

STATEMENT OF REQUIREMENT

DESIGN, DELIVERY AND INSTALLATION OF A NEW STEERING GEAR SYSTEM FOR THE CCGS PIERRE RADISSON



Pêches et Océans
Canada

Fisheries and Oceans
Canada

Garde côtière

Coast Guard

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1 GENERAL NOTES

- 1.1.1 All the following work specified herein and all repairs, inspections and renewals shall be completed to the satisfaction of the Coast Guard Technical Authority (CGTA), who, unless otherwise advised, will be the Chief Engineer (C/E) of the ship. Upon completion of each item of the specification, the C/E shall be so notified so that he may inspect the work prior to final closing up and after complete closing up. Failure to give notification does not absolve Contractor of the responsibility of providing the C/E the opportunity to inspect any item. Inspection of items by the C/E does not substitute for any required inspection by Transport Canada Marine Safety Branch (TCMSB).
- 1.1.2 Any item of work involving the use of heat in its execution requires that Contractor obtain prior authorisation of the C/E prior to starting such heating and upon its completion. Contractor shall be responsible for maintaining a competent and properly equipped fire watch during and for one full hour after all hot work. The fire watch shall be arranged such that all sides of surfaces being worked on are visible and accessible. Contractor shall provide sufficient suitable fire extinguishers and a fire watch during any such heating and until work has been cooled. Ship's extinguishers are not to be used except in an emergency. Contractor shall abide by the Coast Guard Hot Work policy that will be handed over to him before the beginning of work. Contractor shall be responsible to ensure that Contractor's personnel including all subcontractors shall follow the policy.
- 1.1.3 Contractor to include in quote the costs of any and all transportation, staging, rigging, slinging, crantage, installations of parts and equipment such as may be required to carry out work.
- 1.1.4 Any piping, manholes, parts and/or equipment requiring removal to carry out specified work and/or to gain access shall be replaced upon completion with new jointing, nuts, bolts, anti-seize compound, clamps and brackets as applicable (Contractor supply), and secured in original condition. Any removals shall be jointly inspected by both Contractor and the C/E prior to removal.
- 1.1.5 Contractor to ensure that all spaces, compartments, and areas of the ship, both internal and external, are left in as clean a condition as found. The cost of removing dirt, debris, and associated material shall be included in the quote on each item of this specification.

- 1.1.6 Contractor to supply the C/E with marine chemist's certificates in accordance with CGSSB TP 3177E before any cleaning, painting or hot work is commenced in confined spaces or machinery compartments. Certificates shall clearly state the type of work permitted, and shall be renewed as required by the regulations.
- 1.1.7 Whenever any work is being carried out involving a ship's firefighting or fire detecting system, it shall be done in such a way as to leave the vessel and any persons aboard with adequate protection against fire at all times. This may be so accomplished by removal or disarming of only a portion of the system at a time, by replacement with spares while work is in progress or by other reasonable means acceptable to the C/E.
- 1.1.8 Unless specified otherwise, any replacement and/or disturbed steel work to be given a minimum of two (2) coats of marine primer immediately upon completion of work.
- 1.1.9 All materials, unless otherwise specified, shall be supplied by Contractor. Where a particular item is specified, or where substitution must be made, the Chief Engineer must approve all material offered.
- 1.1.10 Contractor to be responsible for calling in the services of Transport Canada Marine Safety Branch (TCMS), when and as required for survey and inspection.
- 1.1.11 Public Service Smoking Policy forbids smoking in Government ships in all areas inside the ship where shipyard personnel will be working. Contractor shall inform shipyard workers of this policy and ensure that it is complied with in all cases.
- 1.1.12 Contractor shall use fully qualified, certified and competent tradesmen and supervision to ensure a uniform and high level of workmanship as judged by normally accepted shipbuilding standards to the C/E's satisfaction.
- 1.1.13 The design, delivery and installation of all machinery and equipment specified herein shall be as per the Manufacturers' applicable instructions, drawings and specifications.

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

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

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

1.1.16 All electrical installations or renewals shall be in accordance with the latest editions of the following Marine Standards:

- a. TP 127 – Ship Safety Electrical Standards
- b. IEEE Standard 45 – Recommended Practice for Electrical Installation on Shipboard

1.1.17 All materials supplied and work carried out by Contractor shall be adequate to meet the following service conditions:

- a. outside air temperature of minus (-) 40⁰ C to plus (+) 35⁰ C;
- b. wind velocity of 50 knots;
- c. water temperature of minus (-) 2⁰ C to plus (+) 30⁰ C;
- d. Shock loading of 2.5g horizontal, 1.5g vertical.

2 Modernization of Steering Gear System (Overview)

2.1 Purpose

- 2.1.1 The purpose of this document is to establish the technical requirements of a project to modernize the steering gear systems, comprising the steering gear controls and hydraulic actuation of the 1200-type vessels *CCGS Pierre Radisson*, *CCGS Amundsen*, and *CCGS Des Groseilliers*, all 3 vessels based in Québec City. They belong to the icebreaker fleet of the Canadian Coast Guard (CCG), a division of Fisheries and Oceans Canada (DFO), Central & Arctic Region.
- 2.1.2 The aim is to provide enough information to give potential bidders a clear picture of the project details so that they may propose replacement solutions that will meet the high reliability and performance objectives that have been established.
- 2.1.3 As the 3 steering gear systems installed on the three (3) 1200-type vessels are similar without being identical, all or most of the differences will be accentuated in the following specification. All through the document, these acronyms will be used to address one or the other vessels: **PR**: Pierre Radisson, **AM**: Amundsen, **DG**: Des Groseilliers.
- 2.1.4 It will be the bidder's responsibility to ensure that he has the required knowledge and understanding of all technical details of this project and to ensure that the requested work as set out in this document is completed to the full satisfaction of the Technical Authority (TA), which includes providing all items and work deemed necessary to enable the safe and satisfactory operation of this type of vessel.

2.2 Background

- 2.2.1 The *CCGS Pierre Radisson* and *Amundsen* are type 1200 vessels. They are two nearly identical icebreakers built at Burrard Dry Dock between 1976 and 1979. The *CCGS Des Groseilliers* is also a 1200 type vessel, built at Port Weller Dry Docks in 1982. The Des Groseilliers has a similar type of steering gear, but not identical. This project is being carried out within the framework of a national modernization program (VLE). The bidder's proposal will apply to all 3 of these vessels. As vessels are similar but not perfectly identical, a few differences will be addressed during this proposal, and will be dealt with by the bidder.

2.2.2 Although some technical improvements have been made to all 3 of the vessels in recent years, many of the steering gear components are original and are approaching the end of their useful life. This poses several problems in terms of reliability and spares procurement, in addition to causing general deterioration of all systems over the years. The mandate of the modernization program is to guarantee the reliability of these systems for an additional 15 years.

2.3 Overview of the Current Steering Gear Systems

2.3.1 The typical Type 1200 steering system is comprised of a single unbalanced rudder with a surface area of 16.07 square metres, coupled to a 0.54m diameter stock rated for a continuous working torque of 425,000 ft.-lbs (58.8 t.m.). The maximum torque recorded during trials was 950, 000 ft.-lbs¹ (131.5 t.m.) and occurred while operating in ice covered waters. The design load of this steering gear system is found to be twice that of an open water ship travelling at 18 knots at designed draft. They were designed by Wagner Engineering Limited, from Vancouver, B.C. Today, Wagner is operated as a division of Jastram Engineering, which occupies the same facility.

2.3.2 The steering gear is arranged for a working angle of 37 degrees port to 37 degrees starboard of the centre line with full strength stops arranged at 39 degrees port and starboard. When the vessel is not underway, the gear is capable of moving the rudder hard over port to hard over starboard in 18 seconds with two (2) power pumps in operation, and 28 seconds with one (1) power pump in operation. This is only possible with the propellers stopped and no ice pressure is exerted on the rudder.

¹ "After Action" Report Arctic Trials CCGS Pierre Radisson, Edwards et al. 1978 Report # 245C-3

Note: Rudder and Steering Gear Load Measurements on CCGS Pierre Radisson, March 31 1985, Report FR1776C TP 6250E infers Max hydrodynamic torque of 0.24 MN-m, normal operations icebreaking and escort duty of 0.44 MN-m and 1.29 MN-m backing and ramming. Report "Results of Trials in Ice & Open Water of Pierred Radisson Volume 1 20 August 1979 (Final Report 245C-7)n states average torques in ice was 550k ft-lbs (0.75 MN.m) and peaks to 950k ft-lbs (1.29 MN.m).Rise times on order of three hundredths of a second. Torque corresponds to one quarter yield torque of rudder stock.

2.3.3 **Steering operations from the wheelhouse** are accomplished through the use of one or many types of steering modes that are not similar on each vessel, as certain discrepancies are illustrated as follows:

- a. **PR:** one (1) Wagner Model D helm pump, Non Follow Up (NFU) and Full Follow Up (FFU) mini hand wheel (Sperry supply) located in the Center bridge console. The manually operated hydraulic helm pump acts directly upon a hydraulic telemotor system located in the steering compartment. The Port and Starboard bridge consoles are fitted with Non Follow Up (NFU) levers (Sperry Supply). All the NFU and FFU controls (in wheelhouse and steering flat) actuate the hydraulic telemotor cylinder via the Control System Pump(s) and solenoid valve system, which in turn operates the 4- way Flow Control valve that directs oil from the main steering pumps to the power cylinders. The Auto Pilot is a Sperry Model Navipilot 4000.
- b. **AM:** one (1) Wagner Model D helm pump, Non Follow Up (NFU) and Full Follow Up (FFU) **large helm wheel** (Sperry supply) located in the Center bridge console. The manually operated hydraulic helm pump acts directly upon a hydraulic telemotor system located in the steering compartment. The Port and Starboard bridge consoles are fitted with Non Follow Up (NFU) levers (Sperry Supply). All the NFU and FFU controls (in wheelhouse and steering flat) actuate the hydraulic telemotor cylinder via the Control System Pump(s) and solenoid valve system, which in turn operates the 4-way Flow Control valve that directs oil from the main steering pumps to the power cylinders. The Auto Pilot is a Sperry Model ADG (older version of the NaviPilot 4000).
- c. **DG:** : one (1) Wagner Model D helm pump, Non Follow Up (NFU) and Full Follow Up (FFU) **mini hand wheel** (Sperry supply) located in the Center bridge console. The manually operated hydraulic helm pump acts directly upon a hydraulic telemotor system located in the steering compartment. The NFU and FFU controls actuate the hydraulic telemotor cylinder via the Control System Pump(s) and solenoid valve system, which in turn operates the two 4- way Flow Control valves that directs oil from the main steering pumps to the power cylinders. The Auto Pilot is a Sperry Model Navipilot 4000.

2.3.4 **Steering operations from the steering gear compartment** are accomplished through the use of many types of steering modes that are not similar on each vessel, as certain discrepancies are illustrated as follows:

- a) **PR:** steering from within the Steering Gear Compartment is accomplished through the use of two (2) Wagner Model D helm pumps. One pump acts directly upon the telemotor cylinder (as per the wheelhouse pump), the other acts directly on the power cylinders. Also, one (1) Non Follow Up (NFU) controller is situated near the telephone booth, complete with a heading binnacle, rudder angle & order indicators for emergency steering. A 5 H.P. locking pin pumpset is also installed in the compartment.
- b) **AM:** steering from within the Steering Gear Compartment is accomplished through the use of two (2) Wagner Model D helm pumps. One pump acts directly upon the telemotor cylinder (as per the wheelhouse pump), the other acts directly on the power cylinders. Also, two (2) Non Follow Up (NFU) controllers (1 for port pump & 1 for starboard pump) are situated near the telephone booth, complete with a heading binnacle, rudder angle & order indicators for emergency steering. A 5 H.P. locking pin pumpset is also installed in the compartment.
- c) **DG:** steering from within the Steering Gear Compartment is accomplished through the use of two (2) Wagner Model D helm pumps. One pump acts directly upon the telemotor cylinder (as per the wheelhouse pump), the other acts directly on the power cylinders. Also, two (2) Non Follow Up (NFU) controllers (1 for control pumps & 1 for auxiliary pump) are situated near the telephone booth, complete with a heading binnacle, rudder angle & order indicators for emergency steering. The auxiliary pump (5 H.P. electric motor + 26V-12 Vickers pump) is used to insert and remove the quadrant locking pin and move power cylinders in emergency steering mode.

2.3.5 A Fast Acting Relief Valve (FARV) is fitted to limit system pressures, as a result of observed rudder torques in excess of 950,000 ft. lbs occurring over a period of 0.03s, without incurring damage to the hydraulic components.

- 2.3.6 The settings of the FARV do not exceed the design pressure. Two (for PR & AM) or four (for DG) Vickers CF-Series relief valves are mounted on the control valve assembly plate. These valves are of the balanced piston design and protect the steering system components and rudder stock from excessive loading. They are set at 1300 psi, or 200 psi above the maximum operating pressure of the steering system for **PR & AM**, and 1740 psi, or 290 psi above the maximum operating pressure of the steering system, for **DG**. They do not operate under normal conditions.
- 2.3.7 The FARV is of adequate sizing and so designed as to avoid undue rise in pressure above the design pressure (1100 psi for **PR & AM**, and 1450 psi for **DG**).
- 2.3.8 The existing control valve assembly currently delivers positional accuracy of better than ± 0.25 degrees at maximum hard over rudder speeds up to 4 seconds and provides motion storage with automatic slack compensation and silent, shock less positioning.
- 2.3.9 The 4-way Flow Control valves (one for each vessel) are identical on PR and AM, but the DG system is different and comprises two (2) 4-way Flow Control valves.
- 2.3.10 A cylinder bypass solenoid valve is fitted and is used to "short-circuit" the steering cylinders at the same time as the lock pin is activated. This allows the pin to pull the steering gear tiller into position as the locking pin enters the tiller pin socket. This valve is normally closed. The steering gear will not operate if this valve is in the open position. The position of these 4-way valves is controlled by the movement of the telemotor cylinder
- 2.3.11 Two (2) main power pumps provide hydraulic pressure for two (2) double acting hydraulic cylinders (rams) connected to the tiller/rudder post arrangement. PR and AM pumps are identical (Vickers 50V-72 @ 1100 psi operating pressure, powered by 75 H.P. electric motors), and DG pumps are different (Vickers 50V-85 @ 1450 psi operating pressure, powered by 100 H.P. electric motors). Main cylinders (rams) are also different, as PR and AM are identical (Model L 100-52), DG cylinders are a different model (L-280-1336).
- 2.3.12 All steering gear systems have a power system header tank, varying from a capacity of 950 litres on PR and AM, to about 345 litres on DG. This tank is positioned above all steering gear pumps in the steering compartment. A smaller control system header tank of a capacity of 35 litres is installed in the wheelhouse ceiling, above the helm pumps.

2.3.13 As the hydraulic oil is constantly being displaced through the system, even when steering gear is in neutral position, cooling is necessary for the oil. Different type coolers are installed on all 3 vessels. Fin-type units with fans forcing air through the units are used. PR and AM have a supply and exhaust air system to mechanically exhaust hot air outside the steering compartment. DG relies on natural ventilation of compartment to get rid of hot air produced by the cooler.

2.4 Objectives of the New System

2.4.1 The bidder must design, deliver and install a modern, reliable and robust replacement steering system capable of meeting or exceeding the operating and design parameters of the steering systems currently fitted on CCGS Pierre Radisson. These systems must conform to Schedule VII, Part 1, Division 1, 2 & 3 of the Marine Machinery Regulations.

2.4.2 The bidder must deliver and install a dual electronic control system that is capable of operating independently and function as backup should one system fail. This control system actuates the hydraulically operated steering gear.

2.4.3 The bidder must include in his design the lock pin functionality present on all three vessels. Also, the bidder will incorporate with the lock pin hydraulic power system the possibility of using this unit as a smaller emergency unit, capable of moving the steering gear rams when main power units are out of service.

2.4.4 The bidder's proposed system must meet or exceed all the requirements laid out in the Design Criteria identified in Section 3.

2.4.5 The new system must replace or eliminate outdated equipment (section 2.6.1).

2.4.6 Within the nominal values and specific limits of the existing steering gear components, the system must be able to provide an effective and efficient steering gear control and power system.

2.4.7 Maintain or improve all control, protection and display functions found in the current system.

2.4.8 Take advantage of technological advances to incorporate the many electronic/analog circuits of the current system into a digital environment.

- 2.4.9 Offer high operational reliability through the judicious selection of equipment and a design that incorporates several redundancy functions.
- 2.4.10 Use mass-produced equipment and components easily available on the North American industrial market.
- 2.4.11 Have its own monitoring system to supervise all new Steering System alarms and offer accurate malfunction diagnostics.
- 2.4.12 Have an open architecture and complete documentation to enable effective intervention by CCG electrical officers in case of malfunction.

2.5 Scope of Work (Summary)

Within the framework of the modernization project, the bidder must meet all technical requirements described in this document and carry out all of the following work:

- 2.5.1 Check the current system's drawings and technical information.
- 2.5.2 Design in its entirety, a new steering system in compliance with the applicable regulations (Section 2.7.1) and receive all required approvals (Section 2.8).
- 2.5.3 Produce all required electrical diagrams and other drawings (Section 3.3).
- 2.5.4 Plan and conduct Factory Acceptance Tests (FAT) to demonstrate the effectiveness and performance of the steering gear system (Section 6.1).
- 2.5.5 Produce all technical manuals (Section 7.1.1).
- 2.5.6 Provide all necessary equipment and components to carry out the project. Specialty cabling, connectors and other ancillary components specifically required to integrate supplied equipment shall be part of the supply.
- 2.5.7 Commissioning, testing and trials for the proposed steering gear system. The bidder shall be responsible for the workmanship and warranty of the steering gear system.
- 2.5.8 Program all equipment. Calibrate all feedback signals and all analog meters.
- 2.5.9 Put entire new system into service using a safe method, which includes sea trials to assess vessel performance in all operating modes (Section 6.1).

2.5.10 Provide advanced training to Canadian Coast Guard personnel in charge of operating and repairing the systems (Section 7.5).

2.6 Equipment to be replaced

2.6.1 The following Table contains a list of primary equipment that the bidder must replace or eliminate, depending on the selected design method.

Equipment to be removed	Identification	Location	PR	AM	DG
Hydraulic power unit 75 HP	Vickers 50V-72 + Emotor	Steering gear compartment	2	2	N/A
Hydraulic power unit 100 HP	Vickers 50V-85 + Emotor	Steering gear compartment	N/A	N/A	2
Main pump motor starters		Steering gear compartment	2	2	2
Helm pump + hand wheel	D-type	Wheelhouse center console	1	1	1
Helm pump + hand wheel	D-type	Steering gear compartment	2	2	2
Lockpin pump	V110-3.5 + Emotor	Steering gear compartment	1	1	N/A
Lockpin & emergency pump	26V-12	Steering gear compartment	N/A	N/A	1
Control system pump	V110-1.5 + Emotor	Steering gear compartment	2	2	2
Control System Header tank	35-liter capacity	In wheelhouse ceiling	1	1	1
Control system piping	1/2, 3/4 & 1-inch lines	S.G + wheelhouse	All	All	All
Air cooled heat exchanger		Steering gear compartment	1	1	1
Heat exchanger ducting + fans		Steering gear compartment	1	1	1
Telemotor cylinder	3008-0000	Steering gear compartment	1	1	1
All pressure lines + valves	3, 2, 1-1/2, 1-1/4-inch	Steering gear compartment	All	All	All
Lock valves		Steering gear compartment	1	1	2
4-way valves		Steering gear compartment	1	1	2
FARV	V6 Series	Steering gear compartment	2	2	4

2.6.2 Subject to approval from the technical authority (TA), the successful bidder may eliminate or replace additional equipment if the proposed new system includes functions that make other components of the old system unnecessary or redundant.

The following steering gear system equipment must be kept:

- a) Cylinder rams (2 of): PR &AM are identical, DG are different model
- b) Tiller
- c) Rudder
- d) Tiller Lockpin
- e) Main oil tank in steering compartment: will be used as oil make-up for new HPU units.

2.6.3 It is the bidder's responsibility to identify all changes to be made so that the new system integrates and functions properly with the equipment to be kept.

2.7 Reference documents

2.7.1 Applicable regulations and official documents:

Number	Description	Availability
TP127E	"Ships Electrical Standards (2008)" Transport Canada	www.tc.gc.ca
IEEE-45	"IEEE Recommended Practice for Electrical Installations on Shipboard (2002)"	ieeexplore.ieee.org ISBN: 0-7381-3381-7
IACS UR E	"Unified Requirements Concerning Electrical Installations (2010)"	www.iacs.org.uk
CSA C22.1-12	"Canadian electrical code, part I (22nd edition), safety standard for electrical installations"	Shop.csa.ca
CSA C22.2 NO. 0-10	"General requirements - Canadian electrical code, part II"	Shop.csa.ca
SOR-90-264	"Marine Machinery Regulation (2014)"	lois-laws.justice.gc.ca
IEC 60533	"Electrical and electronic installations in ships – Electromagnetic compatibility"	webstore.iec.ch
IEC 60092-504	"Electrical installations in ships – Part 504: Special features – Control and instrumentation"	webstore.iec.ch
TP5021E	"Personal Safety on Ship" Transport Canada	Reference CD (File #15)
FSM	"Fleet Safety Manual (V4 Sept 2012)" Canadian Coast Guard	Reference CD (File #15)

Table 5 - Reference documents (Regulations)

2.7.2 Instruction manuals, drawings & technical information

All above documents will be supplied to bidder upon demand by the TA.

2.8 Approval and Regulations

2.8.1 Before installation of the new steering system, the bidder must contract the services of an accredited classification society to approve and certify all technical details of the project. In addition, approval of all technical details must be given by the project's Technical Authority (TA). A list of societies recognized by Transport Canada is available at this WEB address:

<https://www.tc.gc.ca/eng/marinesafety/dvro-fsc-dspi-1781.htm>

2.8.2 Through the services of the selected classification society, the bidder must ensure that the replacement systems meet Transport Canada equipment classification requirements and that the entire project receives all necessary approvals specific to vessels in this class. The bidder must plan and coordinate all statutory inspections and classification surveys in collaboration with the authority concerned. All signed and dated official documents must be delivered to the TA.

2.8.3 At least 48 hours' notice must be given before statutory inspections or scheduled classification surveys so that the TA may attend.

2.8.4 Any new installation within the framework of this project must meet Transport Canada standards TP127 (Ships Electrical Standards) and IEEE45 (Recommended Practice for Electrical Installations on Shipboard).

3 General Requirements – Design & Installation

3.1 General Information

3.1.1 The bidder must ensure that the design meets the objectives in section 2.4 and, unless indicated otherwise in this document, maintain or improve all control, regulation, protection and display functions found on the current system.

3.2 Design Package

3.2.1 Preliminary Design Package

The Bidder shall submit a preliminary design package 8 weeks after contract award consisting of, at least, the following documentation and design details:

- a) Proposed design, testing and commissioning requirements of the new steering gear system;
- b) Systems bills of material and specs;
- c) General arrangements;
- d) Systems block diagrams;
- e) User interface & alarm system documentation;
- f) Power supply arrangement;
- g) Description of safety functions;

3.2.2 Final Design Package

The Bidder shall submit a final design package with the following documentation and design details:

- a) Design, testing and commissioning requirements of the new steering gear system;
- b) Systems bills of Materials and specs;
- c) General arrangements;
- d) Systems block diagrams;
- e) User interface & alarm system documentation;
- f) Power supply arrangement;
- g) Description of safety functions;
- h) Preliminary information about the ship commissioning program including proof of performance criteria;

- i) Electrical wiring schematics and end connection drawings including cable specifications, and recommended lengths;
- j) List of all piping, hosing cabling replacements including specifications;
- k) Installation and service manuals;

Final design package shall be delivered with 16 weeks of contract award.

3.3 Technical Drawings

- 3.3.1 The bidder must produce all drawings & diagrams necessary for the design and execution of work on the new steering gear system. These drawings must provide a view of all equipment and circuits in the steering gear system, including those that will be kept from the old system and incorporated into the new installation. The drawings must also include all necessary information so that a qualified technician can conduct a quick, complete and specific search for diagnostic purposes in case of malfunction or for any other reason.
- 3.3.2 All drawings designed or modified must be presented individually in digital format in the most recent version of the DWG (AutoCAD) standard and allow for optimized standard 11x17 in. (ANSI B) printing. An exception may be made to the size of certain drawings in order to give an adequate view of the entire system, provided these are presented in a separate series. A grouped Adobe PDF version must also be provided for each series of drawings to facilitate electronic consultation (one PDF file per series of drawings).
- 3.3.3 The first version of all drawings shall be submitted to the TA and the classification society for review and approval 8 weeks after awarding of the contract.

3.4 Equipment Selection

- 3.4.1 Main equipment and components used to achieve this project must be of recent design and must also be technically supported by the manufacturer for the next 15 years.
- 3.4.2 The bidder must choose mass-produced equipment/components, easily available from the OEM manufacturers or some distributors already established on the North American industrial market. Custom-made or experimental products are not acceptable for this project.
- 3.4.3 All equipment, components and other materials must be new.

- 3.4.4 To the extent possible, the new system's design and the selected equipment must be made to minimize the inventory of spare parts required on board the vessel.
- 3.4.5 Selected equipment must not be affected by the use of portable communication devices found on the vessel. These devices are UHF and transmit with 5 Watts of power on a frequency band varying from 136 to 870 MHz. They are frequently used in the steering gear compartment and machinery control room.

4 Steering Gear System – Performance & Functionality Requirements

4.1 General Information

- 4.1.1 This section is not intended to describe all technical aspects of the proposed steering system (PSS) in detail. In order to properly assess the scope of the work, the bidder must conduct its own analysis based on the numerous documents and diagrams available, or based on observations and tests previously conducted on board the vessel.
- 4.1.2 The PSS shall fit within the existing steering gear compartment without modification.
- 4.1.3 The equipment shall be delivered to allow access into the existing steering gear compartment without modifications. Direct access into the compartment is limited to the following openings. Deck hatches of 30" x 30" and doorways of 30" x 63".

4.2 Hydraulic Design Criteria

- 4.2.1 All material and equipment must be new, suitable for marine use, simple in operation and of current manufacture to ensure availability of spare parts for the next 15 years. Equipment must be suitable for operation in an ambient temperature of up to 40° C. Cables shall be rated for an ambient temperature of 45° C.
- 4.2.2 The PSS must be approved by a Recognized Organization (RO) approved by Transport Canada within the Delegated Statutory Inspection Program (DSIP) as well as the TA before it's installation in the vessel.

- 4.2.3 The PSS must consist of a main and auxiliary Hydraulic Power Unit (HPU) of equal sizing. The main HPU (herein referred to as either #1 Steering Pump or Port Steering Pump) must be powered from the existing vessel hotel bus. The voltage of this bus is set at 440 volts. The auxiliary HPU (herein referred to as #2 Steering Pump or Starboard Steering Pump) must be powered from the vessel emergency bus. The voltage output of this bus is set at 440 volts. Any changes required to adapt the proposed HPUs electrical system to their respective system bus must be done at the bidder's expense.
- 4.2.4 The #1 and #2 steering pumps shall be variable displacement piston pumps.
- 4.2.5 The HPU's must include the hydraulic reservoir tank which must include suction strainers, return line filtration, tank vent breather, adequately sized access for tank cleaning and liquid level indicator systems. It is to be noted that the original main hydraulic oil tank in the steering gear compartment will be kept, and used as a storage tank for the steering gear system.
- 4.2.6 The PSS must be so designed so that a failure of one HPU and associated piping/hoses will not render the other inoperable.
- 4.2.7 The PSS must be designed so that both #1 and #2 steering pumps can be operated simultaneously.
- 4.2.8 An emergency HPU shall be included in the system. This unit will be of similar design as the main HPU's, but only used for emergency operations. This unit will also be used to insert and retract quadrant locking pin, through appropriate piping and valves.
- 4.2.9 The PSS must incorporate a Fast Acting Relief Valve (FARV) or similar system that is capable of providing pressure relief to the system components to accommodate shock loads of up to 950,000 ft. lbs rudder torque occurring within a period of 0.03s. FARV must be designed to allow the rudder to swing from amidships to full over in 1/10 of 1 second.
- 4.2.10 The existing steering gear hydraulic oil is air cooled by way of a separate heat exchanger that will be removed in its entirety. . The Bidder's solution must fit within the space allocated for the new HPUs and be self-contained. If the bidders design requires a heat exchanger, the cooling medium used must be air. The steering gear compartment is naturally ventilated.
- 4.2.11 The existing steering gear hydraulic oil is Mobil Unis N32 (on PR and AM), and Petro Canada Hydrex AW68 (on DG). It is now stored in the main steering gear oil tank, located in the steering gear compartment (for PR and AM) and just outside the compartment (for DG). Coast

Guard would prefer to maintain the use of this oil, however, the bidder will have the freedom to use another producer provided the oil supply is readily accessible (within 24 hours) and with sufficient quantity to charge the entire steering system, within the province of Québec.

- 4.2.12 The existing emergency steering wheel and manual pump located in the steering compartment is to be removed and replaced with a new hand pump, supplied with the new steering gear system.

4.3 Control Design Criteria

- 4.3.1 All material and equipment must be new, suitable for marine use, simple in operation and of current manufacture to ensure availability of spare parts for the next 15 years. Equipment must be suitable for operation in an ambient temperature of up to 40° C. Cables shall be rated for an ambient temperature of 45° C.
- 4.3.2 The PSS must be fitted with an electronic/digital dual steering control system capable of operating either Port or Stbd steering pumps (one control system can be in operation while the other is in standby). This control system must replace the current manual hydraulic telemotor system in the wheelhouse and steering gear compartment.
- 4.3.3 The PSS must be so designed so that a failure of one steering control system will not render the other inoperable.
- 4.3.4 The PSS must be capable of a seamless transfer between steering control systems (the operating and standby roles of the individual steering controllers can be reversed without interruption or loss of steering).
- 4.3.5 The PSS must automatically switch to the standby steering controller or alert the operator of a need to switch to the standby controller in the event of failure of the 'in operation' mode controller and provide visual and audible alarming to alert the operator of this failure.
- 4.3.6 In case of an electrical power failure, the PSS must automatically restart once power is restored and reach its intended mode of operation without any human intervention.
- 4.3.7 The PSS must be connected to and operate in conjunction with the existing Sperry 4000 autopilot currently installed in the vessel.
- 4.3.8 The HPU's #1, #2 and Emergency, must have individual motor starter cabinets constructed and installed complete with local/remote selector switch, local start and stop pushbuttons and lockable disconnect switch, fitted within the steering compartment.

4.3.9 The PSS must include audible and visual alarm panels that indicates and includes but is not limited to:

- a) Low reservoir oil level
- b) Motor overload
- c) Phase failure
- d) Low Voltage
- e) Hydraulic lock

These alarms must be connected to each steering stations (3) in the wheelhouse and in the Machinery Control Room (MCR). The alarm panels to be located in the MCR must be connected to and operate in conjunction with the existing vessel's alarm and monitoring system.

4.3.10 The PSS must be fitted with a means to indicate the following on the vessels Alarm & Monitoring system in the MCR:

- a) Rudder angle
- b) Rudder order
- c) No.1 Pump run
- d) No.2 Pump run
- e) Oil temperature
- f) System oil pressure

4.3.11 All operating and indicating instruments located in the wheelhouse must be illuminated and be dimmable, however, total extinguishment of the lamps shall not be permitted as per TP 127E

4.4 Environmental and Performance Conditions

4.4.1 Service Conditions. The PSS and all its components shall be capable of withstanding the following service conditions:

Environmental:

- Roll of vessel, 45° out-to-out, cycle frequency 10 seconds;
- A permanent list of 15° port or starboard, not cumulative with the roll;
- Pitch of vessel, $\pm 12^\circ$, cycle frequency 6 seconds;
- A permanent trim of 5° above or below the horizontal, not cumulative with the pitch.
- Shock loading: 2.5 g horizontal, 1.5 g vertical

4.4.2 Performance Specification (General). Main machinery and auxiliaries including the PSS shall be able to endure continuous operations in ice including:

- Conditions of continuous 0.5 G vibration at 10 Hz.

4.4.3 Performance Specification (Shipboard Electronic Equipment)

a) Equipment Below Decks - Notwithstanding the normal between decks environment, all equipment shall be capable of its intended operation at temperatures from 0°C to 50°C, and relative humidity 5 % to 90 %.

b) All shipborne equipment, racks, cables and other accessories shall be mounted so as to be capable of their designed operation under the following conditions:

➤ Shipboard Vibration

a) Short term (up to 8 hrs.)

5 to 15 Hz at 0.75 mm amplitude

15 to 25 Hz at 0.5 mm amplitude

25 to 33 Hz at 0.25 mm amplitude

b) Continuous

5 to 20 Hz at 0.5 mm amplitude.

➤ Shock

Repeated shocks of 10 msec duration each.

a) Short term (up to 8 hrs.)

±2 G vertical and ±4 G horizontal.

b) Continuous

±1 G either axis.

➤ Roll and Pitch

a) Short term (up to 8 hrs.)

±45° roll, ±20° pitch with cycle time of 5 to 20 seconds.

b) Continuous

±15 % roll, ±5 % pitch with cycle time of 5 to 20 seconds.

4.4.4 Additional Requirements for Electrical control and instrumentation

Electrical, electronic and programmable equipment intended for the control, monitoring, alarm and protection systems in ships shall operate satisfactorily within steering gear rooms for the following conditions (as per IEC 92-504):

- Displacement amplitude ± 1.5 mm in the frequency range 2 Hz - 28 Hz.
- Acceleration amplitude ± 50 m/s² in the frequency range 28 Hz -100 Hz.

5 Installation of New Steering Gear

The installation of the proposed steering gear system shall be accomplished by the contractor.

6 Tests, Commissioning and Support

6.1 Tests

6.1.1 Ship Commissioning

The bidder must develop and provide to the TA, before the sea trials can begin, a detailed commissioning program including sea trials that will allow testing of the new equipment, as well as the entire steering gear system and its global performance. This includes verification of all protections and alarms, as well as verification and calibration of all feedback signals.

6.2 Warranty & Technical Support

The warranty and technical support provisions are listed at Para 7.14 of the contract.

6.3 Spare Parts

A detailed list of spare parts required on board the vessel must be proposed by the bidder, at least three (3) months before the vessel's expected return to service. This list must meet the maintenance needs of the system for a period of at least five (5) years. The bidder must take into account that the vessel is often operating in remote regions with limited access. Therefore, the ship's Engineering Staff must be able to carry out repairs on the system. The list must include each current part prices in Canadian dollars of all the components of the electrical and hydraulic systems.

Also the Bidder must supply a list of all the Classification and/or TCMS recommended spares for this type of steering gear.

7 Documentation & Training

7.1 General Information

7.1.1 The bidder must provide all operating and maintenance manuals, as well as all materials and documents necessary for the training of personnel. All manuals and training documents shall be available in French and English versions.

7.1.2 Manuals must be designed in accordance with the general principles described in section 9.2 of document IEEE 45 (2002 Edition). They must include clearly identified sections designed to provide accurate information on the entire steering system, in French and English.

- 7.1.3 All manuals must be presented in 8.5x11 inch format inside standard, good-quality ring binders. In addition to the printed manuals, a digital PDF (Adobe) version of all documents must be provided. If certain schematics or block diagrams are initially drawn in DWG (AutoCAD) or another format, this format must also be included digitally.
- 7.1.4 An initial digital version of the different manuals must be presented to the TA at least one (1) month before producing the final version and providing training to personnel.

7.2 Operating Manual

- 7.2.1 The operating manual must include all information necessary for a complete analysis of the various functions and procedures related to the system's use, in French and English.
- 7.2.2 To facilitate comprehension, the descriptive text must be accompanied by schematics, diagrams and/or photos providing a visual representation of the various elements presented.
- 7.2.3 One section of this manual must clearly explain the different functions offered by the alarm panels and/or electronic/digital steering controller as well as provide a description of potential failures and possible solutions.
- 7.2.4 The final version of the operating manual must be delivered in four (4) paper copies (including an English and French version). Each series of manuals must include a DVD with all documents in digital PDF.

7.3 Maintenance & Trouble Shooting Manuals

This manual must be addressed to qualified technicians and provide, in detail, all the information a technician would need to understand, repair and maintain the steering gear system. In addition to the documents created by the bidder, this manual must include all documents produced by the manufacturers of the different components and pieces of equipment. Depending on how it is organized and the number of pages, this manual may be presented in multiple volumes if necessary.

- 7.3.1 Here is a simplified description of items that the manual must cover, at a minimum:
- a) Overall description of the system (design, specifications and operation)
 - b) Block diagrams and operation logic of the systems
 - c) Overview, specifications and functionalities of the supply circuits

- d) Specifications and technical details of the monitoring and alarm system
- e) Operation and details of the protection and emergency systems
- f) Centralized list of recommended periodic maintenance
- g) Methods of verifying the proper functioning of equipment and protections
- h) Troubleshooting, adjustment and calibration procedures
- i) Methods of replacing main components
- j) Procedures for safe insulation tests on motors and alternators
- k) Complete list of potential defects/alarms and possible solutions

7.3.2 As with the operating manual, the final version of the maintenance manual must be delivered in four (4) paper copies (including an English and French version). Each series of manuals must also include a DVD of all documents in digital PDF.

7.4 Reports and Inspection Tests & Certificates

7.4.1 An additional manual must group together all official documents related to the certification, the installation and the commissioning of the new system, including the various factory tests and other tests conducted on board the vessel. It is the bidder's responsibility to keep the original manual up to date and ensure the accuracy of the collected data.

7.4.2 The bidder must ensure that the TA has, at all times, an up-to-date copy of all documents and certificates produced.

7.5 Training

7.5.1 General Information

- a) The training of CCG personnel must be included within this contract and provided by one or more technical representatives directly involved with the project. If any equipment requires additional expertise, the bidder must retain the services of an expert technician to properly cover all the training.
- b) The various reference documents used must be submitted to the TA at least four (4) weeks before the start of the training program.
- c) Training must be given at the Coast Guard base in Quebec City. If needed, a meeting room will be provided for free by the CCG.

7.5.2 Training and Operators (Engineers & Electrical Officer)

- a) The Bidder must provide one (1) training course of up to eight (8) hour duration to be held onboard after the final installation and commissioning of steering system. This training must be provided to applicable staff of the vessel's engineering and navigation departments (up to 12 persons total) and be conducted by the OEM of the system. Training must encompass all items outlined in the operating and maintenance instructions as supplied by the OEM. This specific training must be presented in French.
- b) This training must familiarize each participant with the following as a minimum:
 - Overview of the system and its operation;
 - Manual controls and operating modes/sequences in real situations;
 - Operation of the alarm system and interpretation of failures;
 - Operation and adjustment
 - Scenarios of potential technical problems and actions required to maximize the speed and effectiveness of responses.
- c) As a quick reference, the bidder must provide each participant with a document summarizing, in a simple manner, all relevant information for effective operation and monitoring of the system. This document must be properly binded and include a French and an English version.

Two (2) additional copies of this training document must be produced for general consultation on board the vessel.

- d) If the design of the new steering gear system results in changes to the different navigation consoles (displays and/or controls), additional training must be provided to wheelhouse personnel in order to explain the changes (Commanding Officer, navigation and wheelhouse officers). The duration of this training must be adapted according to the changes made.