator has a view over the midship equipment deployment positions. The other desk is to face aft such that the operator has a view over the stern equipment deployment positions. A third, portable control unit shall be located within the Science Hangar with hardwired power and signal connections via an umbilical cable. A fourth portable control unit shall be available for installation within the ROV Laboratory Container; this must be capable of being hard wired to power and signal connections in a similar manner to the control unit in the Main Laboratory. Each of these control positions shall be equipped with a means of displaying all winch system status and condition parameters and operational data.

1.4.6 Winch control stations shall be provided with interlocks to ensure only one control position is active at any time. Selection of the active controller shall be made on the main console in the UIC Room.

1.4.7 The facility for the winch operator to programme any winch system to run to a predetermined depth at a predetermined line speed and to stop at that depth without further operator input is required.

1.4.8 No automated (hands off) winch system operation shall be possible above (shallower than) a pre-set minimum depth, nominally 200 metres.

1.4.9 An emergency winch system control facility shall be available within the winch room. This control system is to communicate directly with the frequency converter drives and shall be capable of functioning in the absence of any higher level control system. In addition to synchronised operation of traction winches and storage drums the traction winch and storage drum for each winch system shall be capable of independent operation from the emergency winch control system.

1.4.10 Where active heave compensation is specified it shall allow operation in the following modes:

- Constant depth
- Constant tension
- Constant speed.

1.4.11 Remote access shall be available to the winch system supplier to enable fault diagnosis and remote support.

6.9.1.5 Winch Drum Design

1.5.1 Design of the wire/rope/cable storage drums for all winch systems described shall give careful consideration to the aspect ratio of each drum. The guiding principle to be applied shall seek to minimise the number of layers required to store the whole length of wire/rope/cable on the drum commensurate with the restrictions imposed by the overall space envelope.

1.5.2 For guidance, the design objective shall be to constrain the required number of layers to 13 or less on each storage drum. The purpose of this requirement is to maximise spooling reliability, which becomes increasingly problematic as the number of layers spooled increases.

6.9.1.6 System Flexibility and Redundancy

1.6.1 In consequence of the remote geographical locations in which research vessels may be required to operate spare parts can be difficult to obtain in the event of breakdown. Therefore, to the maximum extent possible an important consideration in the design of the winch suite shall be commonality of frame sizes in major components such as motors, gearboxes and drive units.

1.6.2 An essential requirement in the design of the scientific winch suite is expediency in use. It is often necessary to change from one wire rope or cable to another several times over a short period. To facilitate this, all wire ropes and cables shall be capable of being retained available at the vessel hangar top such that they can be left rove through their respective winch systems while not in service.

1.6.3 Change in the specification of oceanographic wire ropes and cables is a probability during the lifetime of the vessel. Therefore the winch level wind systems shall be capable of adjustment to accommodate wires or cables of different diameters. Level wind sheaves shall be designed such that they are capable of accurately following the lead of the wire rope or cable onto the winch storage drum at all times.

The spooling gear should guide the cable to its correct position, i.e. "put the cable". The spooling gear should be active in ensuring the cable goes in its correct position.

1.6.4 The winch system shall be designed to accept an electrical power supply connection from either port or starboard Main Switchboard. This shall provide means of recovering over-side equipment using the emergency winch control system under circumstances in which the vessel's main power supplies are unavailable.

6.9.1.7 Outhaulers

1.7.1 Outhaulers shall be required to provide operators with assistance in pulling wire ropes and cables through the system and to ensure that the outboard tension necessary to maintain cables etc. correctly in traction winches and other sheaves under conditions of low or zero load is always available.

1.7.2 A separate outhauler unit shall be provided for each winch system such that the requirements for flexibility previously noted can be met.

1.7.3 Outhauler design is to make use of the wheel pair principle commonly used in cable haulers. The wheels shall be fitted with solid or pneumatic tyres manufactured for the purpose and of a pattern which allows the 'nip' to be adjusted through changes in inflation pressure. Wheel pairs shall be capable of being opened or closed and started by the operator as required as solid tyres cannot have inflation pressure altered. . The pinching force on the wire or cable in the closed position shall be adjustable. The pulling force applied to the wire or cable by the outhaulers shall be adjustable. The design shall ensure that outhauler wheels do not slip relative to the wire or cable under conditions of either haul or veer.

1.7.4 The outhauler control system shall apply a force to hold wheel pairs positively open while the system to which they relate is active but the haulers are not engaged. Indications of outhauler status, i.e. open/closed/running; shall be provided at each control position.

1.7.5 The outhauler installation must recognise that this component of the winch suite will be adjacent to accommodation areas. Therefore the design is to consider and control noise levels.

6.9.1.8 Measurement

1.8.1 Calibrated line out encoders and tension dynamometers shall be installed in each separate winch system. It should be noted that experience has shown that line out measurement systems utilising a pair of pinch wheels in contact with the wire or cable have proved to be unsuitable for use with some of the wire ropes specified here, in particular, those with a triangular form. Therefore in these instances alternative methods of measurement should be considered.

1.8.2 Other than an indication of the outboard tension being applied by the outhaulers when they are engaged the tension dynamometer readings are to remain unaffected by the adjustment of any component of the winch system. Tension data accuracy must not be vulnerable to changes in sheave wrap angles which may affect elements of the system.

6.9.1.9 Hydraulic Power Unit

1.9.1.1 It is anticipated that a hydraulic power unit will be required to serve certain components of the winch system e.g. spooling devices. Any such power unit shall be sited within the winch room and shall be suitably isolated from the surrounding structure be means of isolation mounts, installed in an acoustic hood, and flexible pipe connections, such that noise transmission is minimised.

1.9.2 Any hydraulic power unit shall be equipped with two separate motor and pump units and shall be capable of supporting the connected hydraulic loads using one motor and pump unit only.

6.9.1.10 Wire Rope and Cable Preservation

1.10.1 To extend the operational life of the wire ropes and cables, equipment to wash them in an environmentally friendly manner,

1.10.2 A means of washing wires and cables with (technical) fresh water as they are being recovered on board the vessel is required. The washing system should use pressurised fresh water to clear sea water, dried salt and other deposits from the cable surface and interstices. The system shall be economical in the use of fresh water. Arrangements shall be provided to convey used washing water to an appropriate means of disposal such that the deck area local to the equipment is kept clean. Compressed air from the working air system shall be used for drying.

6.9.1.11 Monitoring

1.11.1 The operating conditions (temperatures, pressures, flows etc.) of all significant drive train components of the winch systems shall be monitored and the information made available at each winch control console. Appropriate warning and alarm thresholds shall be capable of being set in the system and, where appropriate, adjusted in the light of operating experience.

1.11.2 The system shall maintain a chronological log of all alarm and fault conditions experienced. This log shall be stored such that it is preserved in the event of a total loss of power to the system. The system shall be equipped with a means of producing fault log records in hard copy.

6.9.1.12 Human Machine Interface

1.12.1 The winch systems shall provide an intuitive primary operator interface which recognises that winch operators will not normally possess an engineering background. This interface shall include all functions and information necessary for effective and safe operation of the systems including system status, alarm or fault conditions and wire and cable measurement information.

1.12.2 Beneath the primary operator interface the system shall provide access to all system condition data both downloadable and programmable via a laptop.. This shall include, but not be limited to; control settings for each element of the system, all system alarm and fault settings, alarm and fault history, communication link status, real time rolling display plots for wire and cable tension, rate and line out data and other significant system variables.

6.9.1.13 Cables and Pipes

1.13.1 All electrical cables and system pipework shall be run along the winch room deckhead or bulkheads in preference to the deck.

1.13.2 Cables carrying data/signals and fibre optic waveguides shall be run in suitable conduit. Access points shall be provided at all changes of direction.

1.13.3 All winch systems carrying conducting or optical cables shall be provided with terminal boxes rotating with the drum into which the sea cable may be connected to the winch slip rings.

6.9.1.14 Water Clearance

1.14.1 Significant quantities of sea water will be carried into the winch room on incoming wire ropes and cables. An arrangement to collect and dispose of this sea water at the point of entry into the winch room (bottom of the spurling trunk) shall be provided which conveys the water by pipe to the nearest bilge well.

1.14.2 A drip tray arrangement is required below each storage drum to collect and dispose of sea water draining from the drums via piping to bilge wells.

1.14.3 The winch room shall be provided with bilge wells, one located at each corner of the compartment and connected to the bilge main or scuppers, depending on location.

6,9.1,15 Safety

1.15.1 All winches and drive systems shall be fitted with emergency stops. These shall be distributed around the vessel in appropriate locations. It is anticipated that there will be approximately eleven locations requiring emergency stops. Operating any emergency stop shall shut down all winches and the winch hydraulic power unit.

1.15.2 Radio remote controllers shall be fitted with fast system ramp-down stops.

1.15.3 Suitable guard rails and access gates shall be provided within the winch room and on the hangar top to protect personnel from contact with moving machinery and wires/cables. Signs warning of the danger shall be provided and fixed at points of access. Cage guards shall be mounted such that they may be removed easily and quickly.

1.15.4 Where necessary, accidental contact with components of the winch system shall be prevented by the provision of cages around the equipment. In these instances the cages shall either be constructed in lightweight solid sheet equipped with viewing windows or from frames covered in mesh. In this instance the pitch of the mesh shall be small enough to prevent fingers from entering the openings. Cage guards shall be mounted such that they may be removed easily and quickly.

1.15.5 Raised lightweight deck gratings shall be installed throughout the winch room.

6.9.1.16 CCTV

1.16.1 CCTV camera coverage is required for the winch room and wire/cable runs. See Section 6.7

6,9,1.17 Outputs

1.17.1 Data outputs of winch system measuring information shall be required for connection to the vessel operator's equipment. Data output should include, but not necessarily be limited to, line out, tension, rate, winch selected.

1.17.2 Messages shall be required in two forms, an Ethernet UDP packet and an RS422 ASCII serial string.

6.9.2 Special Features for Wires / Ropes

R6.338 The following details shall be used in the sourcing of the correct wires and cables for the scientific winch system. The Contractor shall be responsible for ensuring compatibility between the wires / ropes, the winches from which they are deployed and the overboarding equipment.

Note:

Where Certex has been stated as a Supplier the alternative Suppliers are:
Bridon Ropes of Doncaster UK
or
Ormiston Wire of 1 Fleming Way, Worton Road, Isleworth, Middlesex TW7 6EU, UK

6.9.2.1 CTD Fibre Optic cable

2.1.1 System Application

This cable is for CTD operations. Requires electrical power supplies and electrical and/or optical fibre data telemetry.

2.1.2 Cable Specifications

Example: Manufacturer: The Rochester Corporation
2nd Floor, Taylor Building
62-64, Bromham Road
Bedford. MK40 2QG

Type Number:	A305625
MBL:	84.5kN or 8.61Te
Diameter:	0.45" or 11.43 mm
Length:	10,000 metres
Weight in Air:	494kg.km^{-1}
Weight in Water:	406kg.km^{-1}

2.1.3 Winch Requirements

1.3.1 It is essential that the CTD cable is stored under low tension. A traction winch, complete with storage drum, level wind and damper is required.

1.3.2 The storage drum shall be fitted with a Focal slip ring assembly. This slip ring shall contain three FORJ (Fibre Optic Rotating Joint) for a single mode fibre optimised at 1310/1550nm and two electrical passes each rated at 3kV, 10A or better. Note that cable containing a single mode fibre is not being specified at this stage but the facility to install such a cable in future is required.

1.3.3 Active heave compensation is required for the winch system. This heave compensation is required to function by applying changes to the speed of the traction winch and storage drum combination in response to an absolute position reference signal derived from a motion reference unit. Allowance should therefore be made for winch maximum line speeds in excess of that specified above. Compensation is to meet minimum criteria for a 6 metre swell over an 8 second period.

6.9.2.2 CTD metal free Kevlar cable

2.2.1 System Application

2.1.1 The Requirements for the Metal Free CTD system include a single synthetic electro-mechanical cable.

2.1.2 To avoid the risk of contamination the metal free winch, sheaves and all mechanical points of contact between the wire and steel or iron based material shall be dedicated to this system. Additional protection or segregation shall be applied where there is assessed (by the Owner) to be a risk of contamination from other metallic systems or structure.

It is to be electrically driven and controlled using AC frequency converter drive systems.

The system is to be provided complete with all necessary diverter, jumping and overboarding sheaves to enable the cable to be led over the specified over-side lifting equipment positions.

All sheaves to each of the specified overboarding points are to be manufactured of a non-metallic material e.g. Nylatron or equivalent and are to be mounted such that they are not in close proximity to any sheaves carrying steel wires or cables. Hanging blocks (2 in total) fitted with non-metallic sheaves are to be provided at each overboarding point. The cable path is to be fitted with a load dynamometer and a line out encoder.

2.2.2 Cable Specifications

Example: Manufacturer:	The Cortland Companies 44 River Street PO Box 330 Cortland NY 13045-0330 USA
Type Number:	a) EV710272
Construction:	a) Polyester or a) Vectran or
MBL:	a) 73.6kN

Diameter:	a) 14.00mm
Length:	8,000 metres
Weight in Air:	a) 200kg.km-1
Weight in Water:	a) 43kg.km-1
Operating Temperature:	-40C to +80C

2.2.3 Winch Requirements

2.3.1 A live (direct pull) winch incorporating a conventional (normal to drum) level wind is required for this application. The system must be arranged such that when in use the cable is centrally aligned normal to the winch drum. The maximum permitted cable fleeting angle into the level wind under any condition is 3 degrees.

2.3.2 Design of the winch drum shall give careful consideration to the drum aspect ratio. The guiding principle to be applied shall seek to minimise the number of layers required to store the whole length of cable on the drum, commensurate with the restrictions imposed by the overall space envelope of the portable unit enclosure. For guidance, the design objective shall be to constrain the required number of layers to 13 or less. The purpose of this requirement is to maximise spooling reliability, which becomes increasingly problematic as the number of layers spooled increases and is known to be particularly difficult in the case of jacketed synthetic cables due to their dimensional instability.

2.3.3 Synthetic cables are delicate and particular care is required in their handling. The system design is required to consider extension of the cable due to its high elastic modulus and should recognise and accommodate the low critical temperatures associated with certain jacket and s trength member polymers together with the “softness” of these materials. Any design which applies reverse bending to the cable will not be accepted.

2.3.4 In evolving and optimising the winch it is essential that the designer works in close co-operation with the synthetic cable manufacturer.

2.3.5 The winch drum shall be fitted with a Focal slip ring assembly. This slip ring shall contain four electrical passes each rated at 3kV, 10A or better. T he winch drum shall be provided with a terminal box rotating with the drum within which the sea cable may be connected to the winch slip rings.

2.3.7 Active heave compensation is required for the Metal Free CTD winch system. This heave compensation is required to function by applying changes to the speed of the winch drum in response to an absolute position reference signal derived from a motion reference unit. Allowance should therefore be made for winch maximum line speeds in excess of that specified above. Compensation is to meet minimum criteria for a 6 metre swell over an 8 second period.

2.3.8 The Metal-free CTD Winch shall be located within a dedicated room to ensure cleanliness can be maintained.

6.9.2.3 General purpose wire

2.3.1 System Application

Common applications for this cable include but are not limited to support any towing and or trawling operations, it requires no electrical power supplies and electrical and/or optical fibre data telemetry.

2.3.2 Cable Specifications

Example: Manufacturer: Certex (UK) Ltd
Unit 4 Millbrook Trading Estate
Third Avenue, Millbrook
Southampton. SO15 0LD

Construction:	Galvanised steel 3x25 RHO
Tensile Strength:	1960N/mm^2
Minimum Breaking Load:	18.56 Te
Diameter:	16.5 mm
Length:	12,000 metres
Weight in Air:	897kg.km^{-1}
Weight in Water:	780kg.km^{-1}

2.3.3 Winch Requirements

The general purpose wire rope specified here is triangular in form. Experience has shown that when used with a right angled level wind on a live (direct pull) winch the wire accumulates stored rotations over a relatively short period of use. This leads to a rapid degradation of spooling quality to the point when it becomes unusable. To overcome this two alternative approaches are proposed as follows:

a.) A live (direct pull) winch incorporating a conventional (normal to drum) level wind. In this case the wire must be centrally aligned to the drum and the maximum permitted wire fleeting angle into the level wind under any condition will be 3 degrees.

b.) A traction winch system complete with damper, level wind and storage drum. In this case a right angle level wind may be employed.

6.9.2.4 Synthetic rope

2.4.1 System Application

Common applications for this cable include but are not limited to support any coring operations. Requires no electrical power supplies and electrical and/or optical fibre data telemetry.

2.4.2 Cable Specifications

Example: Manufacturer: The Cortland Companies
44 River Street
PO Box 330
Cortland
NY 13045-0330, USA

Type:	Plasma
MBL:	66.5 Te
Diameter:	1.125" or ~28.0mm
Length:	8,000 metres(continuous)
Weight in Air:	475kg.km^{-1}
Weight in Water:	Buoyant, SG = 0.98
Critical Temp:	65^{o}C
Melting Point:	140^{o}C

2.4.3 Winch Requirements

4.3.1 A traction winch, complete with storage drum, level wind and damper, is required. Particular care is required in the handling of this rope. The traction winch unit is required to consider extension of the rope due to its high elastic modulus, as tension is applied. Proposals must explain how this extension is accommodated by the design. Heating of the rope as it passes through the traction unit must also be quantified and addressed appropriately, noting in particular the critical temperature specified above. It is expected that the traction winch design will incorporate multiple independently driven sheaves and that these will be speed/torque matched such that the increase in rope

length through the winch is accommodated by slightly differing speeds between sheaves. Any design which applies reverse bending to the rope will not be accepted. Under no circumstances is any slip or relative motion between the rope and the traction sheaves acceptable and assurance that the winch design provides for this will be required.

4.3.2 In evolving and optimising this winch it is essential that the designer works in close co-operation with the synthetic rope manufacturer.

4.3.3 The coring winch storage drum is not required to be fitted with grooved steel Lebus shells. The dimensional instability of this class of rope makes this approach superfluous. However it should be noted here that great care is required in packing the rope to create an ac curate bottom layer on the storage drum in order to form a bed upon which subsequent layers may be reliably spooled.

4.3.4 This cable should be normalised to at least the manufacturer's recommendations before testing to full capacity to ensure that the wire is being driven correctly throughout its structure.

6.9.2.5 Electrical Optical deep tow cable

2.5.1 System Application

Common applications for this cable include but are not limited to; use as a ROV umbilical, operation of powered bottom sampling tools and deep towing of near bottom instruments. It requires electrical power supplies and electrical and/or optical fibre data telemetry.

2.5.2 Cable Specifications

Example: Manufacturer: The Rochester Corporation
2nd Floor, Taylor Building
62-64, Bromham Road, Bedford. MK40 2QG

Type Number:	A302351
MBL:	205kN or 20.90Te
Diameter:	0.681" or ~17.3 mm
Length:	10,000 metres
Weight in Air:	1112kg.km^{-1}
Weight in Water:	905kg.km^{-1}
Operating Temperature:	-30C to +80C

2.5.3 Winch Requirements

5.3.1 It is essential that the cable is stored under low tension. A traction winch, complete with storage drum, level wind and damper, is required.

5.3.2 The storage drum shall be fitted with a Focal slip ring assembly. This slip ring shall contain a three pass FORJ (Fibre Optic Rotating Joint) for single mode fibres (9/125µm) optimised at 1310/1550nm (suitable for 1510, 1530, 1550, 1570 nm) and t hree electrical passes each rated at 3kV, 20A or better.

5.3.3 For some deep t ow system applications significant amounts of power are transmitted through the cable. For an application working at a depth of 2000 metres some 8000 metres of cable will remain coiled on the storage drum, leading to inductive heating of the cable. Cooling arrangements are to be provided to ensure that the temperature of this coiled cable is maintained within the tolerance specified by the cable manufacturer.

5.3.4 The ratio between the diameter of the winch drum, any sheave throughout the entire wire line to overboard and the wire diameter (D:d) shall be 70:1

5.3.5 Active heave compensation is required for the winch system. This heave compensation is required to function by applying changes to the speed of the traction winch and storage drum combination in response to an absolute position reference signal derived from a motion reference unit. Allowance should therefore be made for winch maximum line speeds in excess of that specified above. Compensation is to meet minimum criteria for a 6 metre swell over an 8 second period.

6.9.2.6 Hydrographical wire

2.6.1 System Application

Common applications for this cable include but are not limited to support small Hydrographical and Biological sampling operations. It requires no electrical power supplies and electrical and/or optical fibre data telemetry.

2.6.2 Cable Specifications

Example: Manufacturer: Certex (UK) Ltd
Unit 4 Millbrook Trading Estate
Third Avenue, Millbrook
Southampton. SO15 0LD

5000 m of 6mm wire, 1t SWL

Additional Information:

a) This is to be a Rotation Resistant Rope 3 x 19 strand

b) The lay of the rope can be either left or right hand

c) The rope will be towing/pulling and lifting.

d) The rope will be Galvanised Steel

e) This is to be continuous length

f) A thimble eye at one end is required with best practice.

2.6.3 Winch Requirements

A direct pull winch, complete with storage drum, level wind and damper, is required.

6.9.2.7 Biological wire

2.7.1 System Application

Common applications for this cable include but are not limited to support any Biological sampling operations. Requires electrical power supplies and electrical and/or optical fibre data telemetry.

2.7.2 Cable Specifications

Example: Manufacturer: The Rochester Corporation
2nd Floor, Taylor Building
62-64, Bromham Road
Bedford. MK40 2QG

Biological Wire (optical/electrical/mechanical) Specification as follows:

- 5000m length,
- 5t SWL
- 3 optical fibres (single mode fibres)
- 3 copper cores (18 AWG)
- Operating temperature: -30°C to +80°C

2.7.3 Winch Requirements

7.3.1 A direct pull winch, complete with storage drum, level wind and damper, is required.

7.3.2 The storage drum shall be fitted with a Focal slip ring assembly. This slip ring shall contain a three pass FORJ (Fibre Optic Rotating Joint) for single mode fibres (9/125µm) optimised at 1310/1550nm (suitable for 1510, 1530, 1550, 1570 nm) and t hree electrical passes each rated at 3kV, 20A or better.

6.9.2.8 Scientific Mooring support wire

2.8.1 System Application

Common applications for this cable include but are not limited to support any scientific mooring operations. No need for electrical power supplies and electrical and/or optical fibre data telemetry.

2.8.2 Cable Specifications

Example: Manufacturer: Certex (UK) Ltd
Unit 4 Millbrook Trading Estate
Third Avenue, Millbrook
Southampton. SO15 0LD

200 m of 12-14mm Stainless Steel wire, 2t SWL

Additional Information:

a) Rope construction shall be 6 stranded and Rotation Resistant.

b) The rope will be towing/pulling and lifting.

c) A thimble eye at one end is required with best practice.

2.8.3 Winch Requirements

A direct pull winch, complete with storage drum, level wind and damper, is required.

6.9.2.9 General purpose wire

2.9.1 System Application

Common applications for this cable include but are not limited to support coring and or fishing operations. No need for electrical power supplies and electrical and/or optical fibre data telemetry.

2.9.2 Cable Specifications

Example: Manufacturer: Certex (UK) Ltd
Unit 4 Millbrook Trading Estate
Third Avenue, Millbrook
Southampton. SO15 0LD

200m of Stainless Steel cable, 1t SWL

Additional: Information:

a) Rope construction shall be 3 x 25 RHD and Rotation Resistant

b) The lay of the rope can be either left or right hand

c) The rope will be towing/pulling and lifting.

d) A thimble eye at one end is required with best practice.

2.9.3 Winch Requirements

General purpose, stand-alone direct pull winch with level wind, electrical driven. The winch has to be bolted down into the deck matrix anywhere on the main deck. The winch has be moveable with a pallet truck.

6.9.3 Winch Room

R6.339 The Contractor shall make allowances for the installation of supporting structures, systems and other arrangements for the procured winch system such as but not necessarily limited to the following:

Steel stools and support structures.

Access gratings mounted on angle bar supports around the equipment.

Lighting to provide an overall illumination of 300 Lux at 1m above the deck.

Adequate lifting lugs and eyes to assist the maintenance of the winches and auxiliary hardware. These items shall be certified and included in any plans or registers developed for the vessel. (Allow for 35).

All necessary cabling, conduit, terminal boxes and connections.

All necessary piping and connections.

All necessary system cooling services. (NOTE: All winch gear boxes shall be fitted with an oil circulation system and an adequately sized water cooling system).

Arrangements to collect and dispose of water shed from wires and cables as they enter the winch compartment and from under each winch storage drum. . The space itself should have strategically placed bilge wells draining down into the ship's bilge system.

Guardrails, safety enclosures and access gates to protect personnel from the equipment.

Emergency alarm displays/sounders and local telephone points.

Thermal and acoustic insulation at the boundaries of the space commensurate with meeting the temperature rise requirements noted above and the control of noise and vibration levels to specified maxima (see section 5.1.29 within adjacent accommodation spaces under all operating conditions.

6.9.4 Winch Drive Room

R6.340 Preparation of space and fitment of the winch drive suites. This space will be subjected to heat from the cabinets. Therefore it shall be fitted with ventilation/air conditioning distributed uniformly throughout the space and sufficient to maintain a temperature of no more than 40ºC under the most onerous (high) external ambient air and water conditions.

Thermal and acoustic insulation at the boundaries of the space commensurate with meeting the temperature rise requirements noted above and the control of noise and vibration levels to specified maxima (see Section 5.1.29) within adjacent accommodation spaces under all operating conditions.

6.9.5 General

R6.341 Along the wire leads to the over-side handling equipment positions various out-hauler units, dynamometer sheaves, diverter sheaves and wire cleaning system will be required, mounted on steel plinths.

Multiple fibre optic cables will be required from the winch room to the Science Hangar and in support of the Isis ROV. These should be continuous lengths of fibre with no intermediate joins.

6.9.6 Emergency Stops (E-stop)

R6.342 Example locations:
Winch Room – E-stop next to the emergency control station, (the one which must control the drives directly) if these are distributed then put an E-stop next to each of them.

UIC Room – E-stop on aft facing panel. E-stop on forward facing panel. (Two in total).

Science Hangar controller – E-stop mounted on control panel. Note, because this is a wandering controller and could therefore easily be knocked and operated by accident it would be sensible to make it a fast ramp-down stop or a true E-stop with a protective cover – to be hinged open to operate the stop.

Portable controller – As for UIC controller above.

Stern “A” Frame – One under each leg, mounted on the pedestals with a cage around to protect from swinging loads/people. (2 in total).

Midships “A” Frame – One adjacent to manual hydraulic control station.

Midships Gantry – One adjacent to manual hydraulic control station.

Operating **any** Emergency Stop must stop **all** scientific winches and the winch hydraulic power unit.

6.9.7 Factory Acceptance Testing (FAT)

R6.343 A comprehensive FAT shall be carried out on the winch system in accordance with the following framework:

Preliminary Checks:

- Verify design coefficients.
- Review design approvals in place and verify that any emergent actions are complete.
- Verify construction materials certification in place and correct.
- Verify welder qualifications current and relevant.
- Examine NDT reports for structural welded connections.
- Review corrective action history of any NDT failures.

- Verify high voltage electrical continuity and integrity of high voltage electrical insulation - pole to earth and pole to pole.
- Confirm all wiring executed and identified in accordance with good practice.
- Verify continuity and integrity of low voltage circuits.
- Confirm all wiring executed and identified in accordance with good practice.
- Verify insulation resistance of all electric motors.
- Verify all electrical IP, voltage, current, frequency and power ratings are as specified.
- Confirm hydraulic circuit component rating.
- Examine hydraulic circuits under pressure test.
- Confirm cooling circuit component rating.
- Examine cooling circuit under pressure test.
- Confirm component Type Numbers and Serial Numbers in accordance with drawings/listings.
- Confirm principal and overall dimensions in accordance with drawings/specification.
- Verify finish in accordance with paint specification and review coating report.
- Review calibration documentation/certification for all test equipment to be employed.
- Verify correct function of all controls.

6.9.8 Test Rig Set-Up

R6.344 Each winch with its level wind, damper and storage reel or reels, shall be set up on the shop floor in a configuration representative of the finally installed arrangements.

For each winch the relevant winch converter/inverter drives shall be set up along with their associated control circuits. Each discrete system shall be tuned and all controls, alarms, etc. proven both by simulation and by driving the hardware under no load conditions.

A length (~300m) of relevant test rope or cable shall be spooled onto each storage reel under typical conditions of back tension. The lay and back tension on the receiving storage reel shall be adjusted as necessary.

6.9.9 Static Testing

R6.345 A static load test shall be applied to the winch and its attendant elements. This is to test the structural integrity of the system at 1.5 times the designed safe working load, (SWL).

A static brake test shall be carried out at 1.5 times the SWL and maximum drum radius.

6.9.10 Dynamic Testing

R6.346 Carry out 1.1 x SWL pull test in a stalled condition.

Verify line pull to specification.

Record hydraulic/electric drive parameters.

A dynamic load test shall be arranged which will allow cycling of the winch, damper and storage reel under varying conditions of load from zero to SWL in both veer and haul conditions at varying speeds between the slowest and highest rates as designed.

Carry out full speed pull test at 1.1 x SWL. Verify line pull and speed are to specification. Record hydraulic/electric drive parameters. Confirm speed control available to specification.

Verify level wind transit rate and turning point accuracy. Confirm level wind function and accuracy of spooling into grooved drum shells and throughout the layering process. For this test it is required that the full length of rope, wire rope or cable specified for the system on test is spooled onto the winch assembly. Throughout this test temperature rises in motors, gearboxes, bearings and drive units etc. shall be monitored and recorded.

Verify veer (pay out) regenerative braking function at 1.1 x SWL and maximum specified cable speed. Record electric drive parameters. Verify range and efficacy of render function. Confirm speed control available to specification.

Verify brake function using a test rope. Use emergency stop to apply brakes with load at SWL and speed at maximum veer to confirm function under these conditions.

Confirm system under test in compliance with noise level specifications under all test conditions.

Within the scope of the dynamic testing a demonstration of control system functions will be required, such as, but not necessarily limited to the following:

- Emergency stop operation.
- Fast ramp-down operation.
- Radio control panel functionality and interlocking.
- Fixed control panel functionality and interlocking.
- Manual, auto, crane, programmed depth and rendering operation.
- Local/emergency operation and interlocking.
- Speed control and resolution.
- Lubrication and cooling system function.
- System error and fault handling.
- System alarm function and intervention.
- Line out measurement resolution.
- Human/Machine interface functionality.

On completion of tests, examine loaded system structures for any evidence of damage or deformation. Examine any hydraulic circuit filters for presence of debris. Examine electrical power components for evidence of excessive heating.

This procedure shall be repeated for each distinct combination of winches, dampers, storage reels and outhaulers etc. Test ropes and cables may be used for all tests with the exception of the spooling test. In this case the full length of rope, wire rope or cable intended for final installation shall be used.

All the various parameters shall be measured and recorded accurately and a report prepared for presentation to the NERC representative.

The winches will only be released for installation in the vessel when the FAT has been completed to the satisfaction of the attendant NERC representative(s).

6.9.11 Harbour Acceptance Testing (HAT)

R6.347 The HAT will test the structural integrity of the winch equipment interface with the ship structure and the correct installation of the necessary electrical cabling and other services. HAT will repeat the testing done during FAT as far as this is practical with the objectives of facilitating the commissioning process and verifying that the system status at the conclusion of FAT has been successfully transferred to the installed equipment. In addition to this the following specific tests are required:

- Functional tests of all winch suite alarm interfaces with the vessel's main alarm system.
- Functional tests of any winch system data input or output requirements to/from other vessel systems.
- A static load test of 1.25 times the designed full load shall be applied to each winch system through all the diverter sheaves and over each relevant over-side handling system using a suitable test wire or rope. This will verify the structural integrity of each component of the installed system, confirm the accuracy of the cable routing to overboard and provide a calibration check on the system load dynamometers.
- Dynamic load tests shall be carried out which will allow cycling of each of the winches and the relevant dampers, storage reels and outhaulers etc. The scope for this will be limited by the allowable travel from the overboarding sheave to the seabed or barge at the fitting out basin. This is to confirm the settings defined during the FAT.

Upon completion of commissioning and the testing programme described above the ropes, wires and cables specified shall be spooled onto each winch system as appropriate. All spooling is to take place in the presence of the attendant NERC representative(s). Throughout spooling operations temperature rises in motors, gearboxes, bearings and drive units etc. shall be monitored.

A record of these temperatures together with all other system parameters and settings shall be kept and a report prepared for presentation to the NERC representative.
The winches will only be released for Sea Trials when the HAT has been completed to the satisfaction of the attendant NERC representative(s).

6.9.12 Sea Acceptance Testing (SAT) & Deep Sea Acceptance Testing (D-SAT)

R6.348 Initial sea trials may be carried out in shallow water. However, the scientific winch suite will not be accepted until a full Deep Water Trials programme has been completed to the satisfaction of the attending NERC representative(s). For the purposes of these trials deep water means 5,000 metres depth or greater. This is an essential requirement for the validation of system performance under representative operating conditions. It is anticipated that 10 days of ship time will be required to complete Deep Water Trials on the scientific winch outfit based on operating from a port in close proximity to the 5,000 metre depth contour. As these trials represent the final stage of commissioning and acceptance, allowance should be made for the *Manufacturer*s commissioning engineers to be in attendance throughout. During the these trials, tests will include but not necessarily be limited to the following:

- Dynamic performance under sustained operation. At least one deployment to full ocean depth or to the bottom layer on the storage drum for each of the wire/cable routes specified for the system under test. During these deployments the attached payloads will be representative of operational expectations and the winches will be run at line speeds up to maximum for prolonged periods. Measurements of temperature rises and acoustic performance throughout the system shall be made and records maintained.

- Spooling consistency and accuracy.

- Depth/line out accuracy.

- Emergency operation of the system under simulated control system failure.

On completion of the trials programme, samples of the lubricating and hydraulic oils used within the winch systems shall be tested.

These trials provide an opportunity to carry out final commissioning adjustments and take measurements under operationally representative conditions. Accordingly, all parameters and settings shall be measured and recorded and a report prepared for presentation to the NERC representative.

The winches will only be finally accepted by NERC when Deep Water Trials have been completed to the satisfaction of the attendant NERC representative(s).

6.10 OVER-SIDE HANDLING EQUIPMENT

6.10.1 Over the Side Operating Requirements

R6.349 The Contractor shall be responsible for correctly purchasing and installing and testing the equipment. The choice of *Manufacturer* shall be approved by NERC as shall be the final designs.

Over the side capability shall include the following permanently or temporarily installed capability. The handling equipment shall be designed for operation in up to and including Sea State 5

Permanent installation:

- Science equipment handling cranes, for operation at sea.
- CTD handing system.
- Multi-purpose storage drums for various wire specifications/ lengths.
- Wire leads and sheaves allowing wires to be deployed by various winches at various positions, for example over the stern, over the side (two positions) or through the moonpool.
- "A" Frame for handling equipment over the stern.
- "A" Frame for handling equipment over the starboard side.

Temporary Installation:

- Coring equipment handling.
- Seabed remote drilling equipment.
- AUV handling.
- UAV handling.
- ROV handling.
- Acoustic towed fish/s
- Surface plankton net handling system (Fwd).
- Trawl/towing winch(es).

As far as practical permanent equipment installed on the vessel shall be used for equipment deployed on a temporary basis.

The Contractor shall provide a complete, optimised package of lifting equipment to achieve these requirements safely, effectively and in conformance with the relevant Classification and statutory approvals and certification.

The requirement shall be achieved by a combination of Cranes and specialist Over-side Handling Equipment

6.10.2 Science Handling System – General Requirements

R6.350 The equipment shall be designed and manufactured by a reputable and experienced contractor who has a proven track record in the particular product or products working in the marine environment.

These are well proven designs but shall require design development specific to this vessel with particular regard to capacity, outreach, configuration and speeds of deployment.

The equipment shall be hydraulically driven, with infinite and precise speed, stop and start controls and each shall be supplied with an independent water cooled power pack and control system.

For example; all hydraulic rams are to have stainless steel rods and end caps, all piping, flexible hose fittings and fittings to be stainless steel and mounted in stainless steel clips with stainless steel nuts and bolts. On completion of testing all fittings to be wrapped and sealed with tape (***EXAMPLAR*** Denso tape).

6.10.3 Hydraulic System Requirements

R6.351 Hydraulic power shall be supplied to vessel aft and side decks for the operation of scientific winches and equipment.

The Hydraulic system requirements are:

1. Where applicable the system is to comply with Lloyds Regulations.
2. To minimize exposure of piping etc to the environment, it shall be painted, according to the ship's colour scheme.
3. Labelling of all connections and systems, should be in English and embossed/ engraved on brass to allow the details to be read even if the label is painted over.
4. All pumps, tanks, manifold units, controls and piping shall be resiliently mounted to prevent transmission of noise and vibration into the hull structures.
5. System should be flushed thoroughly under high flow for at least one hour prior to commissioning,
6. Prior to delivery, system to be filled with new hydraulic oil and all strainers and filters to be renewed.
7. Pressure test certificate to twice the working operating pressure shall be required.
8. All pipe joints and fittings shall be wrapped in Denso or equivalent protective tape after commissioning, to prevent corrosion and ease dismantling
9. Where Stainless Steel is used it shall be at least marine grade SS316L
10. Oil type bio-degradable oil hydraulic oils.

Pipe and hose runs shall be located such that any leaks or bursts shall not cause oil to spray onto electric cabling, equipment or fittings. In this regard, wherever possible pipe runs should be located following the general rule of installing hydraulic pipe runs on deck, well protected from impact damage, and electric cable runs at the deckhead.

During hydraulic pipe installation, pipework shall be kept clean and free of foreign matter. In this regard, areas where hydraulic work is being carried out should be kept dry and clean and open pipes and connections should be temporarily sealed to prevent introduction of foreign matter before final fit-up is completed.

Pipe runs shall be as direct as possible and arranged in a neat and logical manner throughout, utilising a proprietary pipe clamping system such as Stauff Clamps incorporating sound attenuating means as defined in the Noise, Vibration section of the SoR.

6.10.4 Hydraulic Power Packs

R6.352 Dedicated hydraulic power packs shall be arranged to provide flexible power sources to handling systems permanently installed and science handling equipment mobilised for specific tasks and may serve multiple consumers. Each hydraulic power pack shall have redundant pumps, which when all running meet the maximum simultaneous demand. The number and capacity of pumps shall allow equipment operation with one pump stopped or failed. Some loss of performance may be permitted in case of partial failure.

Due attention should be given to redundancy and commonality of motor pump units operating on a staged output basis.

The system should allow the selection of which individual deck connections to put “in use”, noting that in some circumstances all connections may require to be “in use”.

Safety Features according to relevant standards should be incorporated into the system.

Oil reservoir tank(s) should be sized according to requirements. Filling shall only be possible via a filter.

Standby heating and pre-use heating shall be installed to maintain hydraulic oil at a minimum temperature and pre-heat to an operating temperature within the specified range of temperatures in the environment in which the hydraulic power pack is installed.

Hydraulic oil cooling shall be provided appropriate for the maximum specified ambient temperatures, with equipment operating at its rated capacity.

6.10.5 Hard Piping

R6.353 Hydraulic pipework exposed to the elements should be of stainless steel.

Hydraulic piping below deck could be cold drawn seamless tube to DIN 2391 ST 35.4 NBK.

Diameter of hard piping to deck should be optimized for the following flow rates:

- 75 litres/minute for P1, P2 and P3
- 150 litres/minute for P4

The supply pumps should be arranged so that any outlet can be individually selected and pumps connected to supply that outlet in 25 litres/minute steps up to the 75 litres/minute maximum rate. The 150 litres/minute outlets also requires to be individually selectable, though the supply capacity can be supplied from a single source pump i.e. does not require steps, though the option to vary the flow rate would be desirable.

6.10.6 Flushing

R6.354 After assembly and during the first operation of the system the lines to be flushed through, using the medium intended for the service, with exception of lubricating oil and diesel fuel oil lines.

Filters used for hot oil flushing to be:

- For hydraulic systems 100 µm
- For lubricating oil systems </- 20 µm
- Filling of the lubricating oil systems to take place through 10 µm filters.

The cleanliness of each hot oil flushed system to be in accordance with:

- Bio-degradable Hydraulic Oils
- Hydraulic oil ISO 4406 15/12
- Lubricating oil ISO 4406 17/14

6.10.7 Greasing

R6.355 The equipment shall be fitted with greasing facilities where necessary. These shall be readily accessible for routine maintenance under seaway conditions when crane, ladder or platform access is not available. Grouping of grease injection points next to a walkway or fixed access platform would be a typical solution.

6.10.8 Fixed Control Positions

R6.356 Fixed Control positions for all units shall be provided in the Winch Control Room, at the power pack (to enable them to be turned on and off for test purposes) and in a protected position on the working deck close to the operating area of each particular unit. In addition all units shall be capable of operation by remote wireless control. This radio control system shall be coordinated against interference to or by other such systems on the vessel (cranes, winches, etc.).

6.10.9 General Requirements

R6.357 The units shall be required to accept all relevant ropes and cables led from the Scientific Winch System (See Section 6.9 Scientific Winch System) and fitted with appropriate sheave/block types and sizes. In the event that the supplier of the over-side handling systems is different from the scientific winch system supplier the Contractor is to ensure that the two systems are properly integrated together in all respects.

The units shall be fitted with proper safe access for maintenance, reeving of ropes and cables, fitting and changeout of all hanging blocks and auxiliary winches.

The structures of the units are to conform with and be certified in accordance with Lloyd's Register, Rules for Offshore Lifting appliances.

A common adapter system shall be installed for the various science equipment. The common adapter shall mate with owner supplied docking heads for various equipment without modifying the deployment system itself.

6.10.10 Testing

R6.358 The units shall be subjected to a series of tests and trials each of which shall require acceptance by NERC before proceeding to the next stage:

FATs As far as practical equipment shall be function and load tested at the FAT Each unit shall be static load tested to prove its ability to withstand the load requirements listed below factored accordingly for test purposes. Each unit shall be dynamically load tested under luffing loads to prove its ability to withstand the load requirements listed below factored accordingly for test purposes.

HATs On completion of the ship installation, each unit shall be static load tested to prove the equipment and its support structures, ability to withstand the load requirements listed below factored accordingly for test purposes. Each unit shall be dynamically load tested under luffing loads to prove the equipment, and its support structures, ability to withstand the load requirements listed below factored accordingly for test purposes. In addition during the Scientific Winch trials program each unit shall be tested to prove that it works in a fully integrated manner with the scientific winches. Controls and safety systems shall be tested from each location in which they are installed. Simulation of faults shall be included in these tests.

SATs During the Scientific Winch System sea trials and deep water trials each unit shall be tested to prove that it works in a fully integrated manner with each of the scientific winches specified as having a wire / cable leading to it.

Test certificates shall be provided

The following are the basic requirements.

6.10.11 Over-side Handling Requirements

R6.359 The Over-side Handling Equipment shall consist of Aft "'A" Frame, Midship CTD deployment system (via the Scientific Moonpool & over the starboard side "A" Frame.

6.10.12 Stern "A" Frame

R6.360 An "A" Frame or equivalent gantry system shall be installed on the stern of the vessel for handling equipment from the deck overboard and to provide towing points for equipment streamed astern.

Stern "A" frame SWL 15Te luffing; 20Te static to handle rock drills, vibrocorers, landers, the future generation of seafloor observatories, dredges etc).

Clear width between "A" Frame legs 4.7m (extension) 6.5m (main).

Clear height under the "A" Frame 8.3m.

Operating range: 6.5m inboard - 5.8m Main section; 9.2m (extension) outboard.

Gantry is to be equipped with an articulating arm SWL 5 Te luffing; 7.5Te static to deploy packages from deck level. The arm is to be capable of being lowered to deck height in the stowed position to allow reeving of light equipment without climbing in a seaway. It is to be rotatable about the gantry arm top either side of the main hanger beam to allow positioning of loads and to allow the arm to be positioned clear of any load suspended from the main load blocks. The arm is to be fitted with a wide throated block that is free to hang vertical no matter the position of the gantry. The arm is to be capable of being operated at the same time as the main gantry legs to give accurate control of packages. The arm is to be capable of being operated from any position that the main gantry legs are operated from.

A similar idea is shown below;

Heel pins mounted on pedestals forming deck reinforcement combined with Science Crane supporting structure.

Hanging Points/Sheaves - 1 x 20Te counterbalanced. 2 x 10 Te auxiliary.

Wide-throat blocks on the aft "A" frame and ability to hang other blocks and wide cable runs to winch room to allow swivels etc to pass as far as possible along system to ease bad weather/damaged gear recoveries.

Trawling blocks free hanging to allow easy turns.

Aft quarter deployment position outboard of stern "A" frame pedestals for installing handling/deployment davits/gantries etc.

Towing capability for deep-tows, seismic streamers, multiple airgun arrays, etc.

Allowance is to be made for the fitting of additional block anchor points to accommodate RMT trawl blocks to be specified at final design stage

Aft Gantry Sentry boxes, a safety feature allowing easy sanctuary..

Tugger Winches - Two 5Te (may be fitted to "A" Frame legs or top beam to allow the deployment of RMT nets).

Access ladders & walkways for maintenance, exchange of blocks and reeving wires.

Winterised LED floodlighting to illuminate the working area under the head of the "A" Frame. Light fittings with gimbals.

Powered stern gates for safe operation at sea shall be installed between the "A" Frame legs.
EXEMPLAR: Macgregor / Triplex

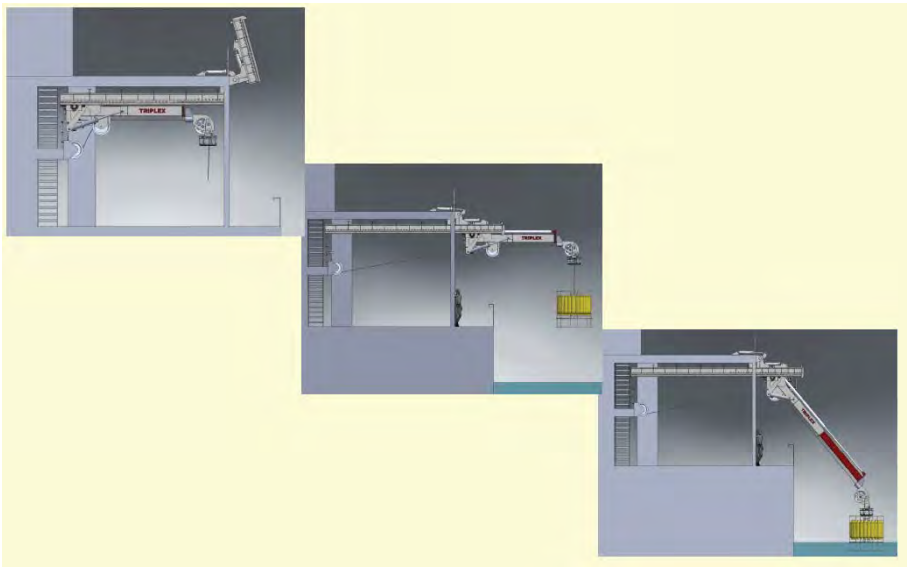
6.10.13 CTD & Multipurpose Handling System

R6.361 A multipurpose CTD handling system shall be installed capable of transferring equipment transversely within the Science Hangar, deployment through the Science Moonpool and over the starboard side.

Characteristics are to include the following:

- Arranged for a selection of different wires to be reeved for the various equipment and purposes.
- Multipurpose mating device to suit the variety or equipment to be deployed.
- Docking with a Moonpool cursor system.
- Equipment mating device to be lowered close the sea surface for fine control of the equipment release and recovery at the air / sea interface.
- Safe Working Load with equipment deployed over the starboard side 10t (deployment arm retracted).
- Safe Working Load during transfer, release and recovery of science equipment 3t, (with deployment arm extended)
- Towing load, 1t offset astern or athwart ship at 45 degrees.
- Outreach beyond the ship side 4.0m (deployment arm retracted).
- Clear headroom above the Main Deck, below the hook / under the final sheave above the load 9.0m.

EXEMPLAR – CSIRO Investigator



EXEMPLAR – Rolls Royce - Odim

6.10.14 Scientific Moonpool Cursor

R6.362 The Scientific Moonpool shall be fitted with a cursor system arranged to dock with the transfer and handling system mating device. The cursor system shall control the equipment mating device as it passes through the moonpool, avoiding the equipment swinging and contacting the sides of the moonpool. It shall also provide a fixed point of control for the wire at the centre of the moonpool on the bottom shell of the vessel, avoiding contact with the sides of the moonpool and snagging the bottom doors.

The cursor system shall be controlled in conjunction with the bottom doors to avoid collisions.

The cursor system is to be securely locked in its deployed position, stowed and preparation / maintenance positions.

6.10.15 Starboard Side "A" Frame

R6.363 An "A" Frame or equivalent gantry system shall be installed on the starboard side of the vessel for handling equipment from the deck overboard.

A-frame SWL 15Te luffing; 30Te static to handle rock drills, vibrocorers, landers, the future generation of seafloor observatories, dredges etc).

Towing load, 1t offset astern or athwart ship at 45 degrees.

Clear width between "A" Frame legs 5.0m.

Clear height under the "A" Frame 9.0m.

Operating range: inboard – 4.0m outboard.

Hanging Points/Sheaves - 1 x 30Te counterbalanced.

Eye plates with auxiliary lifting and towing blocks 2 x 5T

Wide-throat blocks on the aft A-frame and ability to hang other blocks and wide cable runs to winch room to allow swivels etc to pass as far as possible along system to ease bad weather/damaged gear recoveries.

Access ladders & walkways for maintenance, exchange of blocks and reeving wires (may be accessible from an open deck above).

Outreach beyond the ship side 4.0m.

Clear headroom above the Main Deck, below the hook / under the final sheave above the load 8.0m.

Tugger Winches - 2 x 5Te (may be fitted to “A” Frame legs).

Articulating arm to control load. Similar to that shown below controlling a box corer;

The capability of the “A” frame should be seen as the essential requirement and not the configuration of the “A” frame. Other solutions may function equally well, possibly enhancing movement of equipment on and off the deck.

6.10.16 Towing Booms

R6.364 Two towing booms each with capacity for towing loads of up to 1t shall be fitted, one port aft, one starboard aft and extending 5m beyond the ship side. . The towing beams are to be f itted with mounting points to accommodate fairleads for towed equipment. Towing beams shall be arranged recessed within the height of the bulwark. The towing beams shall be deployed hydraulically, possibly combining it with the system operating the stern door. Fixed length pendants shall restrain the towing beams at about 90 degrees to the ship side.

6.11 CRANES

The Contractor will be responsible for correctly purchasing and installing and testing the equipment. The choice of *Manufacturer* is to be approved by NERC as will be the final designs.

6.11.1 General Lifting Requirements

R6.365 The vessel has a variety of lifting requirements, summarised as follows:

- Self-contained in terms of mobilisation and demobilisation by way of loading and off-loading cargo, scientific equipment, containers and ship's, equipment & engine parts, catering stores and parts in port and sheltered waters.
- Transfer of scientific equipment at sea
- Man-riding for mobilisation, inspection and maintenance purposes.
- Man-riding for personnel transfer onto the ice.

Cargo transfer requirements include the following:

- Loading and discharging cargo with loads of up to 50t to and from the cargo holds, all areas of the aft working deck, up to 12m outboard from the ship side, in port / sheltered waters.
- Loading and discharging cargo of up to 10t between the ship and the cargo tender alongside in sheltered waters.
- Loading and discharging science equipment forward with loads of up to 10t to and from the helideck / helicopter hangar.
- Movement of cargo containers, including 20ft ISO freight containers within the Cargo Hold.

Scientific Equipment transfer requirements include the following:

- Loading and discharging scientific equipment of up to 2t to and from the Science Hold.
- Loading and discharging scientific equipment of up to 10t to and from the Helideck / Helicopter Hangar.
- Movement of scientific equipment to and from the Science Hold/Hold Store, Science Hangar and Working Deck.
- Movement of science equipment on all areas of the Working Deck
- Deployment of Science Equipment over the Stern, over the side and through the Scientific Moonpool.
- Movement of Science Equipment within the Science Hangar.
- Transfer of scientific equipment between the Helideck and Helicopter Hangar.
- Transfer of scientific equipment between the Science Hangar and starboard side open deck.

- Movement of scientific equipment along the starboard side open deck in preparation for deployment or following deployment.

Ship's Stores, Provisions & Garbage Handling requirements include the following:

- Loading stores and provisions forward by crane, to a stores hatch & lift.
- Loading and discharging stores and spare parts aft to stores and machinery spaces.
- Discharge of packaged waste material forward and aft.
- Transfer within the ship forward to aft on the Main Deck.

Personnel transfer requirements include the following:

- Passenger lift between the Main Deck and Accommodation Decks 1 – 4.
- Stores Lift is not intended for passenger service.

The Contractor is to provide a complete, optimised and coordinated package of lifting equipment to achieve these requirements safely, effectively and in conformance with the relevant Classification and statutory approvals and certification.

The requirement will be achieved by a combination of Cranes, special Over-side Handling Equipment, lifts, transfer and skidding systems (in the Cargo Hold).

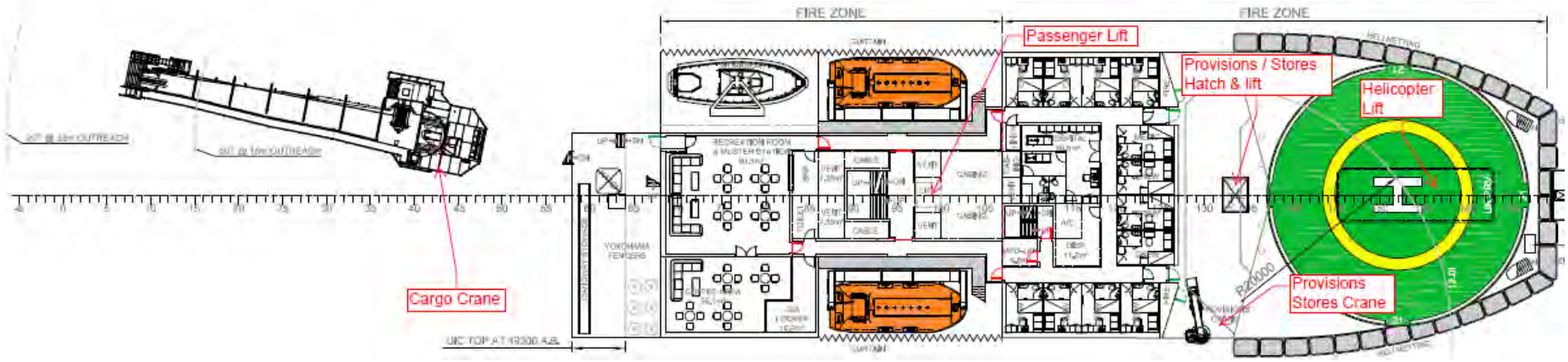
Where there is assessed to be a risk of equipment collision appropriate safety systems shall be incorporated in control systems to prevent such collisions. This will include potential clashes between handling systems and hangar doors and slew limits on cranes.

Where 20ft ISO containers are mentioned it shall be assumed that a height of 8ft 6in is applicable, unless specified otherwise.

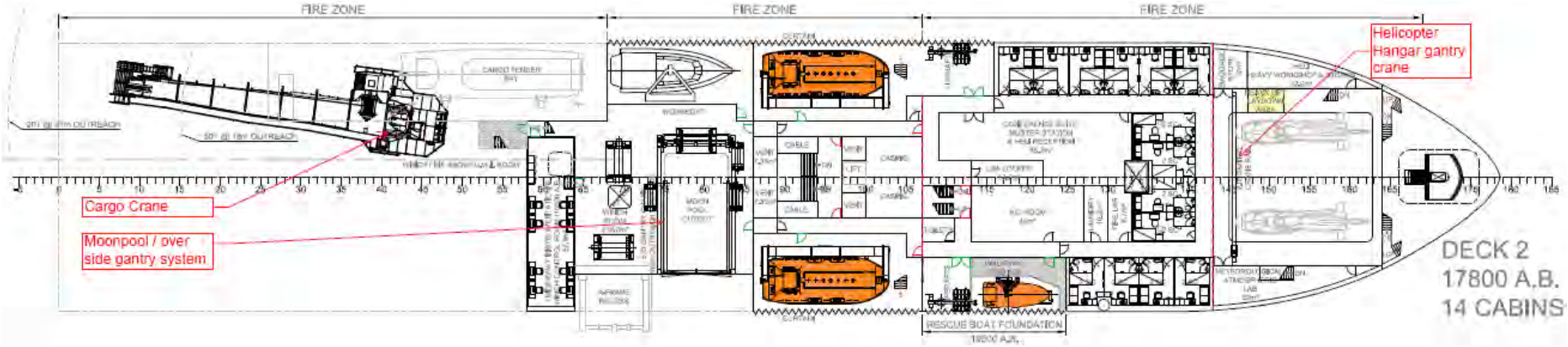
6.11.2 Craneage Requirements

R6.366 *The conceptual arrangement of cranes is shown in the following diagrams.*

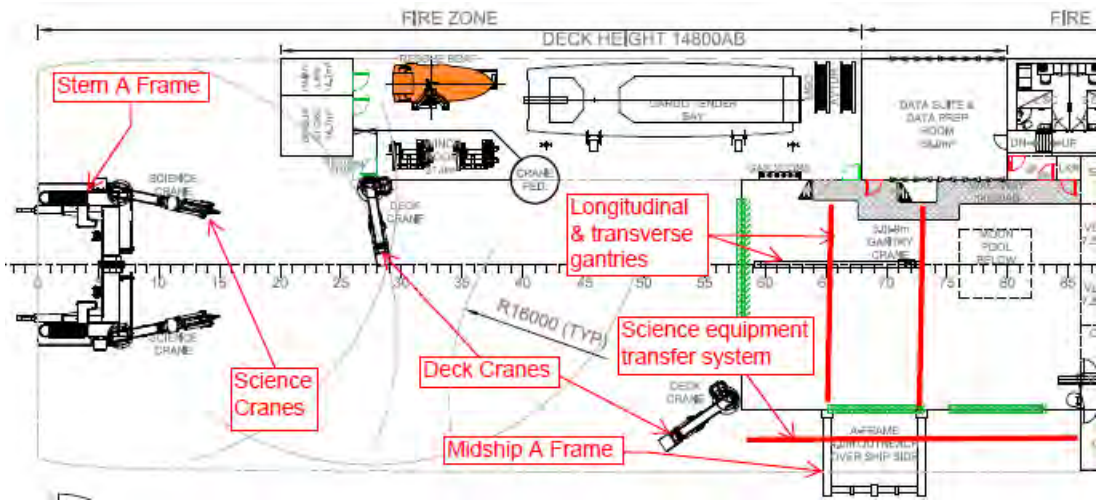
Deck 3



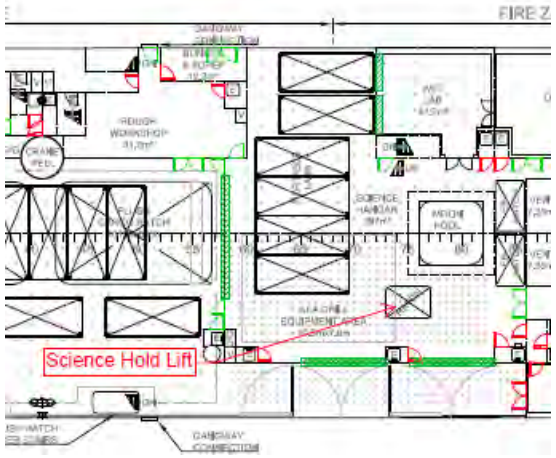
Deck 2



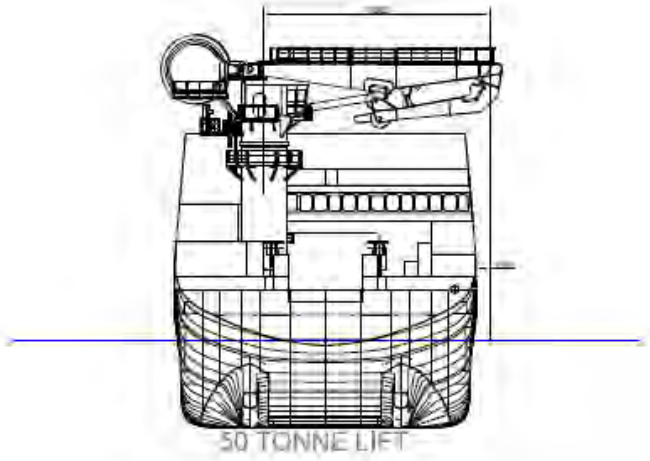
Deck 1

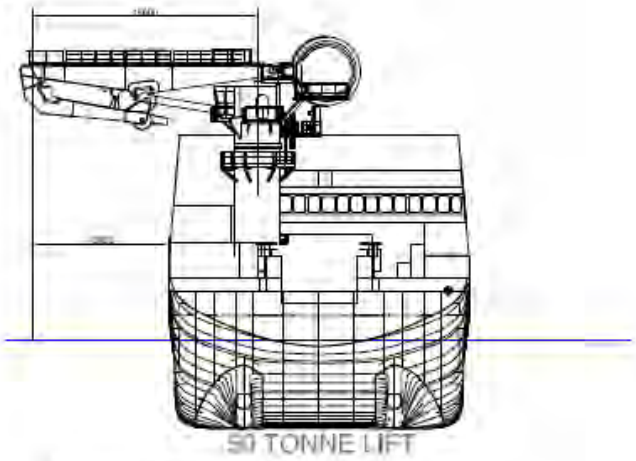

FIRE ZONE
DECK HEIGHT 14800AB
Stern A Frame
Longitudinal & transverse gantries
R16000 (TYP)
Science equipment transfer system
Science Cranes
Deck Cranes
Midship A Frame

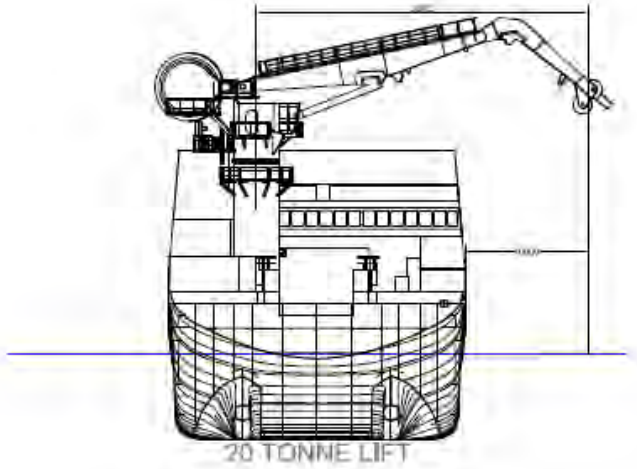
Main Deck

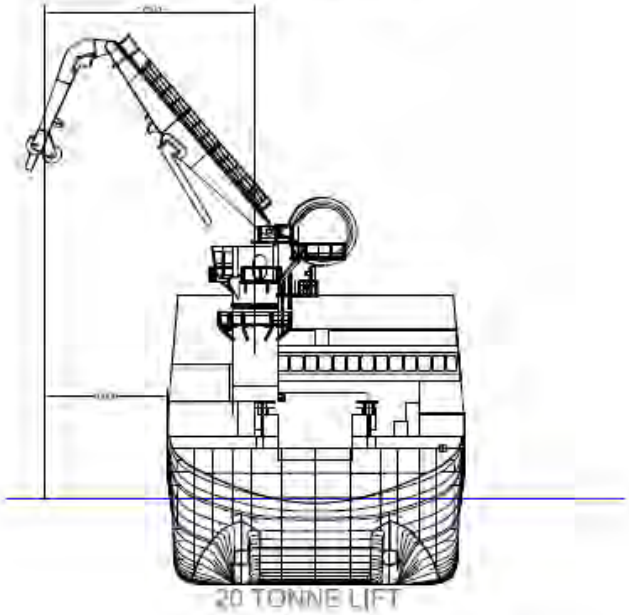

Science Hold Lift

CRANE OPERATION









Cranes – General Requirements
The equipment is to be designed and manufactured by a reputable and experienced contractor who has a proven track record with the particular product or products working in the marine environment.

A suite of marine cranes is to be fitted to cover all working deck areas and containers slots. These are to be well proven designs but may require some design development specific to this vessel.

Particular attention is to be paid to providing smooth and controllable low speed operations particularly in the seaway with suspended loads. Precise creep control when slewing is a prime requirement under conditions of heel up to 7 degrees and transient rolling and pitching angles as predicted by the model tests for the particular hull design being considered

All cranes are to be suitable for the intended use as described, fully marinised, winterised and suitable for operation in the wide range of environmental conditions specified.

All cranes are to be designed and installed for operation at sea in Sea State 5, except where mentioned in the description of individual cranes.

Each crane will be fitted with its own dedicated hoist winch and wire. Scientific wires will not be used for crane lifts. Steel wire ropes shall be of non-rotating construction.

Operating Environment	Cranes mounted externally	Cranes mounted within an enclosed space
Ambient Operating temperature range	+45°C @ 65% Relative Humidity / PST -35°C	+45°C / -15°C
Wind speed		
Maximum operating wind speed	27m/s	Not applicable
Maximum wind speed stored	47m/s	Not applicable
Snow & Ice		
Snow & ice	40mm thick @ 500kg/m^3	Not applicable

The structures of the units are to conform with and be certified in accordance with Lloyd's Register, Rules for Offshore Lifting appliances.

Testing
FATs and HATs will be carried out in accordance with the certifying authority requirements and test certificates provided and in accordance NPRV Acceptance Criteria

The performance of the hoists shall be demonstrated through provisions of Lloyd's Register Certification for lifting appliances.

Sufficient system readings shall be recorded to enable future fault finding/ diagnostic checks to be performed on the hoists.

Full function and load testing shall, as far as practical, be carried out at FATs.

Simulated faults / failures shall be induced to confirm the intended consequence. Function tests shall be carried out following installation to confirm the correct and safe operation. Load tests shall be performed to confirm the integrity of the structural interface.

Operating space envelopes shall be checked during tests following installation. Potential clashes with other equipment are to be identified.

Each crane shall be demonstrated in its intended role and over its intended operating area.

Winterisation Features
All cranes installed externally shall be subject to winterisation measures, including, but not exclusively the following:

- Hydraulic system pre-heating
- Control cabin heating (frost free)
- Material selection, including structural steel quality

6.11.3 Pedestal Cranes (externally mounted) – Common Features

R6.367 The pedestal cranes mentioned herein are to be of a design or designs that suspend the load from the lowest practical height to minimise pendulum effects.

Externally mounted pedestal cranes shall be electro-hydraulic type, each with an independent water or air cooled power pack and control system. All hydraulic systems are to use bio-degradable Hydraulic Oil. All cylinder rams and end caps are to be stainless steel (SS316L) and all piping, fittings, hose end fittings and nuts and bolts are to be stainless steel (SS316L)

Luffing, hoist and slewing motions are all to be hydraulically activated and controlled via a PLC (Programmable Logic Controller). Cranes are to be fitted with data logging systems.

The crane designs are to incorporate box section booms for minimum maintenance.

Boom supports or similar secure stowage shall be provided for each pedestal crane.

Access to the crane for operation, maintenance and inspection will be provided externally on the crane pedestal by vertical access ladders with safety cages. Similar access will be provided on the crane boom rest (Cargo Crane only).

The units are to be fitted with adequate access for maintenance, reeving of wires. Adequate securing against movement at sea is to be provided for each crane, including Boom rests for pedestal cranes and mechanical locking for gantry or monorail hoists. The stowage position should ensure that all rams are fully closed and protected against the elements. Hooks are to be capable of being ‘tied down’ when the crane is in the stowed position.

Design Criteria
The cranes will be designed and manufactured to comply with the following requirements:

- All equipment shall be designed to “fail-safe”, in the event of a failure the equipment shall not collapse but retain the load in the configuration of the hoist at the time of failure.
- Electrical protection to IP65 for external equipment and IP44 where protected inside.
- Installation in a safe area - explosion rating of electrical installation is not required.

Design Standards
The cranes will be designed and manufactured to comply with the following standards:

- Lloyd's Code for Lifting Appliances in a Marine Environment.
- BS 2573 Part 1 & 2 Rules for the Design of Cranes.
- BS EN 14985: 2007 Cranes - Slewing Jib Cranes.
- EN 13001-1:2004 Crane Safety, General Design, General Principles and Requirements.
- EN 13001-2:2004 Crane Safety, General Design, Load Effects 2.
- EN 13852-1:2004 Cranes, Offshore Cranes, General-Purpose Offshore Cranes.
- BS EN 13586:2004 Cranes, Access.
- IEC 60204 - Machinery Directive.
- IEC 60204-1 General Electrical Equipment.
- IEC 60204-24 Electrical Safety for Hoisting Machines.
- IEC 61131-3 PLC Simatic S7 (equivalent to BS EN 61131).
- BS 7671 - Electrical Installations.
- EN13135-1 Electrical Equipment on Cranes.
- ISO 13849 - Control systems & safety features.
- ISO 4413 Part 1 - Hydraulic systems (equivalent to BS 4745).

In any conflicting areas, then the most onerous requirement shall take precedence.

Hoist
The hoist arrangement shall incorporate a hydraulic variable speed drive. Two independent braking systems are to be fitted. All hoist functions shall remain stationary and inert until power is applied. Power is required to release the brakes. In the event of a power failure the brakes are to be automatically and safely applied to bring the hoist and its load to standstill.

A manual back-up system to release the brakes is provided and allows the manual control of lowering the load by gravity using the brake for speed control.

The brakes are to be independently rated.

Luffing
The boom is to be supported by hydraulic cylinders, which provide controlled luffing motion. The boom may also be lowered by manual operation of the throttle valve in a controlled & safe manner – valve locked to avoid tampering / accidental activation when on load.

Over-raise of the boom can be limited by the hydraulic cylinder end stops. Boom down motion may also be limited by the hydraulic cylinders fully retracted end stops.

Hose burst valves protect against the boom dropping in case of hose failure.
Luffing speed is to be inherently limited within the hydraulic system by the pump capacity when luffing up. In the event of failure of the luffing position sensors or the processing of their output the luffing motion will be ultimately limited by the end of stroke of the luffing cylinders, at which point pressure relief valves prevent excessive load being applied that might otherwise lead to failure.

Relief valves in the system are to limit the available pressure so that pressure cannot be applied beyond the design limits of the cylinders, their attachment and crane structure.

Each hydraulic cylinder is to be designed to hold the complete load.

Slewing
Slewing may be activated either by hydraulic powered slew motors fitted with a brake, released only on demand for slewing motion or by twin hydraulic rams. In case of main power or hydraulic failure the crane is to be slewed using a hand pump. The slew drive brakes are to be rated for the maximum load at start, including wind and safety factors.

The slew ring is to feature a captive arrangement to prevent overturning in case of bearing failure. The installation arrangement shall also limit the bearing drop.

Hydraulic & Power System
The crane motions are to be powered hydraulically from a dedicated power pack.

The hydraulic power pack is provided with cooling.

The electrical and hydraulic systems are to be provided with adequate heating to ensure effective starting in the stated environment. This may include both trace heating and start-up heating to bring hydraulic oil to a temperature sufficient for starting.

Hydraulic fluids and greases are to be suitable for low temperature operation.

Oil filters with differential pressure switches shall provide protection and condition monitoring of the hydraulic oil.

The crane is to have two electrical power supplies, one for the operation of the crane and another for auxiliary power consumers when the crane is not in operation and each crane is to have a redundant electrical power supplies. Power supplies to crane control systems shall be specially considered and arranged to ensure un-interruptible operation.

Crane Operation & Control
Operation is to be via wireless remote control chest packs.

Safety features are to be fail-safe and in the event of a failure, the hoist will retain the load and with no features that will cause a common mode failure to danger.

Operating limits for slew and luff angles are to be incorporated. Back-up control shall be available locally on a control platform and control panel mounted directly on the crane.

Crane Controls & Safety Functions

The crane motions and safety systems are to be controlled by a PLC system, which incorporates separate processors for control and safety functions. Before operation an automatically pre-check of safety function sensors is to be carried out. Further checks are to be carried out at regular intervals during operation. Many of their safety features incorporated in the PLC system are only available by the processor based continuous health check (or watch dog functions). These features are typically identified as safeguards in the assessments made in the safety case.

Safety features are to be incorporated which are independent of the plc safety processor. These provide protection against failure leading to dropped loads.

Safety features are to include the following:

- Detection of un-demanded motions by the PLC system.
- Wire break monitoring for sensors.
- Out of range monitoring for redundant sensors/output current from valve amplifiers.
- Overspeed
- Independent back-up overspeed.
- Hoist over-raise limit - activation will stop the hoist raise function.
- Hoist over-raise and wire out limits monitored by the control & safety PLC.
- Programmable limit switches for the winch-drive and slewing system.
- Slack wire alarm.
- Load indication system with alarms. Load may be lowered if overload is reached.
- Luffing control and feedback set to sequentially slow down and stop luffing motion.
- An automatic visual beacon and manually operated audible warnings are provided to indicate crane motions.
- Full flow pressure relief valves in all hydraulic circuits.
- Pilot controlled check valves (lock valves) mounted directly to the winch drums.
- Hydraulic brake valves directly on the luffing cylinder.
- Fail-safe spring loaded hydraulically released hoist winch brake.
- Fail-safe spring loaded hydraulically released slew brake.
- Spring loaded safety latch on the hook.
- SLI / personnel warning horn.
- Crane movement indicator lights.

- Emergency stop push-buttons.
- Emergency lowering system for the main hoist winch.
- Emergency lowering system of the boom (empty hook only).
- Emergency slewing system.

6.11.4 Gantry / Monorail / Hoists (mounted within an enclosed space)

R6.368 Gantry cranes and hoists are to have electric drive systems.

All gantry hoists are to be fitted with pendant and remote radio controls

The design of all gantries is to be coordinated to make sure that no clashes occur and that maintenance access is arranged without the use of ladders or temporary staging.

All hooks shall have full travel from winch drum to deck level. All lifting heights are to be agreed at detailed design stage.

Portable radio controls (Belly box) will also be required for each crane. This radio control system is to be coordinated against interference to or by other such systems on the vessel (cranes, winches, etc.).

6.11.5 Crane - Safety Case Analysis

R6.369 The overall safety requirement is as that the safety risk can be shown to have been reduced to agreed levels, which are ALARP (**A**s **L**ow **A**s **R**easonably **P**racticable).

The scope of the analysis forming this safety case is confined to safety aspects during operation of the equipment in its stated mode of operation, within the defined operating parameters.

The Safety Analysis is based on the following process:

- Study of the plans and technical documentation.
- Hazard identification (HazID) based on a SWIFT(**S**tructured **W**hat **If** **T**echnique) approach.
- Assessment of risk.
- Identification of safeguards.
- Identification of further actions or clarifications.
- Elimination of action points.

6.11.6 Cargo Crane

R6.370 A pedestal type knuckle boom deck crane(s) is to be installed serving:

- All areas where cargo may be stowed on the open deck.
- Cargo holds via the cargo hatches.
- Overside to load discharge to/from a quay/ice shelf, up to 12m from the ship side, port and starboard.

The Cargo Crane is to be designed for offshore use, with capacity not less than SWL 50 tonne for use in harbour or sheltered waters with conditions up to sea state 2.

Operating radius is to be determined by the above service requirements. A heave compensated whip hoist is to be provided with 5t capacity (offshore lifts) at maximum radius. The whip hoist is to comply with man-ridding requirements.

The crane(s) will be used for the following functions:

- Load/discharge cargo of up to 50t, including transfer of 20ft cargo containers of up to 30t from the quay to/from the cargo hold or deck cargo space.
- Load/discharge scientific equipment of up to 35t to any part of the working deck.
- Transfer of stores (including a 20ft ISO container) to/from the cargo tender (up to 10t) in sheltered waters.
- Operate at up to full load in sheltered waters/harbour conditions and at nominal load (5t) at sea (whip hoist).
- Bulk material and fuel/potable water loading hose handling.
- Transfer of garbage.
- Lifting port & starboard side gangway into position.
- Carry out cargo/equipment transfers at established ports / harbours / jetties, which may have no other infrastructure.
- Personnel basket transfer using the whip hoist.

6.11.7 Cargo Crane Performance

R6.371 The crane performance is described as follows:

Operating envelope

Working radius	Main hoist 5 - 33m
	Auxiliary Hoist 6 – 36m
Hook height	Main Hoist Up to 41m above the Main Deck

The hoist winches shall be arranged to enable the hooks to reach the light waterline plus 10m.

Hoist

Crane capacity	50t @ 18m in harbour & sheltered waters upto Sea State 2,
	20t @ 33m in harbour & sheltered waters up to Sea State 3
Hoist speed	0 - 20m/min (with full load – may be double reeved)
	0 – 30m/min (with 20t load)

50t capacity shall be achieved using a double fall hoist rigged from the main boom section, requiring a 25t SWL hoist winch. 20t capacity shall be achieved using a single fall reeved from the knuckle boom section.

The hoist winch shall be located internally to prolong its life.

Hoist – Auxiliary Winch (man riding)

Auxiliary / Whip Hoist	5t @ 36m at sea, in up to Sea State 3.
Hoist speed	0 - 40m/min

The auxiliary hoist shall be offset by 3m longitudinally (ie at greater radius) from the main hoist and 1m transversely.

Luffing / full extension of the crane boom

Luffing time up/down	100s (with full load)

Slewing

Slewing angle	about 400 degrees (non-continuous)
Slewing speed	0 - 1 rpm

Cargo Crane Luffing

The boom is to be supported by twin hydraulic cylinders, which provide controlled luffing motion. The hydraulic cylinders are to be designed such that in case of failure of one, the other is capable of taking the load and maintaining a safe condition. The crane boom design shall include a load case with one luffing cylinder failed, ensuring that the resulting torsion in the boom structure is accommodated. If necessary the boom can be lowered using the remaining serviceable cylinder. The boom may also be lowered by manual operation of the throttle valve.

Maximum pump pressure is to be limited to prevent the cylinder push out force exceeding structural limits.

Each hydraulic cylinder is to be designed to hold the complete load.

Slewing

At least two hydraulic powered slew motors will be fitted, each with a brake, released only on demand for slewing motion. In case of main power or hydraulic failure the slew drive brakes may be released using a hand pump and the crane slewed manually. The slew drive brakes are to be rated for the maximum load at start, including wind and safety factors.

Hydraulic & Power System

The Cargo Crane shall be electro-hydraulic, with the electric driven power pack located in the crane housing above the slew ring. The crane is to have two main motors, which drive the hydraulic system pumps.

The cargo crane is to have a redundant electrical power supply. The power supply shall be arranged to provide the full specified performance with both power supplied available. Reduced performance is respect of speed of operation may be accepted in case of loss of one of the power supplies. A further power supply is to be installed for auxiliary power consumers. Power supplies to crane control systems shall be specially considered and arranged to ensure un-interruptible operation.

Cargo Crane Operation & Control

The cargo crane is to be outfitted with an air conditioned operator's cabin providing good visibility of the load working area. The operator's cabin shall be fitted with the following:

- Operators chair
- Space heating
- Heated window(s)

- Window demisting
- Air conditioning unit
- Window wiper(s)
- Emergency escape
- UHF radio
- Talk back
- PA communications
- Fire extinguisher

A data logger unit will be fitted to record hoist faults/conditions. The data logger provides the facility to look back at the history of the lifts the hoist has undertaken including the ability to monitor the loads lifted.

Electrical

Adequate illumination is to be provided of all working areas of the crane. Gimballed floodlighting is to be fitted to the crane boom for general winterised LED illumination of the load area.

A winterised aviation warning light shall be fitted.

6.11.8 Science Crane

R6.372 Two pedestal type folding telescopic boom deck cranes are to be installed serving:

- Movement of science equipment on the aft part of the open deck.
- Overside deployment and recovery of science equipment, port and starboard, and over the stern.

The Science Cranes are to be designed for offshore use, up to sea state 5. Operating radius is to be determined by the above service requirements.

6.11.9 Science Cranes Performance

R6.373 The crane performance is described as follows.

Operating envelope

Working radius	3 - 16m
Hook height	10m above the Main Deck

The hoist winches shall be arranged to enable the hooks to reach the light waterline plus 10m.

Hoist – Main Winch

Crane capacity	5t @ 10m, up to Sea State 5
	3t @ 16m, up to Sea State 5
Hoist speed	0 - 30m/min with full load – single reeved)

Luffing / full extension of the crane boom

Luffing time up/down	100s (with full load)

Slewing

Slewing angle	400 degrees (non-continuous)
Slewing speed	0 - 1 rpm

6.11.10 Deck Service Cranes

R6.374 Two pedestal type knuckle boom deck cranes are to be installed serving:

- Movement of science equipment on the aft and starboard working decks.

The Service Cranes are to be designed for offshore use, in sea state 5. Operating radius is to be determined by the above service requirements.

Deck Service Crane Performance

The Service Crane performance is described as follows.

Operating envelope

Working radius	2 - 16m
Hook height	7m above the Main Deck

The hoist winches shall be arranged to enable the hooks to reach the light waterline plus 10m.

Hoist – Main Winch

Crane capacity	5t @ 16m in sea state 5.
Hoist speed	0 - 20m/min (with full load)
	0 – 30m/min (with light load)

Luffing / full extension of the crane boom

Luffing time up/down	100s (with full load)

Slewing

Slewing angle	400 degrees (non-continuous)
Slewing speed	0 - 1 rpm

6.11.11 Provision Stores Crane

R6.375 A pedestal type Provision Stores Crane is to be installed serving:

- Movement of ship's stores and provisions to and from the quay to the Provisions Stores Lift hatch on the open deck.
- Loading and discharge of science equipment and portable laboratories onto or from the Helideck for transfer to the Helicopter Hangar.
- Deployment of UAVs and their launch / recovery systems from the Helicopter Hangar onto the Helideck.

The Provision Crane is to be designed for offshore use, in sea state 3. Operating radius is to be determined by the above service requirements.

The Provision Crane location and configuration when stowed shall take account of the clear zones required for helicopter operations (with crane stowed during helicopter operations).

The crane performance is described as follows:

Operating envelope
Working radius 2 - 20m

Hook height 7m above the open deck.

The hoist winches shall be arranged to enable the hooks to reach the light waterline plus 10m.

Hoist – Main Winch
Crane capacity 8t @ about 10m in harbour & sheltered waters up to Sea State 3 for handling science laboratories and 3t at a radius sufficient to load stores and provisions via the stores lift.

Hoist speed 0 - 30m/min (with full load – single reeved)

Luffing / full extension of the crane boom
Luffing time up/down 100s (with full load)

Slewing
Slewing angle 400 degrees (non-continuous)

Slewing speed 0 - 1 rpm

6.11.12 Science Hangar

R6.376 A combination of fore / aft and transverse gantry cranes, monorails and handling systems are to be installed to work in co-ordination with overboard handing systems. The whole Science Hangar deck area is to be served by these cranes.

These cranes are to have outreach beyond the main doors to the Science Hangar leading aft to the open working deck and to the two overboard deployment positions on the starboard side open deck.

Container transfer and skidding systems shall be installed to move laboratory containers into position adjacent to the Wet Laboratory.

Lifting Capacity – Science Hangar Gantry crane system:

- 20ft ISO containers / Portable laboratories up to 20t in harbour / sheltered waters Sea State 1 / 2.
- Science equipment up to 8t on all areas of the Hangar deck in up to Sea State 5.
- Science equipment transfer to and from the Science Equipment Hold in up to Sea State 5.
- Machinery spares and parts to and from the Engine Room hatches (Largest / heaviest item passing through the hatch).

The transverse (movement of load) gantry crane serving the Moonpool area may be combined with the over side / moonpool handling system.

For general material handling on the deck the transverse gantry will use an integral hoist, with sufficient hoist wire to reach the bottom of the Science Moonpool.

Collision avoidance systems shall be fitted to cranes and lifting systems which may otherwise operate in the same space envelope.

6.11.13 Helicopter Hangar Gantry Crane

R6.377 Helicopter Hangar Gantry Crane shall be installed in helicopter hangar. Refer also to Section 6.1.34

General characteristics:

- One overhead gantry crane
- Capacity 2t, hoist winch lifting height 5m
- Hoisting speed 3m/ min (Two speed steps)
- Travelling speed 5m/ min (Single speed steps)
- Safety brake device for hoisting and Clamp
- Travelling and traversing by rack and pinion drive.
- Local control at installation area.

6.11.14 Starboard Open Working Deck

R6.378 A mechanical handling system shall be installed for the transfer of science equipment into and from deployment positions on the open working deck to starboard of the Science Hangar. Its capacity shall be 3t. Lifting arrangements shall be arranged to minimise the risks associated with an elevated point of suspension.

6.11.15 Lifts

R6.379 The following lifts and associated equipment shall be installed.

Provisions / Stores Lift

A Provisions / Store Lift shall be installed to transfer standard pallets between the following decks:

- Open Deck
- Helicopter Hangar
- Provisions Stores
- Garbage stores
- Main Deck level for servicing laboratory spaces

Capacity shall be 2t. The lift shaft and doors shall be provided with the appropriate fire protection measures. This lift is not intended for personnel transfer. Safety features necessary for a goods lift in use at sea shall be incorporated.

Passenger Lift

A passenger lift shall be installed to transfer personnel between the following decks:

- Accommodation decks
- Hospital deck
- Public spaces decks; Mess Room & Recreation Room
- Main Deck on which laboratories are located
- Engine Room access

Capacity shall be for 6 persons. The lift shaft and doors shall be provided with the appropriate fire protection measures. Safety features necessary for a passenger lift in use at sea shall be incorporated.

6.12 CARGO TENDER, WORKBOAT and SMALL BOATS

6.12.1 Cargo Tender

R6.380 A cargo tender shall be provided to facilitate the transfer of cargo and personnel between the ship and shore where there are no suitable harbour facilities.

Cargo tender features shall include:

- Fully compliant with latest MCA and Workboat Code and requirements MCA Notation Category 1.
- Crew (up to 4) + 12 scientists for LSA purposes.
- Aluminium construction of the hull with suitable protection to prevent electrolytic corrosion between steel items placed onboard.
- Superstructure of aluminium or composite construction. If composite then shall be able to withstand Antarctic temperatures and not be subject to de-lamination.
- Retractable cargo cover (e.g. as seen on military LCVPs).
- Cargo deck capacity for a 20ft ISO container (up to 20t gross weight), with space to open the doors and discharge cargo or 2 x 10ft ISO containers and access around sides
- Flush fitting twist lock pockets to suit 1 x 20ft and / or 2 x 10ft containers.
- Break bulk cargoes shall be carried and suitable lashing-rings or equivalent should be provided, such as flush hemispherical indents with a bar for ratchet straps.
- Bow ramp to discharge onto a beach, including a vehicle of up to 10t. Consideration shall be given to a split ramp would improve forward visibility from the wheel house and handling of the tender in high wind conditions.
- Winch for capable of pulling 20ft ISO container (up to 10t gross weight) from beach into cargo tender with an elevated pulley block, like an A-frame, to provide lift.
- Speed minimum 8-9 knots (loaded).
- Inboard Twin diesel suitable separated in case of fire, each with independent fuel tanks, driven stainless steel propellers in fixed nozzles or recessed with suitable ice and grounding protection fitted. Both propellers shall have rope cutters and engine cooling shall have a good size strainer to clean out any kelp if needed. Intakes to be located such that they don't suck up sand during beach landings.. Both engines to have PTO hydraulic pumps able to run all hydraulic systems for greater redundancy. Dealer level Diagnostic laptop to be included
- Fire detection and extinguishing systems.
- Folding crane located forward on the starboard side of the cargo area and having capacity of 2t to discharge cargo.
    - ❖ The crane is a reach the furthest point of the cargo area and a minimum of 3m forward of the bow to land cargo on a beach.

- ❖ Crane to have wireless remote control.

- Dedicated launch & recovery davits.
  - ❖ Recommend “Offshore Industry” Daughter craft davit.
  - ❖ Should lock onto craft until outboard and wave compensation.
  - ❖ Launch and Recovery of Cargo Tender in up to top of Sea State 4.
  - ❖ No part of the boat or davit is to protrude beyond the ship side to facilitate the weather protection cover.
  - ❖ Cargo Tender davit shall be certified for man riding
- Range of at least 200nm for fuel purposes only.
- Subdivided double bottom, with flush fitting inspection hatches for each compartment.
- Liferaft & LSA appropriate for the vessel and the environment.
- Survival supplies and outfit to meet Polar Code Requirements
- Stern anchor & winch for beach landings. The winch / capstan shall be electrically driven to ensure it can be us ed with the engine(s) on t he tender running at full power.
- Cargo & machinery space bilge systems.
- Sewage retention tank, with by-pass overboard discharge.
- Substantial “D” section rubber fenders all round.
- Lifting points for handling by davits and crane.
- Plug in electrical supplies for pre-heating / standstill heating of the propulsion engines, accommodation and wheelhouse.
- Full spares package for boat, engines and systems.

A fully enclosed temperature controlled wheelhouse (Including accommodation) shall be provided and include the following features

- Seating for coxswain
- Crew seating
- Heating
- Heated windows
- Window wipers
- Engine, steering controls,
- Compass

- Radar
- GPS
- Echo sounder
- Speed log
- Autopilot
- Chart plotter
- VHF Communications and AIS (Class 2) linked to the chart plotter.
- Talk back system between the wheelhouse and the forward end of the tender
- Thermal insulation
- Seating for 12 scientists on removable seats in Cargo Bay.
- Toilet
- Tea / coffee making facility.

The Wheelhouse / accommodation will be easily removable or hinged forward for access to the machinery compartment and removal of engines.

Winterisation Features

Winterisation features shall include, but not be limited to the following:

- Engine pre-heating
- Cabin heating (frost free)
- Cargo crane / winch pre-heating
- Liferaft (Polar compliant)
- Davit power system pre-heating
- Material selection for davits and cargo tender

6.12.2 Workboat

R6.381 This shall be about 10.5m in length with fixed enclosed air conditioned wheelhouse with space for 2 x crew + 6 scientists and survey equipment and required for the following duties:

- Transfer of personnel and their equipment between the ship and the shore.
- Conduct acoustic surveys in support of bathymetric and biological research
- Dive operations.
- Regulations: MCA Small Commercial Vessel & Pilot Boat Code 2.

The boat is to have the following features:

- Fully compliant with latest MCA and Workboat Code and requirements.
- RIB. Aluminium hull with foam filled modular sponsons. Aluminium deck with non slip surface.
- Design operational speed shall 20 Knots
- Self-righting in the event of capsize and remain fully functional.
- Climate controlled accommodation for two crew + six scientists.
- Open cargo deck for at $1m^3$ or 1,000Kg with suitable lashing points.
- Inboard Twin diesel, each with independent fuel tanks, driven stainless steel propellers in fixed nozzles or recessed with suitable ice and grounding protection fitted. Both propellers shall have rope cutters and engine cooling shall have a good size strainer to clean out any kelp if needed. Engines to be supplied with dealer level diagnostic laptop
- Range of at least 200nm or twelve hours continuous running whichever the greater.
- Fixed or portable platform and ladder for diving operation.
- Fixing towing strong points for towing alongside and astern.
- Fixed waterproof, permanently fitted VHF radio installation with handset and connections to fit Gecko boat crew helmets.
- Waterproof permanently fitted GPS Colour display plotter.
- Dedicated heave compensated launch & recovery davits certified for man riding, with its full complement.
- Small winch for deployment/recovery of small nets, CTDs, grabs

The workboat shall be capable of being fitted with the following survey equipment:

:

- Multi-frequency (at least 38, 70, 120, 200 kHz) calibratable scientific echosounder system, with broadband capabilities (exemplar Simrad EK80)
- Shallow-water hydrographic swath bathymetry system with water column logging capability (exemplar Kongsberg EM2040) and associated GPS (e.g. Seapath) and Motion Reference Unit
- GeoAcoustics 2094 Side Scan Sonar.

The boat shall be stowed in a cradle on deck in a hull recess, closed by a manually operated curtain. The launching and recovery system shall be specially considered to ensure safe operation. It may be assumed that the launch and recovery will take place with the vessel moving ahead at up to 6 knots and in conditions up to Sea State 3. Recommend “Offshore Industry” Daughter craft davit. S hould lock onto craft until outboard and offer wave compensation.

The work boat is to have air conditioning and heating available both when stowed onboard.

Winterisation Features

Winterisation features shall include, but not be limited to the following:

- Engine pre-heating
- Cabin heating (frost free)
- Liferaft (Polar compliant)
- Davit power system pre-heating
- Material selection for davit & workboat

6.12.3 5m General Purpose Inflatable Workboat

R6.382 Two 5m inflatable Small Commercial Vessel (ISO 6185) Design Category 'C' workboats shall be provided and stowed in a boat workshop. The boats are to be launched and recovered using one of the ship's cranes, to and from the low level boarding positions, port / starboard.

All boats to be certified for man riding.

Each boat will have the following features:

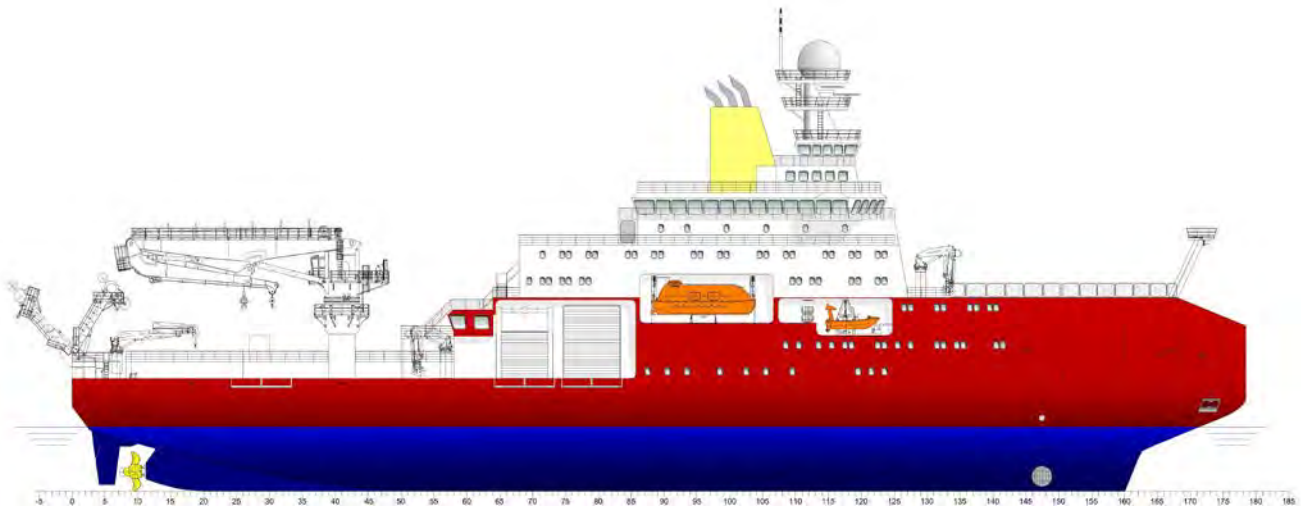
- Fully compliant with latest MCA and Workboat Code and requirements.
- 40hp outboard motor Inflation chambers – 5 off
- Over pressure relief valves – 5 off
- Inflatable keel positioned under floor boards with single inflation valve
- 100mm outer tube rubbing strake running full length of each tube
- Strong moulded rubber carrying/lifting handles – 8 off
- Bow painter securing point, heavy duty with webbing attachment
- 12cm reinforced panel underside tubes each side on straights
- 20cm wide reinforced panel positioned underside hull keel area. Heavy duty 1500 gms Hypalon
- 30cm reinforced underside tube protection on straights each side. Position from very back of second panel to very cone end, tapering at rear.
- Reinforced outer bow protection, 100mm flat rubbing strake positioned 1 off above & 2 off below standard outer tube rubbing strake, 2m in length.
- Double skin tube top protection bonded full length of straight of tubes each side – black
- 150mm single D profile strake vertical centreline of bow, turned under the forefoot
- Individual life lines mounted with D rings fittings. Positioned diagonally on tube tops 3 off each side (6 in total)

- Webbing securing patches fitted to inside underside of tubes 8 off (4 each side)
- SOLAS Reflective tape bonded to tube tops, bow canopy and underside floor
- Commercial heavy duty paddle holders mounted to tube tops, supplied with Canadian pine paddles
- Aluminium fairlead positioned to tube top bow, mounted on securing block
- Bow Apron, 1300 gms Hypalon with canopy pole and cup holder or internal support hoop depending on current design specs (to discuss?)
- Velcro storage straps – 2 off (positioned port and starboard under bow canopy)
- Large storage pockets under the bow apron, port and starboard, Hypalon
- VHF Radio pocket mounted under bow apron, starboard side.
- Tube colour Orange 1100 dtx (1500gms Hypalon fabric)
- Floor colour: Black 1670 dt x (1500gms Hypalon fabric)

STATEMENT of REQUIREMENTS (SoR) for the DESIGN and BUILD of the NEW POLAR RESEARCH VESSEL (NPRV)

Company Confidential

NERC 2015



Section 7 – THE REQUIREMENTS OF SCIENTIFIC SYSTEMS AND EQUIPMENT

7. SCIENTIFIC SYSTEMS AND EQUIPMENT

7.1 Acoustic Doppler Current Profiler (ADCP)

R7.1 The Contractor shall provide and correctly install two nos. Acoustic Doppler Current Profiler systems (75kHz & 150kHz) complete with data acquisition, processing packages and computer platforms.

The systems shall be installed to the *Manufacturer*'s recommendations within the hull of the vessel, utilising a sea-chest and arctic acoustic window arrangement.

The Contractor in conjunction with the equipment supplier and hull designer shall provide a combination of hull, ship performance and transducer installation which minimises the occurrence of aeration and results in high performance solutions.

The material used for the acoustic windows needs to match the operating frequency of the transducer and should be provided by the system Manufacturer.

The void between the transducer face and the acoustic window shall be filled with fresh water treated with an anti-freeze agent of known concentration. A means of topping off and a bleed valve are required.

Point to point cabling installation will be required between the transducers and the computer platforms.

Both systems shall be interfaced to navigation and heading information. The heading information shall come from the Inertial Navigation Unit (R7.2).

A means by which synchronism (R7.14) can be achieved between the ADCP's (R7.1), Swath Bathymetry Systems (R7.5), Sub-Bottom Profiler (R7.6), Scientific Echo Sounder (R7.7), Multi-Frequency Echo Sounder (R7.8), Biological multi-beam Echo Sounder (R 7.9), Biological multi-beam sonar R7.10) and Omni-directional sonar (R7.11) shall be provided to prevent mutual interference.

The system shall be configured to allow operation and data display within the major scientific spaces R7.21.

***EXAMPLAR**:* The 75kHz system will be a Teledyne RD Instruments Ocean Surveyor 75 type or a similar unit which is directly equivalent, this equivalence having been proved satisfactorily by use on vessels undertaking similar tasks.

***EXAMPLAR**:* The 150kHz system will be a Teledyne RD Instruments Ocean Surveyor150 type or a similar unit which is directly equivalent, this equivalence having been proved satisfactorily by use on vessels undertaking similar tasks.

The ship shall be capable of collecting data in Sea State 5 without any lost pings or data degradation, no data gaps or reduced coverage at all headings at 10 knots. At Sea State 5/6 the ship must be capable of collecting data running with the waves without any dropouts or degradation.

7.2 Inertial Navigation Unit

R7.2 The Contractor shall provide and correctly install an Inertial Navigation Unit which outputs position, heading, roll, pitch, depth, velocity, and heave. These high accuracy inertial measurements shall be based on (fibre optic gyrocompass) FOG technology or ring laser gyroscope coupled with an embedded digital signal processor that runs an advanced Kalman filter.

The unit shall be installed as close as possible to the vessel's centre of motion. Its position relative to the midship, keel and centreline must be precisely known and marked.

The unit shall be interfaced to a GPS navigation message.

The unit will provide motion data to a number of scientific instrument systems e.g. ADCPs.

Location Gravity meter Room.

EXAMPLAR: The system shall be an IXSEA Phins or a similar system which is directly equivalent, this equivalence having been proved satisfactorily by use on vessels undertaking similar tasks. The system should have IMO certification.

7.3 Position, Heading and Attitude System

R7.3 The Contractor shall provide and correctly install two nos. position, heading and attitude systems that can accept GPS, GLONASS, L1 and L2 signals.

The units shall be installed as close as possible to the vessel's centre of motion. Its position and orientation relative to the midship, keel and centreline must be known to a precision of 1 mm and five one-hundredths of a degree and marked.

The antenna baseline shall be greater than 2 metres and resonance / vibration free.

The units will provide motion data to a number of scientific instrument systems e.g. Swath Bathymetry and Ultra Short Baseline Navigation Equipment. It also likely shall be used in conjunction with the vessels Dynamic Positioning system.

Location: Gravity Meter Room.

EXAMPLAR: The system shall be an APPLANIX POSMV or a similar system which is directly equivalent, this equivalence having been proved satisfactorily by use on vessels undertaking similar tasks.

7.4 Switching Arrangement

R7.4 The Contractor shall provide a switching arrangement which allows the scientific motion reference unit and inertial navigation system output to be made available to the vessel's Dynamic Positioning System.

This will provide redundancy or the ability to share data from multiple sensor units with key pieces of instrumentation.

The Contractor is also to provide a similar switching arrangement which will allow data from the marine attitude and heading systems to be shared with key pieces of scientific instrumentation.

7.5 Swath Bathymetry Systems (Deep and Shallow Water)

R7.5 The Contractor shall provide and correctly install two nos Swath Bathymetry seabed mapping systems, one for full ocean depth (12kHz) and one for shallow water (40 - 100kHz). Both systems shall be fully tested on sea trials (deep & shallow). Both systems should have the ability to capture water column data for subsequent analysis.

The Contractor in conjunction with the equipment supplier and hull designer shall provide a combination of hull, ship performance and transducer installation which minimises the occurrence of aeration and results in high performance solutions. These combinations shall be proven satisfactory (no data dropout) at Sea State 6 and a vessel speed of 8 knots with full directional capability.

The deepwater system shall integrate with the Sub Bottom Profiler in R7.6.

The shallow water system shall be hull flush mounted.

Ice protection or ice windows shall be provided for the transducer arrays.

Both systems shall be complete with all necessary data acquisition, processing packages and computer platforms with 22" screens as a minimum screen size for acquisition systems and 22" minimum for the processing platform.

The system shall be configured to allow operation and data display within the wheelhouse console, the Aft DP Console and major scientific spaces R7.21 with the ability to switch between the deepwater and shallow water systems.

In addition a slave display/operator stations shall be provided within the forward wheelhouse console and the Aft DP Console position with the ability to switch between the deepwater and shallow water systems.

A means of transferring survey plan information (waypoints) via the vessels data network or dedicated wiring to the Wheelhouse IBS shall be provided.

A means by which synchronisation and sequencing can be achieved between the Swath Bathymetry Systems, Sub-Bottom Profiler Scientific Echo Sounder, Multi-Frequency Echo Sounder and ADCPs shall be provided to prevent mutual interference.

Two hydrophones with associated cabling shall be installed in the hull in close proximity to the shallow water multi-beam Echo Sounder transducers. The hydrophones shall be suitable for the measurement of acoustic noise around the scientific transducers.

***EXAMPLAR**:* The full ocean depth system: Kongsberg Maritime EM122 1º x 1º type or a similar unit which is directly equivalent, the system shall inclusive of Seapath 330+.

In order to future proof the hull is to be designed to incorporate a 1/ 2º Degree system as shown on Concept General Arrangement.

***EXAMPLAR**:* The shallow water system: Kongsberg Maritime EM710 Mark II 1º x 1º full performance version or a similar unit which is directly equivalent, this equivalence having been proved satisfactorily by use on vessels undertaking similar tasks.

The vessel must be capable of collecting data in Sea State 4 without any lost pings or data degradation, no data gaps or reduced coverage at all headings at 8 knots. At Sea State 5/6 the ship must be capable of collecting data running with the waves without any dropouts or degradation.

7.6 Sub-Bottom Profiler (1.5 - 7KHZ)

R7.6 The Contractor shall provide and correctly install a sub bottom profiler system. The system provided will share a receive transducer array with the deep water system.

The system shall be complete with all necessary data acquisition, processing packages and computer platforms with 22” screens as a minimum screen size.

The system shall be configured to allow operation and data display within the major scientific spaces R7.21.

A means of synchronisation and sequencing will be required to prevent interference between this and other acoustic systems.

EXAMPLAR: Kongsberg Maritime TOPAS PS018 system or a similar system which is directly equivalent.

The system shall be capable of collecting data in Sea State 4 without any lost pings or data degradation, no data gaps or reduced coverage at all headings at 11 knots. At Sea State 5/6 the ship must be capable of collecting data running with the waves without any dropouts or degradation.

7.7 Scientific Echo Sounder

R7.7 The Contractor shall purchase and correctly install a full ocean depth (8000m) scientific echo sounder system with two frequencies (10kHz & 12kHz).

The Contractor in conjunction with the equipment supplier and hull designer shall provide a combination of hull, ship performance and transducer installation which minimises the occurrence of aeration and results in high performance solutions.

The system shall be configured to allow operation and data display within the major scientific spaces R7.21.

The ship must be capable of collecting acoustic observations using this equipment in ice infested waters as well as open ocean. Therefore the system shall be installed to the *Manufacturer*'s recommendations within the hull of the vessel utilising a sea-chest and ice window arrangement.

A means of synchronisation (R7.14) must be achieved between the ADCP's (R7.1), Swath Bathymetry Systems (R7.5), Sub-Bottom Profiler (R7.6), Scientific Echo Sounder (R7.7), Multi-Frequency Echo Sounder (R7.8), Biological multi-beam Echo Sounder (R7.9), Biological multi-beam sonar (R7.10) and Omni-directional sonar (R7.11). This should enable instruments to ping together and sequentially to prevent interference.

The system shall be capable of collecting data in Sea State 6 without any lost pings or data degradation, no data gaps or reduced coverage at all headings at 8 knots.

EXAMPLAR: Kongsberg Maritime EA600 (with two GPTs, one 10k Hz the other 12kHz) system or a similar system which is directly equivalent, this equivalence having been proved satisfactorily by use on vessels undertaking similar tasks.

7.8 Biological Multi-Frequency Echo Sounder

R7.8 The Contractor shall provide and correctly install a multi-frequency echo sounder system to be fitted on the hull. The system must be capable of collecting calibrated acoustic backscatter data at - 18, 38, 70, 120, 200, 333 kHz. In addition it should have wideband functionality, operating from 10 to 500 kHz and should collect volume backscatter and target strength continuously at least 45 to 500 continuously over the entire band. Single target detection (through split beam transducers) is required and a narrow beam angle for individual frequencies of ~7° at centre frequency, 11° for 18kHz.

Two units required as BOTH flush hull mounted AND as deployed through moon pool - equal priority

Transducers (assuming multiple transducers) shall be mounted as close to each other as possible (within operational guidelines) to ensure water ensonified by each transducer is overlapping.

The Contractor in conjunction with the equipment supplier and hull designer shall provide a combination of hull, ship performance and transducer installation which minimises the occurrence of aeration and results in high performance solutions.

The ship must be capable of collecting acoustic observations using this equipment in ice infested waters as well as open ocean. Therefore at least one system shall be installed to the *Manufacturer*'s recommendations within the hull of the vessel utilising a sea-chest and ice window arrangement.

The system shall be complete with all necessary calibration spheres, data acquisition packages and computer platforms with 22" screens as a minimum screen size. A processing package shall be provided (*EXEMPLAR:* Echoview or LSSS).

The system shall be configured to allow operation and data display within the major scientific spaces R7.21.

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A means of synchronisation (R7.14) must be achieved between the ADCP's, Swath Bathymetry Systems (R7.5), Sub-Bottom Profiler (R7.6), Scientific Echo Sounder (R7.7),the Multi-Frequency Echo Sounder (R7.8), Biological multi-beam Echo Sounder (R7.9), Biological multi-beam sonar (R 7.10) and Omni-directional sonar (R7.11). This should enable instruments to ping together and sequentially to prevent interference.

The system will require calibration prior to sea trials and will be tested during sea trials.

These combinations will need shall be proven satisfactory (no data dropout) at Sea State 6 and a vessel speed of 8 knots with full directional capability.

EXAMPLAR: Kongsberg Maritime Simrad EK80 system (with 6 transducers operating at 18, 38, 70, 120, 200 and 333kHz as well as providing wideband coverage from 10 to 500kHz) or a similar system which is directly equivalent, this equivalence having been proved satisfactorily by use on vessels undertaking similar tasks.

7.9 Biological Multi-Beam Echo Sounder

R7.9 The Contractor shall provide and correctly install an instrument capable of collecting high resolution high frequency (circa 70-120 kHz) multi-beam quantitative data from the water column and seabed.

Unit required as deployed through moon pool only.

Key requirements: Beams can be configured as split beams, adjustable fan of stabilised and calibrated beams for biomass estimation, plankton/micronekton school studies.

The Contractor in conjunction with the equipment supplier and hull designer shall provide a combination of hull, moonpool, ship performance and transducer installation which minimises the occurrence of aeration and results in high performance solutions.

The system will require calibration prior to sea trials and will be tested during sea trials. The system shall be complete with all necessary calibration spheres, data acquisition packages and computer platforms with 22" screens as a minimum screen size.

The system shall be configured to allow operation and data display within the major scientific spaces R7.21.

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A means of synchronisation (R7.14) must be achieved between the ADCP's (R7.1), Swath Bathymetry Systems (R7.5), Sub-Bottom Profiler (R7.6), Scientific Echo Sounder (R7.7), Multi-Frequency Echo Sounder (R7.8), Biological multi-beam Echo Sounder (R 7.9), Biological multi-beam sonar (R 7.10) and Omni-directional sonar (R7.11). This should enable instruments to ping together and sequentially to prevent interference.

The system shall be capable of collecting data in Sea State 6 without any lost pings or data degradation, no data gaps or reduced coverage at all headings at 8 knots.

EXAMPLAR: The Simrad ME70 scientific multi-beam Echo Sounder or a similar system which is directly equivalent, this equivalence having been proved satisfactorily by use on vessels undertaking similar tasks

7.10 Biological Multi-Beam Sonar

R7.10 The Contractor shall provide and correctly install an instrument capable of collecting high resolution high frequency (circa 70-120kHz) multi-beam quantitative data from the water column.

Unit required as deployed through moon pool only.

Key requirements: An acoustic matrix of stabilized and calibrated beams for biomass estimation, plankton/micronekton school studies, in one single transmission.

The Contractor in conjunction with the equipment supplier and hull designer shall provide a combination of hull, moonpool, ship performance and transducer installation which minimises the occurrence of aeration and results in high performance solutions.

The system will require calibration prior to sea trials and will be tested during sea trials. The system shall be complete with all necessary calibration spheres, data acquisition packages and computer platforms with 22" screens as a minimum screen size.

The system shall be configured to allow operation and data display within the major scientific spaces R7.21.

A means of synchronisation (R7.14) must be achieved between the ADCP's, Swath Bathymetry Systems (R7.5), Sub-Bottom Profiler (R7.6), Scientific Echo Sounder (R7.7), Multi-Frequency Echo Sounder (R7.8), Biological multi-beam Echo Sounder (R7.9), Biological multi-beam sonar (R7.10) and Omni-directional sonar (R7.11). This should enable instruments to ping together and sequentially to prevent interference.

The system shall be capable of collecting data in Sea State 6 without any lost pings or data degradation, no data gaps or reduced coverage at all headings at 8 knots.

EXAMPLAR: The Simrad MS70 Scientific multi-beam Echo Sounder provides an acoustic matrix of 500 stabilized and calibrated beam with a horizontal operating sector of 60° and a vertical operating sector of 45°, or a similar system which is directly equivalent, this equivalence having been proved satisfactorily by use on vessels undertaking similar tasks

7.11 Omni-Directional Sonar

R7.11 The Contractor shall provide and correctly install an instrument capable of collecting and recording high resolution high frequency of 114 kHz omni-directional sonar data.

The sonar should have full 360° omni-directional capability with full beam stabilisation. The beam should be steerable, and the beam width variable. Data from the sonar shall be recorded in a RAW format , which should be supported from 3rd Party post processing SW.

The Contractor in conjunction with the equipment supplier and hull designer shall provide a dedicated hull deployment system, ship performance and transducer installation which minimises the occurrence of aeration and results in high performance solutions.

The system shall be complete with all necessary data acquisition packages and computer platforms with 22" screens as a minimum screen size.

The system shall be configured to allow operation and data display within the major scientific spaces R7.21.

A means of synchronisation (R7.14) must be achieved between the ADCP's, Swath Bathymetry Systems (R7.5), Sub-Bottom Profiler (R7.6), Scientific Echo Sounder (R7.7),the Multi-Frequency Echo Sounder (R7.8), Biological multi-beam Echo Sounder (R 7.9), Biological multi-beam sonar (R7.10) and Omni-directional sonar (R7.11). This should enable instruments to ping together and sequentially to prevent interference.

EXEMPLAR: Simrad SH90 fish finding sonar or a similar system which is directly equivalent, this equivalence having been proved satisfactorily by use on vessels undertaking similar tasks

7.12 Ultra Short Baseline (USBL) Navigation System (Starboard)

R7.12 The Contractor shall provide and integrate an ultra short baseline navigation system (20 – 33kHz); the system will be fully tested by sea trials.

The instrumentation (transducer and electronics unit) will be provided.

The unit consists of a transducer array on a s talk which is deployable through a dedicated hull penetration on the ship's bottom. A 500mm diameter hull penetration piece shall be fitted on top of which a horizontally placed gate valve shall be mounted.

When the unit is not in place the valve shall be closed and fitted with a blank flange.

The valve and spar shall be hydraulically driven and remotely operated from outside the space.

The trunk position and length of spar should position the transducer 2.5 metres below the line of the keel when fully deployed.

A remote indicator is required at the wheelhouse console in the head up displays to show valve open/valve closed and spar deployed / spar retracted. A safety interlock is required to prevent an operator from ramming the transducer into a closed gate valve.

Access ladders and working platforms shall be fitted at the requisite levels to allow access and safe working. Lighting (waterproof) should be provided from the top of the transducer space.

A large bolted access panel is required in the trunk to allow shipment/removal of the spar equipment. A bolted manhole cover shall be provided for normal access to the trunk shall be 600mm x 500mm with steps and grab rails externally on the trunk. The manhole cover to have handles to aid removal and a t ell-tale valve to check for flooding.

The access manhole shall be located above the normal load waterline and a bilge pumping connection shall be fitted to the bottom of the trunk.

A 1" air-vent with valve shall be fitted to the top of the trunk with suitable access.

Point to point installation cabling will be required between the transducer and the UIC Room. Cabling to the trunk should be via watertight glands.

The precise position of the spar in extended mode needs shall be surveyed and included within the vessels co-ordinate systems.

Additional information:

USBL system to be:

a) connected to DP System

b) Rack mountable

c) Multiple targets

The Contractor shall liaise with the supplier to ensure that the unit is integrated and installed correctly. The Contractor shall design, manufacture and fit the deployment spar system.
***EXEMPLAR*:** Sonardyne Ranger 2 complete with Transceiver Deployment Machine or Kongsberg HiPAP

7.13 Ultra Short Baseline (USBL) Navigation System (Port)

R7.13 The Contractor shall provide and correctly install a duplicate deployment arrangement including a 500mm diameter hull penetration piece, gate valve, hydraulic drive, spar and cabling from the transducer position to the UIC and Laboratories.

Fittings and general arrangement shall be the same as described at R7.12

In the future a second system will be fitted to this position.

7.14 Synchronisation Unit

R7.14 The Contractor shall provide and integrate a synchronisation control unit for use with a number of acoustic systems. The system shall be easily configurable to control the triggering of acoustic systems to allow co-operation with minimal interference.

Systems shall be integrated and interfaced are ADCPs (7.1), Swath bathymetry systems both shallow and deep (7.5), Sub-bottom profiler (7.6), Scientific Echo Sounder (7.7), Biological multi-frequency Echo Sounder (7.8), Biological multi-beam Echo Sounder (7.9), Biological multi-beam sonar (7.10), Omni-directional sonar (7.11) plus two spare channels.

Ideally other ship acoustic systems (navigation Echo Sounder, Doppler logger) would be integrated into this system, however it must not impede their operation for the safety of the ship

The system shall be complete with all necessary data acquisition packages and computer platforms with 22” screens as a minimum screen size.

The system shall be configured to allow operation and data display within the major scientific spaces R7.21.
***EXAMPLAR**: Kongsberg K-sync*

7.15 Net Monitor System

R7.15 The Contractor shall, in conjunction with NERC and major equipment suppliers, provide and correctly install a Scanmar net monitor system for deep water nets.

The transducers shall be mounted on the hull and in the same.

Point to point cabling installation will be required between the transducer(s) and the electronics/operator unit shall be located within the UIC Room.

The system shall be configured to allow operation and data display within the major scientific spaces and wheelhouse R7.21.

The system comprises items that are permanently mounted to the vessel.
Transducers associated cabling and display/control hardware.

The system comprises the ancillary sensors, battery chargers, software and system licences.
***EXEMPLAR**:* Scanmar ScanScreen System with 4 trawl hydrophones installed in the hull set for deep water operation.

7.16 Air Sampling System

R7.16 The Contractor shall provide and correctly install an air sampling system which can be deployed forward of the vessel in free air above the bow.

Clean air, uncontaminated by ship emissions, shall be drawn from at least 2m forward of and as high as is practical above the peak of the bow.

NERC will provide all necessary sampling equipment and consumable tubing for the purpose.

The sampling tube and instruments shall be easily and safely mounted on the system both on a cruise-by-cruise basis and during cruises.

The system shall be r etractable, stowable and robust taking into account the high seaway accelerations which will be prevalent at its position.

GAS SAMPLING

- Gas sample line - 1/2 or 1/4 inch synflex suitable.
- Gas sample line should have an impactor/cyclone on inlet to prevent water droplets or large sea-salt aerosol particles entering the system. This must be matched to the flow rate through the sample line (most inlets matched to 16.7 lpm by default).
- Condensation in the sample lines is a potential problem. Should install driers or water traps in the sample line.

AEROSOL SAMPLING

- Requirements for an aerosol particle sample line are more critical than for gas sampling. Tubing should be r elatively large diameter (~50mm), and bends minimised and made as large-radius as possible.
- Tubing should be stainless steel – needs shall be conductive and resistant to corrosion.
- Inlet should have a particle size cut-off to prevent large particles and droplets entering (cut off size of order 10 μm). Within the laboratory space the sample line should have a series of iso-kinetic inlets sampling the flow within the tube to provide sample feed to individual instruments.
- A high-volume pump should provide a w ell calibrate flow rate through the system.
- Similar sampling arrangements are required to the aerosol lab above bridge, with samples drawn from forward and above crow's nest (CFD modelling of flow should inform precise location of inlet to obtain representative sample of ambient air)
- Design and installation should involve aerosol community to ensure sampling requirements are properly met.

7.17 Clean Air Sampling Tubing and Cable Runs

R7.17 The Contractor shall provide and correctly install an air sampling system which can be deployed forward and above the bridge into the Aerosol Laboratory complete with tubing and cable runs. Specification as per 7.16

7.18 Scientific Meteorological Instrumentation

R7.18 *NERC will provide meteorological equipment from the National Marine Equipment Pool* which shall be correctly installed by the Contractor.

This shall be mounted on the meteorological platform forward and the instruments connected to equipment in the Atmospheric Science Laboratory.

A duplicate set of instrumentation shall be mounted above the crow's nest, and instruments connected to equipment in the Aerosol Laboratory.

A 12 twisted pairs (24 wires) cable shall be run in conduit pipe from the junction box back to the Atmospheric Science and Aerosol Laboratories and thence to the Main Laboratory. Wiring to junction boxes (on foremast, above crow's nest & other upper decks where instruments may be mounted) should include network access and power (24VDC, ideally multiple connections separately switchable from lab space to allow easy power cycling of instruments)

Addition of DC power and Ethernet (ideally to ~12-port switch in junction box) shall ease powering of instruments & access to data – many instruments now fitted with network as well as RS232/485.

Twisted pair cabling shall be sufficient for both permanent fit instruments, and temporary fit plus a reasonable excess to requirements.

Spare wires in twisted pairs for temporary instruments may need shall be used for DC power – ensure current capacity is sufficient for ~50-100W (have had to double up wires to power kit on JCR foremast)

- The mountings will consist of:

  - Two horizontal plates, 600mm x 300mm x 8mm, mounted, one to port and one to starboard, at the extremities of the aft end of the platform. These will carry gimballed light sensors.

  - Two vertical plates mounted in line on the outside of the forward port side of the platform to which a 2m high pole carrying wind speed and direction sensor which will be fitted.

  - Two plates 800mm wide welded to the inside of the aft transverse guard railing drilled to suit the fitment of junction boxes and other equipment. A matrix of holes 8mm diameter shall be drilled all over the plates at pitch 100mm x 100mm

  - Utilisation of Deck Matrices on w here installed on ope n accommodation deck areas.

7.19 HRPT RECEIVER

R7.19 The Contractor shall provide and correctly install an HRPT receiver which shall be installed correctly and fully tested by sea trials.

The aerial dome shall be installed on the wheelhouse top in a position free from interference from other equipment and with clear viewing of the satellite horizons.

It shall be supplied with a UPS, isolation transformer and all data, control connections to the control/monitor unit which shall be installed in the Electronics Space

EXAMPLAR*:* The system will be a DARTCOM type or a similar unit which is directly equivalent, this equivalence having been proved satisfactorily by use on vessels undertaking similar tasks

7.20 Hull Sea Surface Temperature Indicator

R7.20 The Contractor shall provide and correctly install two independent hull sea surface temperature sensors.

1. The sensor shall be fitted into the Clean Seawater Supply intake. The system electronics and display shall be included with the display/operation console within the Laboratories R7.21. The system shall have an absolute accuracy of 0.001°C (1 mK) and a resolution of 0.00025°C or better.
   NB. This sensor will only provide a reliable measurement when the pumped sea water system is turned on.
   ***EXAMPLAR**: SBE38 with mounting kit from Sea-Bird Electronics Inc.*

2. Hull contact sensor shall be fitted to outer hull below waterline. This will provide an effective temperature measurement when pumped water supply is turned off.

   This sea surface temperature sensor shall be fitted in the void space that will measure sea surface temperature by contact with the inside of the outer hull. This sensor shall operate when the pumped Clean Seawater supply is not operating. System electronics and display shall be included with the display/operation console R7.21.

7.21 Scientific Display / Operation Consoles

R7.21 The Contractor shall ensure, in conjunction with NERC and major equipment suppliers, that each major science space shall have the facility to display a significant quantity of scientific data in real time from a variety of disparate sources detailed in the SoR.

Control of some of those sources may also be needed.

The system shall be tested during sea trials.

Scientific Display / Operation Consoles shall be in All Laboratories, UIC, Data Suite and other scientific control spaces via ethernet connection.

Data display capability (7.21 and 7.29) required in ALL Laboratories. Data operation and display (7.21) required in the UIC (local control), Data Suite (remote control) and Main Laboratory (remote control).

7.22 Winch / CTD Operations Console

R7.22 The Contractor shall in conjunction with NERC and major equipment suppliers develop an ergonomic console for simultaneous operation of the winch and CTD by two personnel.

The console shall be made from suitably sized 19” or 22” wide instrument cabinets of a depth to accommodate instrumentation. The height of the cabinets should be below bench height. A minimum of two pedestal cabinets with bench over shall be included. The console shall be positioned so as to enable winch operation whilst also enabling full visibility by the winch operator of the working deck fore and aft.

Displays should be arranged for comfortable viewing when seated with “helmsman” type seating.

The console shall be installed (connected to electrical power supplies and attached to the structures with substantial portable attachments allowing for maintenance and replacement) in the Underway Instrumentation and Winch Control Room

The console arrangement should be large enough to accommodate the following items:

- Scientific Winch Logging & Monitoring System (R7.23)
- Scientific Winch Systems (R6.337)
- Data Display System (R7.29)
- CCTV System (R6.330)
- Networked Maritime Surveillance System (R6.331)
- Internal Communications (R6.332)
- Spare space (for CTD system; Owner to provide post interim delivery)

240v power distribution boards with at least 10 outlets per cabinet should be feed from the scientific electrical supply.

7.23 Scientific Winch Logging & Monitoring System

R7.23 The Contractor shall provide and correctly arrange the system to collate and display, log and store the output signals from the chosen scientific winch system metering system and to shall install equipment installation bracketing and cable ways within the winch room and from there to the UIC winch control room, and the display/operation console in the Data Suite, Main Laboratory and the Wheelhouse. See , R7.21

NERC will test and check the correctness of the output signals at destination on completion of the installation and based on output signal testing during the scientific winch FAT.

7.24 Scientific Wiring

R7.24 The Contractor shall purchase and correctly install an inter-laboratory and working deck scientific wiring facility which shall be properly installed and tested during trials.

A comprehensive system of inter laboratory and working deck wiring is required shall be permanently installed so that equipment, both installed and brought on board, can be properly integrated into the data management system without undue need for temporary wiring on a cruise by cruise basis.

Open tray work and ducting will however be required for the temporary additional wiring needs which will inevitably arise.

Allow for 400m overall length of open topped channel trays, 125mm wide and 50mm deep, fitted with support brackets which can be bolted to the deckhead Stauff rails in the laboratories as required. Each piece of tray channel shall be 2m long. Positioning generally around the periphery of each lab, interconnecting alleyway routes and finger benches, final positions shall be agreed by Owner. Channel tray material may be galvanised steel or stainless steel or powder coated steel.

The permanent wiring system will consist of a system of Junction Boxes located throughout the vessel both inside and outside in working areas linked together by various types and sizes of wiring. The junction boxes should include a schematic illustrating cable types and source destination.

This shall be in conjunction with R7.25

Scientific Wiring Standards

General
NERC will consider alternatives which, through the use of modern materials and production techniques, offer improvement with regard to robustness, durability, and cost effectiveness.

In the unlikely event that any of these standards create a conflict with the requirements of the Classification and Surveying Authorities then the requirements of the latter will generally apply. In such event however it is to be brought to the immediate attention of NERC who will discuss the issues with the Classification and Surveying Authorities directly.

Specification for Junction Boxes

- All external boxes to be to IP67. They may be plastic (but not susceptible to UV degradation) or stainless steel (SS316)
- All cables to be uniquely numbered (visibly on the cable). All wires to be individually identifiable (colour / number)
- Internal boxes to have letterboxes for cable entry.
- External boxes to have removable gland plates. Spare plates required
- Screens are not to be connected to ground but individually connected to a terminal.
- Single terminals to be used at the start and end of a cable run. Dual terminals to be used in mid cable runs.
- Coaxial connectors should be colour coded to show impedance (Red - 75 & Green - 50ohms).
- Aerial connectors should be terminated in N type connectors.
- CCTV connectors should use F type when in a junction box.
- Cables designated as special should be run separately in metal conduit and terminated where required in separate junction boxes.
- Cable tray arrangements should allow for the temporary cables to be fed runs across the laboratories etc.
- Bootlace ferrules (or similar) should be used.

Siting of Junction Boxes

- Easily Accessible
- Not placed where likely to be obstructed by equipment
- Not inside lockers
- Not under benching
- Close to cable tray
- Close to Gooseneck/Duct if appropriate

Fibre Optic Cables
Where fibre optic cables are installed, they should be run point to point as continuous cables without any in-line connections which would induce cable loss.

7.25 Ship's Integrated Network System

R7.25 The Contractor shall design, supply, fit and test the system in total.

A network system shall be fitted throughout the vessel in accordance with the following requirements:

- The main network infrastructure should be based on Category 7 copper wire terminated in Category 7 GG45 connectors. Shielded cable should be used throughout to support 1 Gbps data transfer rates at workstations. The backbone links of the network should be fibre with transmission capability of at least 10Gbps. These backbone links will need to be duplicated to provide redundancy in event of failure. All cable and connectors used should have "Type Approval Certification" from either Lloyds Register or Det Norske Veritas.

- All managed network components should utilise a Cisco operating system with associated tools.

- It is anticipated that the network components will be distributed through the vessel. Distribution should be limited to ideally three locations; based on the concept vessel drawing these locations are the Electronics Space (Navigation Bridge Deck), the Server Room (Upper Deck) and the Bottom Equipment Room (Main Deck). The Server Room should house the server, management system.

- The powered system components should be supported by a dedicated local UPS (Uninterruptible Power Supply) capable of powering the system components for at least 20 minutes during a power outage. A clean shutdown should be accomplished on any managed components in the event of a greater than 20 minute power outage occurring. A common model of UPS should be utilised, sized for the space with the most demanding requirement.

- A WLAN (Wireless LAN) should be implemented with coverage of the following areas of the vessel:

  - ❖ All indoor science areas, including all Laboratories, Dark Room, Sensor Room, Gravity Meter Room, Salinometer Room, Deck and Rough Workshops, Data Suite, UIC, Science Hangar, Starboard Side Deck, Aft Deck & Forward Area (Forecastle Deck), and Helicopter Hangar.

  - ❖ Wheelhouse, Library & Conference Room, Research Room, Recreation / Coffee Area, Video Room, Mess Room, Helicopter Reception and All Cabins. In some cases this will require an external antenna arrangement.

  - ❖ Where cables penetrate boundaries for EMC, water or fire integrity then the method used needs to provide protection for the delicate nature of the data cabling, so it is not damaged during installation or during the vessel lifetime.

  - ❖ Where patch cables or splitter cables are required to access data points or internal to the network installation these should be provided at build.

- ❖ The presentation of outlet points will be dependent on the location and the style of outlet. Typically laboratories will require a data / power conduit where as accommodation spaces are likely to have discrete outlets.

Ships Integrated Data Acquisition and Processing System
An enterprise / data centre level multimedia capable storage area network and appropriate backup facilities capable of nightly incremental, full weekly and monthly backups with a retention policy of one year.

Multiple associated servers capable of supplying uninterrupted file access and hosting multiple virtual servers, with full redundancy and hot swap capable shall be sourced, installed and configured either in conjunction with the BAS ICT section.

Contractor shall provide test procedure approved by NERC. Tests shall be witnessed by NERC representative. Random sample testing will be carried out by NERC.

7.26 Low Power (RS232/485) Network

R7.26 The Contractor shall design, supply, fit and test the system in total.

A low power network system shall be fitted throughout the vessel in accordance with the following requirements

- A low or zero power cabled network is required for the transmission of typically serial data messages from the laboratory spaces to the Server Room. The network should incorporate a method of patching signals from one point to another using the Server Room as the hub.
- The distribution of outlets can be clustered into one point in most laboratories or space but should be split into two points for the Main Laboratory, Data Suite and the Deck Laboratory to facilitate access.
- It would be of benefit if Category 7 cabling was utilised and if the system installed was capable of being upgraded in the future to interface with the Ship's Integrated Network System described above R7.26. If Category 7 cabling is not utilised then an overall shielded cable UL style No. 2919 or better should be used.
- Where patch cables or splitter cables are required to access data points or internal to the network installation these should be provided at build.

Contractor shall provide test procedure approved by NERC. Tests shall be witnessed by NERC representative. Random sample testing will be carried out by NERC.

7.27 Gyro Inputs

R7.27 The Contractor shall design, supply, fit and test the system in total.

A buffered interface providing six outlets of heading data in NMEA string format in the Main Laboratory (3), Server Room (1) and Deck Laboratory (2) UIC Room (3) and Data Suite (3) as well as all other slave monitors in other Laboratories shall be provided.

The data source shall be switchable between any of the navigation heading sources, including ship's gyrocompasses or inertial navigation units.
NERC will test and check the correctness of the output signals at destination.

7.28 Data Signals to the Server Room

R7.28 The Contractor shall in conjunction with NERC and major equipment suppliers ensure that each science space shall have the facility to display a significant quantity of scientific data in real time from a variety of disparate sources.

The system shall be tested during sea trials.
Inspection and testing by checklist and to NERC satisfaction.

7.29 Data Display System

R7.29 The Contractor shall purchase and correctly install the hardware for a display system. The system shall be used to display information from a variety of ship systems and scientific data in real time. The system shall be tested during sea trials.

Provision shall be made for a distribution of bulkhead mounted monitors and video over IP system shall be used to display real time underway data from any available running instrument.

A display system shall be fitted throughout the vessel in accordance with the standards in R7.24 and R7.25 with at least 2 x 22" slave monitors in each laboratory.

Stauff rails should be provided sufficient to allow both removal and addition of further monitors in each console location

A white marker board shall also be provided in each laboratory.

7.30 Laboratory Gas System

R7.30 The Contractor shall provide permanently installed laboratory gas piping. This must be installed by a specialist qualified for the task and the installation must be to relevant standards.

A section of the ductwork described in Gas Bottle Store (R6.110) shall be allocated to the permanent installation of 4 pipes (Nitrogen, Oxygen, Helium, pure air) from the gas bottle store to each of the laboratories. The pipes shall be 6mm nominal bore with no in line couplings if at all possible

Connection manifolds shall be provided within the Gas Bottle Store and each laboratory at locations that shall be defined.

On occasion gas bottles will be stored and used from the Hangar. It is therefore a requirement that temporary lines can be run in a similar duct as described in Gas Bottle Store (R6.110) from the Hangar to the Laboratories.

A bottle storage position or positions shall be provided to secure for use up to 12 J sized gas bottles in the vicinity of the Atmospheric Science Laboratory; a suggestion is within the forward Heli Hangar or Mooring Deck.

A gas leak (above gases plus hydrogen) detection and alarm system shall be provided covering the laboratories, bottle storage locations and the ducting for temporary lines. Gas detection sensors for Nitrogen and CO_2 will be required in the Atmospheric Science Laboratory and associated storage space. The detection / alarm system control unit should be located in the Main Laboratory. It should be interfaced to the vessels VMS system. The system should be fully calibrated at "Interim delivery".

Liquid nitrogen generator location shall be fitted alarms interfaced to the vessels VMS system to monitor of nitrogen

The specialist shall be identified and employed directly by the Contractor and approved by NERC.
***EXEMPLAR**: The system installed on the R.R.S. DISCOVERY was installed by specialists from Medical Gases Ltd UK.*
***EXEMPLAR**: The system on the RRS James Cook was installed by specialists from Haakon Rygh.AS (www.haakon-rygh.no)*
EXAMPLAR Detection Alarm System: Oldham MX52
Inspection and testing and calibration shall be carried out to NERC satisfaction.