Annex A

High Endurance Multi Task Vessel
Type 1100
Propulsion System Renewals
Statement of Work

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1.0 PROPULSION SYSTEM RENEWALS

1.1 Scope

1.1.1 Background

There are multiple High Endurance Multi Task Vessels (HEMTV) currently in operation. From herein, a HEMTV vessel will be referred to as "Type 1100" vessel.

A typical Type 1100 class vessel operated by the Canadian Coast Guard works year round, primarily on the East Coast of Canada, performing Search and Rescue, Maritime Navigational Aids, Ice Breaking, and Conservation and Protection Patrol operations.

The vessel uses a twin screw diesel-electric propulsion system. The two 3500 hp synchronous motors are controlled by two Canadian General Electric (CGE) cycloconverters. The cycloconverters produce the +/- 18 Hz necessary to obtain the speed regulation of the vessel. The terms "Cycloconverter System", "Cycloconverters", "Converters", and "Propulsion System" refers to the two cycloconverters and all associated equipment supplied for the control, monitoring, protection, and integration of the system.

1.1.2 Vessels

This contract applies to the Canadian Coast Guard Ship (CCGS) Ann Harvey and Sir William Alexander.

- Vessel # 1 – **CCGS Ann Harvey**
  - Commissioned - 1986
  - Builder – Halifax Shipyards, Halifax
  - Home Port – St. Johns Newfoundland
  - Installation Schedule - July 2017

- Vessel # 2 – **CCGS Sir William Alexander**
  - Commissioned - 1987
  - Builder – Marine Industries of Tracy, Quebec
  - Home Port – Dartmouth, Nova Scotia
  - Installation Schedule - November 2017

1.1.3 Objectives

1.1.3.1 The intention of the Canadian Coast Guard as part of the Vessel Life Extension (VLE) Program will be to procure the following Class approved propulsion equipment along with the following services for each Type 1100 vessel:

1.1.3.2 Equipment

- Propulsion Control Levers;
- Propulsion Generators Excitation Systems;
- Complete Water Cooled Cycloconverters with Motor Disconnects;
- Motor Encoders with Mounts;
- Harmonic Filters;
- Dynamic Brakes;
- Propulsion Motor Excitation Transformers;
- Neutral Ground Resistors;
- Medium Voltage Power Cables;

1.1.3.3 Services

- Baseline Data Collection;
- Power Quality Study and Harmonic Analysis;
- Classification Society System Approvals and Design Review;
- Installation Specifications and Drawings;
- Vessel Drawing Updates;
- Alongside Installation labor for Supervisory and Field Service Rep;
- Sea Trials and Acceptance Testing;
- Performance Period Service.

1.1.4 Alongside Installation

The propulsion renewal systems shall be installed while the vessels are afloat, under the Canadian Coast Guard's custody, and docked at their home ports. Bidders must submit the detailed supervisory and FSR costs associated with the installation phase of this solicitation with responsibilities as outlined in 1.1.4.2. The bidder must also include a detailed price for the subcontractor items listed in 1.1.4.1 and the list of subcontractors to be used. These costs will form a part of the evaluated and awarded totals for the resulting contract. The Contractor is responsible to contract for sub-trade requirements to cover those items as outlined in 1.1.4.1 of this document for the installation phase. The bidder shall create all the installation specifications and construction drawings needed for the subcontractor's involvement.

1.1.4.1 The following is a breakdown of the subcontractor's responsibilities during the installation period:

- Provide new cabling needed as derived from the Design Package, excluding the Medium Voltage Cable as identified in 2.3.14;
- All steelwork / hotwork;
- Coatings / surface prep;
- Insulation removal / reinstallation or replacement;
- Electrical cable installation and securing;
- Existing equipment physical removal and disposal;

- New equipment physical installation;

1.1.4.2 The following is a breakdown of bidder's responsibilities during the installation period:

Generator Excitation

- Entire removal of the existing AVR systems.
- All wiring within the generator excitation cubicle and main switchboard.
- All testing as required by the Canadian Coast Guard, Transport Canada Marine Safety, and / or the Classification Society.

Propulsion Control Levers

- Identify, disconnect and pull back any cabling that is to be re-used.
- Advise the shipyard on the existing system removal.
- Supervise the removal of all equipment.
- Supervise the physical mounting of the new system.
- Advise, supervise, and inspect all new cabling routes and installations.
- Complete all terminations and connections within the system.
- Complete all terminations required for power feeders.
- All testing as required by the Canadian Coast Guard, Transport Canada Marine Safety, and / or the Classification Society.

Cycloconverter

- Identify, disconnect and pull back any cabling that is to be re-used.
- Advise the shipyard on the existing system removal.
- Supervise the cycloconverter tear down.
- Tag existing cycloconverter sub-components for CCG salvage.
- Supervise all new equipment rigging and mounting.
- Advise, supervise, and inspect all new cabling routes and installations.
- Complete all motor mounted equipment and connections
- Complete all terminations within supplied equipment.
- Complete all Motor Control Room terminations.
- Complete all Wheelhouse terminations.
- Supervise all Fresh Water system modifications.
- All testing as required by the Canadian Coast Guard, Transport Canada Marine Safety, and / or the Classification Society

1.1.5 Performance Period

Upon completion of the vessel sea trials included in the installation period, the contractor shall enter into a 15 month performance period*. During this period, the contractor shall be responsible for the continued functionality, performance, and additional tuning of the new propulsion system upgrades such that the systems meet the functional requirements stated within this statement of work. Beyond the virtual assistance provided, the contractor shall be available to travel to the vessel within 48 hours' notice during this

period.

One (1) visit to the vessel during ice breaking season shall be included during the performance period to tune the vessel to the peak demands experienced during ice breaking. The contractor shall be responsible for travel to the vessel's home port, and the Coast Guard will cover any follow-on travel costs to reach the vessel. For the ice breaking visit, the contractor must be willing to be flown onto the vessel via helicopter and commence testing while the vessel is underway.

*All contractors shall assume six (6) site visits of 2 days each, excluding travel time, at the vessel's home port to be performed during performance period. Within these 6 site visits shall be the first month initial checkup and the onboard ice breaking season tuning.

1.1.6 Optional Replacements for Coast Guard Cycloconverter Driven Vessels

All six of the T1100 vessels were designed and built with identical propulsion lever, cycloconverter, and generator excitation systems. The Canadian Coast Guard may exercise the option to purchase up to four additional cycloconverter, propulsion control lever, and generator excitation systems. To reduce duplication of effort, options shall be purchased in pairs with timelines to coincide with each vessel's installation schedule. For options pricing, the contractor shall assume the vessels engineering and installation shall take place in the vessel's home port, and the equipment shall be delivered on the month of the installation start date. An allowance of $10000 per vessel shall be given for the four option vessels to take into account the differences that exist between builds. The contractor shall provide pricing* for the components, engineering, installation, and performance period for the following vessels and timeframes ($10000 allowance shall be included in the engineering costs):

- Vessel # 3 – **CCGS George R Pearkes**
  - Commissioned - 1986
  - Builder – Versatile Pacific Shipyards Limited, Vancouver
  - Home Port – St. Johns Newfoundland
  - Installation Schedule - August 2018

- Vessel # 4 – **CCGS Edward Cornwallis**
  - Commissioned - 1986
  - Builder – Marine Industries of Tracy, Quebec
  - Home Port – Dartmouth, Nova Scotia
  - Installation Schedule – July 2018

- Vessel # 5 – **CCGS Martha L Black**
  - Commissioned - 1986
  - Builder – Versatile Pacific Shipyards Limited, Vancouver
  - Home Port – Quebec City, Quebec
  - Installation Schedule – October 2018

- Vessel # 6 – **CCGS Sir Wilfrid Laurier**

- Commissioned - 1986
- Builder – Collingwood Shipbuilding, Collingwood, Ontario
- Home Port – Victoria, British Columbia
- Installation Schedule – January 2019

*Each of the three systems (Propulsion Control Levers, Cycloconverter, and Generator Excitation) shall be broken into the four line items (Engineering, Components, Installation, and Performance Period) as not all vessels need each system.

1.1.7 Classification Society and Transport Canada Requirements

The Canadian Coast Guard T1100 vessels are not currently in class. The original systems included in this contract were built to Lloyds Register standards. The function of classification society approvals within this contract is twofold; (a) the class approvals and oversight will be used as the foundation to obtain the necessary Transport Canada plan approval for the modifications to the vessel and (b) the class approval of the systems allows for future delegated inspections to be completed by class societies.

The following is a basic overview of the contractor's responsibilities for this contract:

Pre-Refit Period

- The equipment provided shall be type approved. The contractor shall provide certificates to verify.
- The contractor shall prepare a submission for Transport Canada plan approval for all the work included within this contract. To achieve "plan approval", the contractor shall submit a design package to the Classification Society chosen during the preliminary planning period and request the design to be stamped reviewed or approved should the vessel be delegated to class during this contract.
- The complete or "built up" propulsion control lever and cycloconverter systems shall be class approved prior to installation in the vessel. Where possible, this approval and inspection shall take place in conjunction with the Factory Acceptance Testing.

Refit Period

- The contractor shall provide an onsite class surveyor to verify the installations were completed to the class society's approval.

1.2 References

A Technical Data Package (TDP) consisting of all the drawings, manuals, and reports is available on the DFO File Sharing Site. This TDP will be available for download during the solicitation process and will be removed upon contract award. To access the TDP, copy the following url into your windows explorer address field:

ftp://ftp1.dfo-mpo.gc.ca/BaggsJ

The TDP is located in a folder named "T1100 Propulsion Renewals TDP".

1.3 General Particulars of the Vessel

Type: - Type 1100 Vessel
Ice Class - Arctic Class 2 (Lloyds Class 100A1, Ice Class Super, LMC)
Years Built – 1986, 87, 88
Builders - Marine Industries Limited, Halifax Shipyards, BC Shipyards, Collingwood

Principal Dimensions:
Length - 83 m (272 ft 4 in)
Breadth -16.2 m (53 ft 2 in)

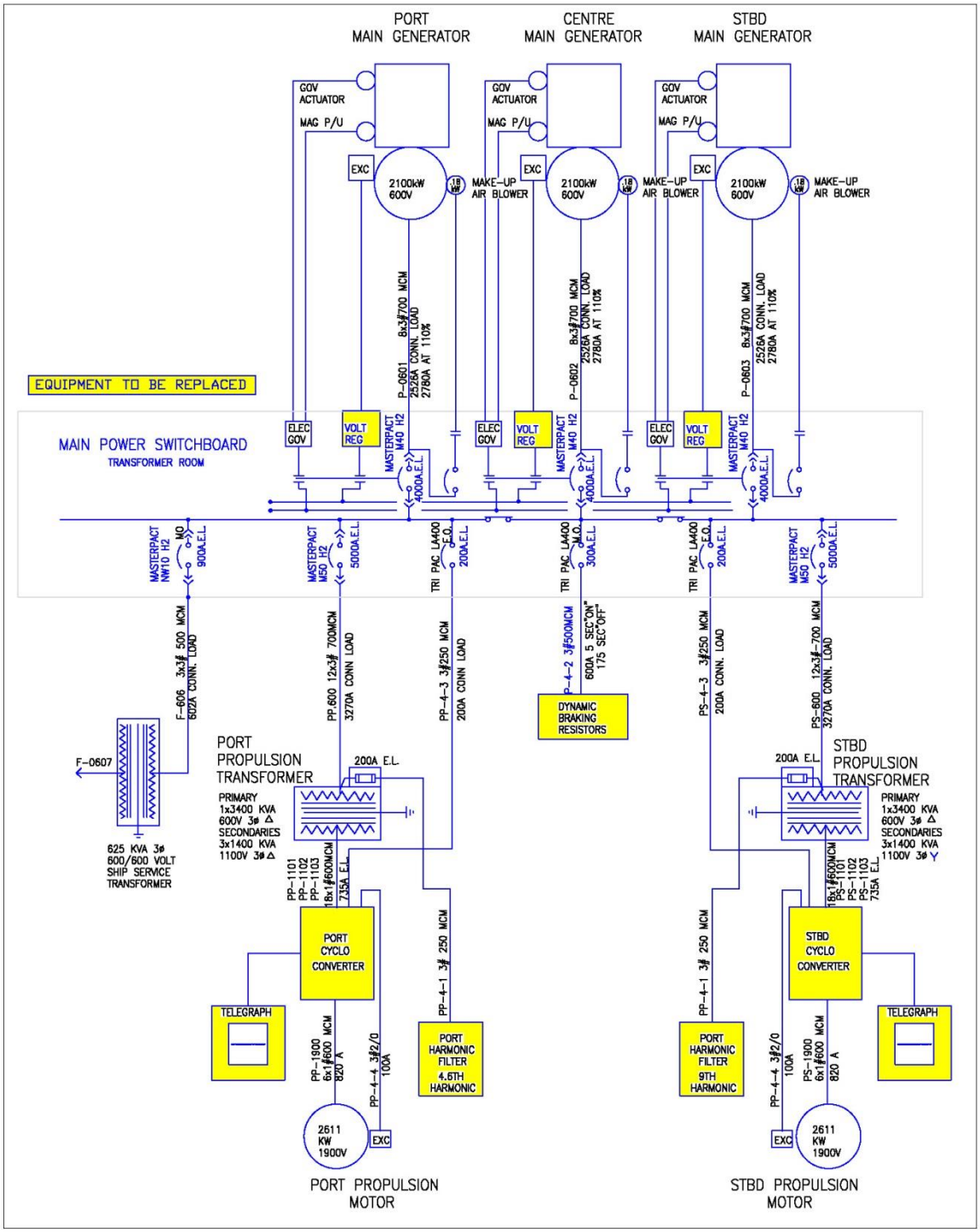
The Type 1100 is an AC/AC diesel electric vessel that is comprised of 3 Alco 251 engines coupled to 600V 60Hz General Electric synchronous generators rated at 2100kW each, 1 Caterpillar 3508 auxiliary engine coupled to a 600V 60 Hz Stamford generator rated at 500kW, and one Caterpillar 3406 emergency engine coupled to a 600V 60 Hz Stamford generator rated at 100kW. The power conversion for the vessel propulsion is achieved via two 600V/1100V 3400 kVA propulsion transformers feeding port and starboard cycloconverters that convert the incoming fixed AC into a +/- 18Hz 1900V 2800kW feed for each General Electric 3500 hp 12 pole synchronous motor.

1.4 List of Acronyms

A&M	Alarm and Monitoring
AC	Alternating Current
ADP	Approved Design Package
ANSI	American National Standards Institute
AVR	Automatic Voltage Regulator
CA	Contract Authority (PSPC)
CCG	Canadian Coast Guard
CCGS	Canadian Coast Guard Ship
CCV	Cycloconverter
CGE	Canadian General Electric
CLC	Canada Labour Code
CSA	Canadian Standards Association
CSM	Contractor Supplied Material
CT	Current Transformer
DC	Direct Current
DFO	Department of Fisheries and Oceans
DSIP	Delegated Statutory Inspection Program
ECR	Engine Control room
FAT	Factory Acceptance Test
FMEA	Failure Mode Effects Analysis
FSR	Field Service Representative
FSSM	Fleet Safety & Security Manual (CCG)
GES	Main Generators Excitation System
GSM	Government Supplied Materials

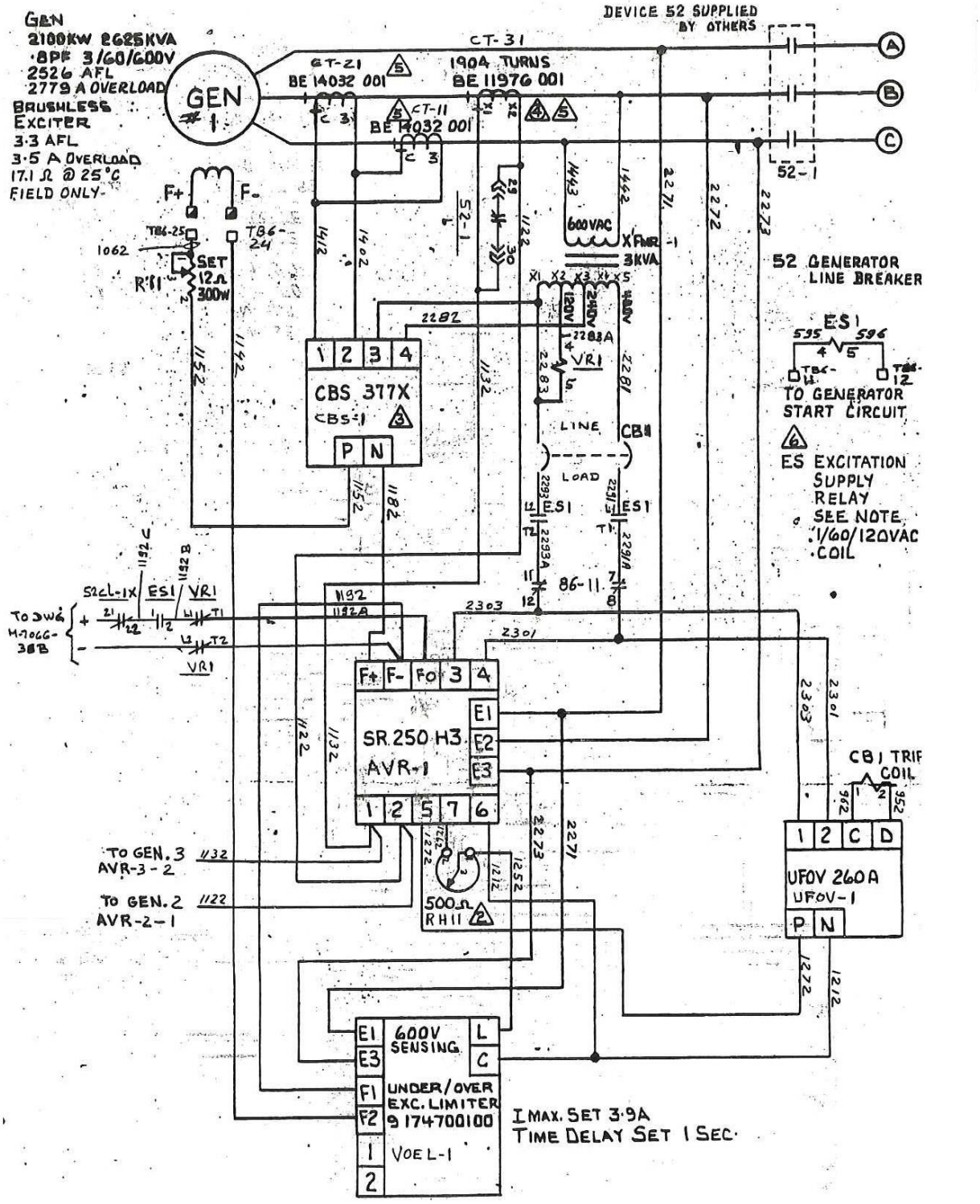
HC	Health Canada
HEMTV	High Endurance Multi Task Vessel
HMI	Human Machine Interface
IACS	International Association of Classification Societies
IEEE	Institute of Electrical and Electronic Engineers
ITP	Inspection Test Plan
LOA	Length Over All
MCC	Motor Control Center
NDE	Non-Drive End
OEM	Original Equipment Manufacturer
PCL	Propulsion Control Levers
PDF	Portable Document Format
PDP	Preliminary Design Package
PLC	Programmable Logic Controller
PSPC	Public Services and Procurement Canada
PT	Potential Transformer
QA	Quality Assurance
RTD	Resistance Temperature Detector
SSMS	Safety & Security Management System
STBD	Starboard
TA	Technical Authority – Owner's Representative (CCG)
TCMS	Transport Canada Marine Safety
TDP	Technical Data Package
TIFF	Tagged Image File Format
THD	Total Harmonic Distortion
URL	Uniform Resource Locator
VAR	Volt-Ampere Reactive
VLE	Vessel Life Extension
VTS	VTScada HMI Software

2.0 DEVICES AND SYSTEMS FOR REPLACEMENT

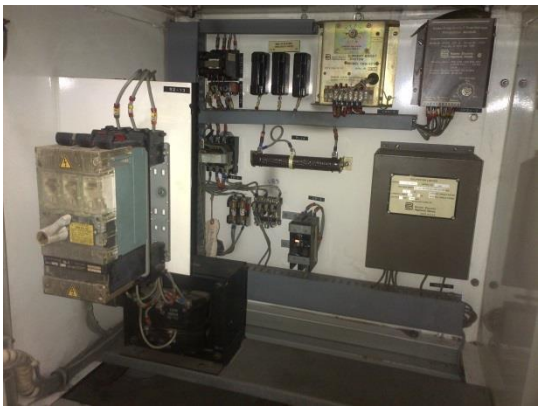


2.1 Main Generators Generator Excitation Systems

The three General Electric main generators use the following system to achieve the brushless excitation needed for the vessel's voltage regulation:



Brushless exciter field power is controlled by the Basler SR250H3 regulator. Feed-back to the regulator is obtained by direct connection to the three generator output lines. Control of the generator output voltage is obtained by adjusting the remote-mounted 500 ohm rheostat. Power to the regulator is obtained from the 600 volt generator lines via the 600/480 volt 3kVA power transformer under normal operating conditions. The current boost CBS377X module has been included to provide short-circuit fault clearing capability for the generator. Under these conditions, the current boost module provides field power to the exciter independently of the regulator. This power is derived from the generator line currents flowing through the BE 11976 001 2 power current transformers. The under frequency/overvoltage module UFOV260A and associated circuit breaker provide protection against generator overvoltage and prime mover speed variations.



2.1.1 Basic Design

There are 3 total systems required for the vessel Automatic Voltage Regulator (AVR) module (field output) that can be easily installed in any of the generator cubicles. All three generators shall have the ability to run in parallel or single operation. The replacement regulation systems shall be of current technology with a minimum design life of 15 years. All existing solid state componentry shall be replaced within the system. Existing potential transformers, control circuit transformers, current transformers, and control and instrument fuses can remain where compatible with new equipment. Proposals shall include new components where required. All replacement equipment shall fit within the existing cabinetry. A singular unit performing the field output, current boost, under frequency, under voltage, and under / over excitation is preferred.

2.1.2 Functional Requirements

The replacement excitation systems shall meet the following functional requirements:

1. The new system shall meet or exceed the existing systems functionality and response. The existing response characteristics under dynamic conditions shall be verified by the contractor prior to the design phase of this contract.

2. The voltage regulation shall remain within +/- ½%.

3. There shall be a manual voltage adjustment provided that can be accessed without opening the GES system cubicle. The device used for adjustment shall be digital. The ergonomics of this adjustment device shall be situated such that the operator can easily

observe the generator power factor and voltage meter while adjusting the field output. The voltage adjustment shall be within +/- 10% of the nominal voltage and have the precision of 0.17% or 1/600.

2.1.3 Additional Functional Requirement & Alarm Integration

Diode Monitoring - The CCGS Edward Cornwallis (sister ship) has seen the application of a Basler EDM200 Brushless Exciter diode monitor added to the voltage regulation system and integrated into the A&M system. The remaining Type 1100 vessels currently do not have this system installed. The contractor shall include similar functionality to the EDM200 with the new system to provide means of integrating the diode status into the Alarm and Monitoring system.

2.1.4 Commissioning/Acceptance Testing in lieu of Factory Acceptance Testing

Due to the nature of the generator excitation upgrades, traditional FAT cannot be completed. The excitation system upgrades acceptance testing shall take place in the following manner (for the Ann Harvey Only):

- Within the ITP, a hold point shall be established for acceptance testing to take place on the vessel once the first generator has been completed.
- After the first generator passes the initial acceptance tests, the second generator shall be completed and another hold point shall be established within the ITP. This portion of the acceptance test shall establish the load sharing functions of the excitation upgrades.

2.2 Propulsion Control Levers (PCL)

The vessel currently uses a Chadburn Bloctube chain style mechanical control lever system with long life potentiometers affixed to the center wheelhouse and ECR consoles to provide the speed reference and direction for the propulsion system.

Original Chadburn System


Example Upgraded System

2.2.1 Basic Design

The replacement PCL system shall consist of 4 individually powered electronic remote stations that will be connected to the cycloconverters via a dual network connection. The system shall be a dual speed non-mechanical repeater control Lever with custom controls incorporated that match the existing system functionality. There shall be two main control levers. One shall be located in the machinery control room and one in the wheelhouse center console.. There shall be auxiliary control Levers located on both wheelhouse wing consoles. The replacement PCL system shall be of current technology with a minimum design life of 15 years.

2.2.2 Functional Requirements

The following list shall be used as the base functional requirements that the replacement PCLs shall meet or exceed:

1. All custom control ladder logic for the existing system resides within the digital controller for the cycloconverters. The new propulsion lever system and cycloconverters shall be designed in the same manner.

2. The control Levers shall supply individual signals to the port and starboard cycloconverters.

3. The control Lever handles shall be suitable for individual control but mounted such that an operator can move both levers with one hand when required.

4. The control Lever handles shall be equipped with friction devices as to prevent motion due to vibration and to provide a tactile feel for the operator.

5. The three wheelhouse control Lever heads shall be connected via an electric shaft system. This system shall simulate a direct connection between the heads allowing immediate transfer of one control to another without alignment procedures ("bumpless" transfer). *In order to successfully change the position of the control Lever, a "Control Here" pushbutton shall be pushed and illuminated to signify control. The levers on the other heads shall resist change and shall be incapable of influencing the head that is currently in control.
   NOTE – Due to the navigation night watch having all illumination dimmed, it can be assumed that the two remaining out of service control Levers on the bridge will be unknowingly or accidentally forced during the life cycle of the control Levers. Beyond resisting change, the control Levers shall be designed such that any such movement, forceful or otherwise, will not permanently damage the off-service control Levers. A test to this effect shall be included in the Inspection Test Plan (ITP) generated by the contractor.

   * An auto-sensing automatic change of control between the wheelhouse units (port, center, stbd) can be used in way of the "Control Here" pushbutton system as long as it is industry proven and meets applicable IACS rules.

6. The dials for all instruments shall be black with white letters (for ahead) and black with red letters (for astern) and marked so that the dial markings and position or pointers are clearly visible at all times.

7. The control Levers shall be labelled and equipped with either mechanical or electrical detents to indicate movement to the next incremental position through the range of motion of the control Lever. The nine detent positions shall be placed at the following positions:
   7.a Stop Position
   7.b Dead Slow Ahead and Astern
   7.c Slow Ahead and Astern
   7.d Half Ahead and Astern
   7.e Full Ahead and Astern

8. The master control Lever systems located in the wheelhouse center console and machinery space control room shall provide the speed reference/ signal to the new cycloconverters. This signal shall be configured in duplicate and utilize a dual bus network. In the event of a failure, the system shall automatically switch over to use the operational network and provide notification thereof.

9. The control Lever heads at the wheelhouse center and control room consoles shall be complete with voltage free contacts on both the port and starboard transmitters to indicate transmitter lever positions of Ahead, Stop, and Astern. Contacts shall be rated for a minimum of 1A, 120VAC.

10. The control Lever head located within the ECR shall provide additional voltage free contacts signifying Bridge Control, ECR Control, Finished with Propulsion, Standby, and Alarm. Contacts shall be rated for a minimum of 1A, 120VAC.

11. Custom Control

    11.a The wheelhouse units shall operate as propulsion control levers in the "Wheelhouse Control" mode of operation.

    11.b The ECR unit shall be inoperative (does not follow) in the "Wheelhouse Control" mode, except that the order indicator dial will indicate the position of the wheelhouse transmitters.

    11.c In the "Machinery Space Control" mode, the units shall operate as combined control levers and telegraph transmitter / receivers.

    11.d In the control Lever mode of operation, the console mounted instruments shall connect to a bell within the consoles, which will ring when an order is transmitted and continue to ring until the order is properly matched.

    11.e A wrong direction audible and visual alarm shall be installed in the machinery space and wheelhouse consoles for each shaft. The controlling contact shall be operated by the shaft revolution sensing system and ahead and astern position of the machinery space operating station control level position. The alarm circuit shall be de-energized when the system is in wheelhouse control.

12. A system of illuminated pushbuttons mounted in the wheelhouse center and ECR control Levers and connected to the control Lever bell relays shall be installed to provide combined plant "STAND BY" and "FINISHED WITH PROPULSION" orders. Operation of a button in the wheelhouse shall cause the lamps to flash and the audible device to operate until acknowledged in the ECR. The control Levers shall also contain "ON-SERVICE" pushbuttons to activate and signify system control at the head, "ECR" and "BRIDGE" control lights to signify which area is in control, "ALARM" to signify a fault within the control Lever system, and "ACKNOWLEDGE" signifying the ECR has seen the finish with propulsion command.

13. A system of illuminated pushbuttons mounted in the wheelhouse consoles shall be installed to provide "CONTROL HERE" pushbuttons to activate and signify system control at the head, "ECR" and "BRIDGE" control lights to signify which area is in control, and "ALARM" to signify a fault within the control Lever system.

14. Each control Lever shall have independent means to dim both the dial illumination and the pushbutton illumination.

2.3 Port and Starboard Cycloconverters

The port and stbd cycloconverters shall be entirely replaced with new. All devices and functions currently located within the existing cabinets shall be renewed. For the T1100 vessels this incorporates, but is not limited to, the following components:

- One single metal roof with embedded cable transits;
- One single air supply plenum mounted beneath entire unit;
- 16 full size metal cabinets;
- 6 cabinets used for cable entry (Top to Side);
- Water heat exchangers;
- Internal lighting and receptacles for test equipment;
- Permanently mounted instrumentation used for watch keepers;
- Instrumentation CTs and PTs;
- Rigid bus work;
- Cycloconverter control voltage transformers 600VAC Primary;
- Cycloconverter control uninterruptable power supplies;
- Cycloconverter integration controller (CGE Fanuc Series 6 PLC);
- Cycloconverter drive master control (CGE Direct-o-Matic II Analog Control);
- Cycloconverter power converters with gating;
- Propulsion motor AC brushless exciter control;
- Excitation transformers and associated switchgear;
- Propulsion motor neutral ground resistors;
- Propulsion motor latching disconnects;
- Total Weight = 13,600 kg

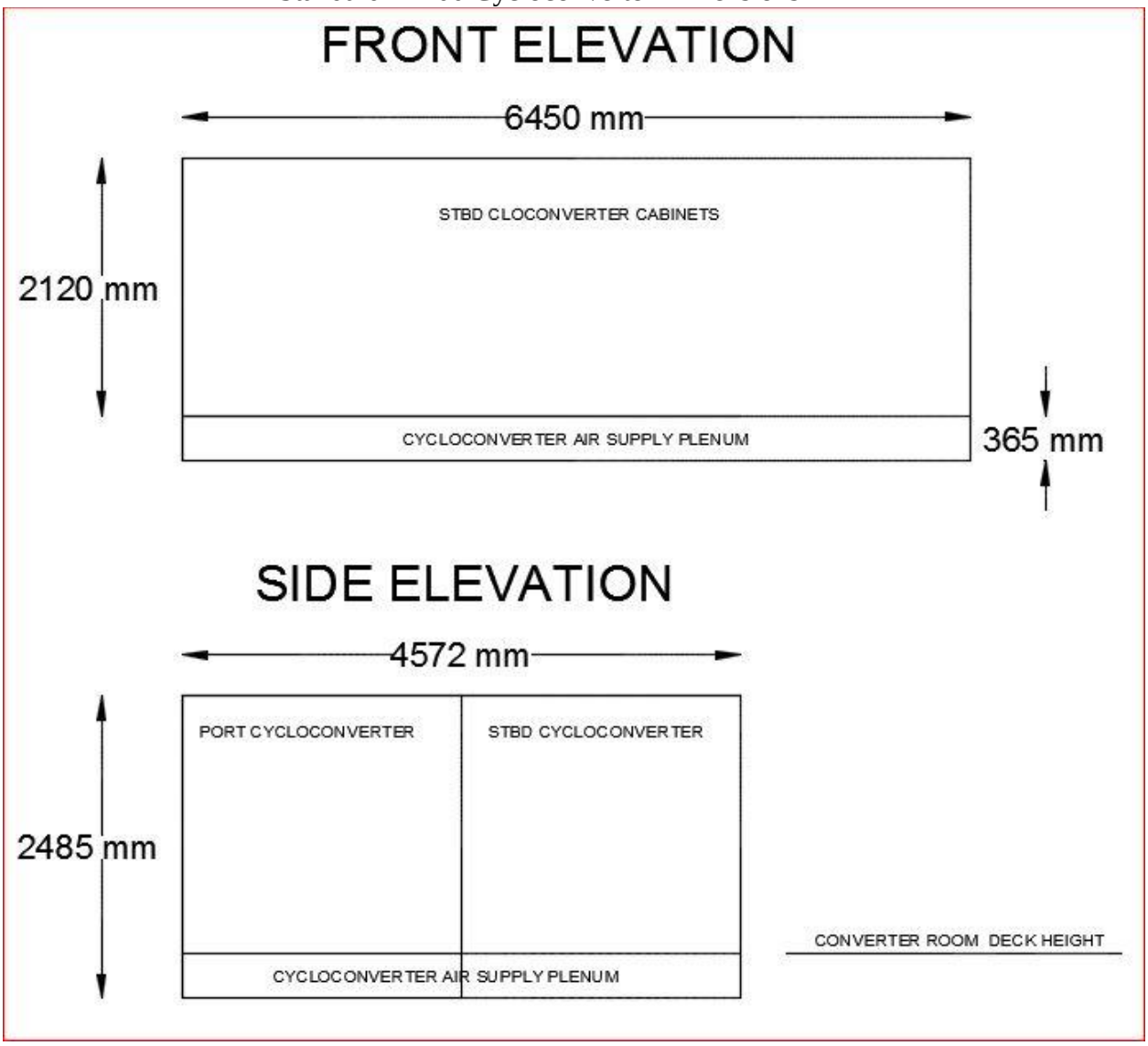
2.3.1 Basic Design

The replacement cycloconverters shall be static frequency thyristor based 6 pulse reversing drives. Each cycloconverter shall consist of 36 thyristers. No prototype cycloconverters shall be accepted. The cycloconverters shall be digitally controlled and consist of current generation technology. All components within the cycloconverter shall have a minimum of fifteen years remaining in their complete life cycle services and 20 years remaining in the their limited life cycle services. All equipment must have classification society type approval certificates from a Transport Canada recognized organization under the Delegated Statutory Inspection Program (DSIP). The complete cycloconverter must receive class approval during the Factory Acceptance Tests.

2.3.1.1 Basic Design - Dimensions

The replacement cycloconverters must fit within existing cycloconverter footprint as seen below. The existing cycloconverter air supply plenum can be used as a seat or can be removed to allow for extra height. There is no ability to increase the maximum height beyond 2485 mm. All cabling must be top entry. If the bidder's standard cabinet does not allow for top entry, a small top entry transition cabinet shall be used between the main cabinets. The max LOA cannot exceed 6450mm.

Standard T1100 Cycloconverter Dimensions



2.3.2 Functional Requirements

The successful contractor shall be responsible for verifying the actual operating and performance requirements of the existing cycloconverters via baseline sea trials prior to engineering and manufacturing the replacements. Optimal performances, overload values, and allowable generator frequency excursions/regulation stated within this specification are based on the general T1100 design. Over 30 years, the vessel's ability and plant

characteristics have changed or been modified slightly (typically decreased). In the case where there is a discrepancy between the existing measured parameters and this specification, the new converters shall be designed to meet the greater value or performance.

The following list shall be used as the base functional requirements that the replacement cycloconverters shall meet or exceed:

1. Provide stable operation under all load conditions.

2. Provide independent starting, stopping and control of each propeller from zero to full speed in both directions of operation. Effect smooth and gradual changes in each propeller speed from a minimum continuous operating speed of 9 rpm to the set propeller speed by means of manually operated speed controllers. This shall be accomplished by suitable variation of the magnitude of the propulsion motor speed regulator reference to provide the correct values of stator current, MMF angle, and rotor current needed to maintain the propeller speed.

3. Ensure utilization of power allocated from the main power system as shown in Annex C entitled "Propulsion System Characteristic Curve page D.13". The full travel of the propulsion control levers is to be calibrated for three generator mode of operation to correspond to the continuous rating of the propulsion motors.

   3.a When three main diesel generators are connected to the power system:

   The propulsion system overload level of 6180kW will be utilized in a linear relationship from zero to motor speed of 144 rpm corresponding to a bollard condition, and at a linear reduction in power to 5620kW for a maximum motor speed of 180 rpm corresponding to free running conditions. Prolonged operation at the propulsion motor overload condition to be limited by automatic control function (8). Other loads on the main power system will tend to produce a total load above the continuous rating of the diesel generator sets. (Operation at diesel generator set overload will initiate the main power system overload indication and requirement for ships service generator as provided by others). The propulsion system shall be automatically regulated to prevent the total system load on the system from exceeding the available output of the diesel generators (Original design capped the total load on the system at 6930kW, 8660 kVA).

   3.b When two main diesel generators are connected to the main power system:

   In proportion to the propulsion control levers range to 90% of scale, the diesel generator overload capacity of 4620kW shall be utilized in a linear relationship from zero to bollard to 160 rpm without exceeding the overload rating of 5774 kVA. Operation at or near and up to the 90% control Lever position with other loads on the main power system will tend to produce loads in excess of the limit. The propulsion system shall be automatically regulated to prevent the total load from exceeding limits of 4620kW, 5774 kVA. (Operation in the overload condition will initiate the main power system overload indication for the third diesel generator set as provided

by others).

3.c When one main diesel generator is connected to the power system:

In proportion to the propulsion control levers range to 70% of scale, the diesel generator overload capacity of 2310kW shall be utilized in a linear relationship from zero to bollard to 125 rpm without exceeding the overload rating of 2887 kVA. Operation at or near and up to the 70% control Lever position with other loads on the main power system will tend to produce loads in excess of the limit. The propulsion system shall be automatically regulated to prevent the total load from exceeding limits of 2310kW, 2887 kVA. (Operation in the overload condition will initiate the main power system overload indication for a second diesel generator set as provided by others).

3.d Operation of the propulsion control levers above the 90% position in the two generator mode and above 70% position in the one generator mode will not allow loads in excess of the generator mode kW and kVA limits. Only when the required compliment of diesel generators sets are connected to the main power system will the propulsion motors accelerate to the ordered speed if above the generator limits.

4. Provide automatic re-calibration and limiting of propulsion circuit currents to safe levels and automatic limiting of diesel engine loading and unloading to a safe margin of the power available at any point in the diesel operating range under transient and steady state conditions, for any operating conditions of the vessel.

5. Generator Mode Specific Limiting

5.a Automatic limiting of propulsion circuit currents and diesel engine loading under transient and steady state conditions shall also be affective when the vessel is brought up to speed from the stationary condition with only one prime mover / generator connected into the power system.

5.b Provide means to maintain the power system frequency within +/- 4% excursion for all conditions of loading and unloading for any operable condition of the vessel, except for crash reversal when excursion can be +5% to -8%.

5.c Provide means for a cross connection between both cycloconverters such that all limiting is done in unison, or in the case of trials or breakdown, limiting can be done independently.

6. Provide automatic control of each propulsion motor such that for any position of associated control Lever reference, the power available can be fully utilized as detailed in item 3 but not exceeded as ship conditions vary between bollard and free running or vice versa.

7. Provide means of automatically limiting the propulsion motor stator current to safe values consistent with the following requirements:

7.a The input current to each propulsion system at the motor stalled condition will be limited to 135% of the current level corresponding to power allocation of the connected power in the system. Gradually the limit will be reduced to 100% as the propulsion motor voltage comes to full value. (The 135% current to be maintained from stalled propeller up to intermediate speed within the capabilities of the diesel engines.)

7.b The propulsion motor will, when the full numbers of generators are connected, be capable of developing 165% of rated torque at the stalled condition with 135% stator current flowing.

7.c All conditions of stall shall be considered, including stalling when starting the ship from rest in ice, and sudden stoppage of the propeller from full speed during ice breaking.

8. Provide automatic control of the time permitted for operation of the propulsion motors in the overcurrent conditions as described in items (3) and (7), with reduction to rated current for cooling purposes before the overload currents can again be utilized.

9. The cycloconverter waveform shall be designed to achieve a power factor at or close to unity. The overall regulation of Reactive Power drawn shall be equal to or better than the existing system.

10. In the event of a propeller stalling faster than the ability of the regulator to maintain current limit, the propulsion system is to be protected against an overcurrent by suppression of the cycloconverter firing pulses.

11. Dynamic Control

11.a Provide means of reversing the direction of rotation of each propeller from any speed in one direction to any speed in the other direction in the minimum time with 165% of the torque levels, corresponding to the power allocation level at the motor over the widest possible speed range while stator current is limited to 135% of corresponding levels. The control system shall be designed to provide the minimum reversal time consistent with the permitted voltage and frequency excursions of the power generation system and consistent with reliable operation of the equipment.

11.b Provide means of absorbing regeneration power into dynamic braking resistors during a crash reversal of the propellers. Dynamic resistors are rated for 600 amps and have a duty cycle of 5 seconds on 175 seconds off.

11.c Crash reversal from full power ahead to full power astern not to exceed 28 seconds.

11.d Commands for reduction in power by repositioning the control Levers for a lower value of propeller speed will not require dynamic braking to obtain the new commanded speed. The vessel will be allowed to coast down until the reduced power value is reached to maintain the lower vessel speed. This condition shall apply for all

speed controller repositioning over the range to zero speed.

11.e Only by repositioning the control Lever for an opposite direction of propeller rotation will dynamic braking be required for reversing propeller rotation with the retarding power to the vessel being in proportion to the speed control lever position.

11.f Over the life of the existing system, acceleration and deceleration time curves have been significantly modified by the use of digitally controlled ramp rates. The new system shall provide means of simulating the same response times as existing at the time of renewal.

12. Cycloconverter Protection

12.a Instantaneous and time overcurrent protection at the propulsion system feeder breakers.

12.b Differential protection for phase to phase faults of the converter transformers with winding RTD for alarm annunciation. Transformer secondary CTs are to be mounted within the cycloconverter while the primary CTs and relay are mounted in the main switchboard (provided by others)

12.c Differential protection for phase to phase faults from cycloconverter input to motor neutral.

12.d Static overcurrent, circulating current, cell loss, phase loss, under voltage, ventilating air loss, voltage balance and excitation loss at the cycloconverter.

12.e Ground fault detection at the propulsion motor.

13. For the cycloconverter system, fault protection shall be achieved by the AC feeder breakers (Supplied by others).

13.a In the event of a fault, the applicable circuit breaker to be tripped.

13.b In the event of high over currents associated with rapid stalling of a propeller, only the firing pulses of the cycloconverter shall be suppressed and stall indication shall be given via the cycloconverter control. The converter shall only be reset via the HMI located within the cycloconverter room.

14. Prevent application of power to a motor until the associated shaft turning gear has been disengaged and the associated shaft brake has been released. Indication of shaft brake and turning gear position shall be provided at the control room console. Sensors for detecting the position of the brakes and shaft are provided by others.

15. Provide means to ensure that power cannot be applied to propulsion motors under conditions when less than minimum excitation is applied, and to ensure that power will automatically be removed in the event of failure of the motor brushless excitation supply.

16. Provide for transfer of operating control of the propulsion system between control stations located in the control room console and the wheelhouse console, such that transfer shall require the return of the control Lever handles to the zero position. The transfer shall provide indication of the completion of transfer and the location of the operating control consoles. Recovery of operating control at the control room shall be possible at all times.

17. Motor Excitation
    The motor exciter is a brushless exciter that consists of a stator mounted on a base (with a three phase random winding), a rotor with a three phase AC winding, and an AC to DC converter assembly.

    17.a Provide variable AC static exciter drives for each propulsion motor brushless exciter.

    17.b Provide one standby unit capable of supplying either motor. Once selected by the operator, the switchover shall be automated and a visual display of the excitation feeder circuit shall be provided via the HMI located within the cycloconverter space.

18. Provide permanent means of monitoring the status of all converter internal three phase transformers and single phase control transformers.

19. Provide permanent visual ground detection indication for each propulsion motor using a neutral ground resistor.

20. Not Used

21. Provide a contact to switch the starter for the motor and transformer anti-condensation heaters, so that they are energized when the equipment is not in use. Manual/Auto switch is provided by others (Located in MCC).

22. Control Room Indication:

    22.a Provide all necessary signals for the continuous indication of the condition of each propulsion system together with the description of operating devices which shall be supplied by others.

23. Provide interlocks as required to prevent improper operation of the equipment or hazard to personnel.

24. Utilize passive harmonic filters to limit voltage distortion caused by the cycloconverters on the main power bus to 5% or less.

25. Human Machine Interface (HMI)

    To retain information during a black out, all units shall be fed from the vessel's 24VDC power supply system. Six units in total are required.

25.a One unit per cycloconverter to be mounted in the cycloconverter space. Each unit shall perform the following functions:

25.a.1. Display current operating parameters above and beyond the permanent instrumentation mounted in the space. Each input and output, both analog and digital, shall be able to be called up from the HMI.

25.a.2. Trend selected operating parameters greater than 24 hours

25.a.3. Through system software, proprietary or otherwise, provide fault finding and trouble-shooting assistance to the on-board technician. All faults shall be broken up into three categories:

25.a.3.1. Class 1 – Immediate Trip / Drive Offline

25.a.3.2. Class 2 – Alarm Condition Requiring Immediate Attention

25.a.3.3. Class 3 – Equipment Problems not Requiring Immediate Attention.

25.a.4. The fault finding software shall be able to assist in component level diagnostics and replacement.

25.a.5. Provide supervisory ability to on-board technicians to adjust / force permissive level registers only. No "runtime edits" shall be permitted and any and all changes shall be tracked and flagged as a Class 3 fault (not requiring immediate assistance). Permanent program changes shall be limited to OEM trained technicians only.

25.a.6. Higher level supervisory access shall be limited to the OEM trained technicians and shall be protected as such.

25.b One unit to be mounted in the engine control room. This unit shall performed the following functions:

25.b.1. Display current operating parameters above and beyond the permanent instrumentation mounted in the control room. Each input and output, both analog and digital, shall be able to be called up from the HMI.

25.b.2. Trend selected operating parameters greater than 24 hours

25.b.3. Display current and past faults with a brief description of each

25.c Three units shall be mounted in the wheelhouse. These units shall perform the following functions:

25.c.1. Display current operating parameters above and beyond the permanent instrumentation mounted in the space.

25.c.2. Have the ability to progressively dim the screens to complete black out while still operating.

26. Provide dry contacts for the automatic sequence start of propulsion system auxiliaries. Initiation and display of sequence shall be provided on the control room console by others.

27. Provide means to form a permissive function with contacts from others from all necessary pre-conditions for each propulsion system with display of pre-conditions at the control room console by others. This basic permissive information will be permanently displayed on engine room console and shall be separate from the control room HMI function.

28. Provide sequence for “OFF- READY-RUN” selector switch located in the main control room console:

“OFF-TO-READY”

28.a Initiate the sequence to turn on propulsion motor blowers and cycloconverter cooling

28.b Once all permissives are met, turn on the propulsion system “READY” light

“READY-TO-ON”

28.c When power is on, the cycloconverter will enable the controller to produce a speed reference (lifts suicides)
Turns on propulsion system “ON” light when the drive is ready to go.

“ON -TO- READY”

28.d If the selector switch is moved back to READY, the control disables the speed reference in the program (suicides regulators)

“READY-TO-OFF”

28.e Propulsion motor and cycloconverter cooling is shut off.

2.3.3 Cycloconverter Cooling

The replacement cycloconverter shall be water cooled and utilize the Converter Room’s available fresh water cooling such that no additional space cooling shall be required to be installed by the CCG. The replacement converter shall be able to operate with an ambient room temperature of 45ºC. The converters shall be designed to a max FW cooling inlet temp of 35ºC

2.3.4 Cycloconverter Baseline Sea Trials and Vessel Power Study

The contractor shall conduct thorough sea trials prior to manufacturing the propulsion system renewals included in this contract. All results gathered from the sea trials shall be compiled in a document and submitted electronically to the Canadian Coast Guard.

The contractor shall conduct, at a minimum, the following tests, trials, and studies.

2.3.4.1 Cycloconverter and Plant Performance

With one, two, and three generators online, the contractor shall accurately measure and graph the following values against time under dynamic conditions ranging from slow ahead to crash reversal:

- Main Generator Automatic Voltage Regulator Field Output
- Main Switchboard Voltage
- Main Switchboard Line Frequency
- Total kW demand on the Main Switchboard
- Main Switchboard Power Factor
- Speed Reference from Telegraph/Propulsion Control Levers
- Total Current demand on the Main Switchboard
- Propulsion Motor Current Feedback

- Cycloconverter Speed Regulator demand to Current Regulators
- Cycloconverter Speed Taper Break Point
- Cycloconverter Torque Taper Limit
- Cycloconverter VAR Regulation
- Shaft Speed
- Dynamic Brake Contactor Control Voltage

2.3.4.2 Power Quality and Harmonic Analysis

The T1100 vessels were designed to limit the harmonic voltage distortion caused by the thyrister based cycloconverters to less than 5% on the main switchboard. The primary method used for harmonic mitigation on the vessels is passive harmonic filters connected to the propulsion transformers. The auxiliary switchboard is further protected by a 500kVA electrostatically shielded isolation transformer.

The contractor shall perform a harmonic analysis on both the main and auxiliary switchboards during all the dynamic conditions being tested for the cycloconverter and plant baseline trials. All the data collected must be correlated directly to the test parameters being performed at that time. The contractor shall provide a report to the Canadian Coast Guard that describes in detail what nominal and peak total harmonic distortion values were obtained and what the exact parameters of the baseline trials were at that moment in time. The report shall include an analysis of the effectiveness of the vessel's existing harmonic filters and transformer, as well as an overall report on the voltage and frequency regulation experienced during the dynamic sea trails.

2.3.5 Cycloconverter Dock Trials and Sea Trials

The contractor shall conduct dock trials for the initial commissioning of the new system. During these trails, the basic functionally and safety of the new cycloconverter and related systems shall be proven. All testing shall be completed to the satisfaction of the TA, TCMS, and Chief Engineer before sea trials can begin.

Upon completion of dock trials, the contractor shall conduct sea trails. These trials shall incorporate all of the same parameters as the baseline sea trails including the power quality and harmonic analysis. The contractor must prove the new performance is equal to or better than the initial baseline trials for each parameter that was previously tested.

In addition to the baseline trials parameters, the contractor must prove that the new generator excitation, propulsion control levers, and cycloconverters meet all the functional requirements as stated in 2.1.2, 2.2.2, and 2.3.1 respectively. Where the sea conditions are not conducive to a functional test, that test shall be left unverified and shall be incorporated into the performance period for future evaluation.
Example – Functional Requirement 2.3.2.3a may need to be completed in ice conditions:

"The propulsion system overload level of 6180kW will be utilized in a linear relationship from zero to motor speed of 144 rpm corresponding to a bollard condition".

2.3.6 Propulsion Motor Encoder and Speed Feedback with Wheelhouse Meters

The existing accessory drive package fitted to the non-drive end of the propulsion motors shall be removed and replaced with a directly coupled position encoder and speed feedback unit similar to the picture below:

Right – Existing ADP with gearbox.

Below – Directly coupled "Hubner" dual encoders.

1. The contractor shall provide a position encoder to be used with the cycloconverter.

2. The contractor shall provide a speed feedback unit to be used for the wheelhouse and motor control room shaft speed meters. The method for shaft speed feedback can be digital or analog.

   2.a The contractor shall provide 4 shaft speed indication meters per motor (8 per vessel) to be used in the three wheelhouse consoles and the single motor control room console. The meters shall be 8 ¾" (AB16) or the closest standard available size. The wheelhouse meters illumination shall be capable of being fully dimmed from a 24VDC source (supplied by others).

3. The contractor shall provide the mounting flange and all associated hardware needed for securing the encoders / sensors to the shaft.

2.3.7 Cycloconverter Space Permanent Instrumentation

The following analog meters shall be individually mounted in the cycloconverter space:

1. Supply from Propulsion Transformer
   a. 2 x AC ammeter (input to cyclo)
   b. 2 x Ammeter selector switch; Phase A, B,C, Off
   c. 2 x AC Voltmeter (input to cyclo) reading true RMS
   d. 2 x Voltmeter Selector Switch; Phase A,B,C, Off

e. All Current and Voltage transformers needed for metering

2. Converter Output – Motor Stator
    a. 2 x AC ammeter (motor current)
    b. 2 x Ammeter selector switch; Phase A, B,C, Off
    c. 2 x AC voltmeter (motor volts) reading true RMS
    d. 2 x Voltmeter Selector Switch; Phase A,B,C, Off

3. Converter Output – Motor Exciter (from drive)
    a. 2 x Exciter ammeter
    b. 2 x Exciter voltmeter

4. Temperature
    a. Converter temperature
    b. Room Temperature
    c. Water Cooling Inlet Temperature

2.3.8 Cycloconverter Remote Monitoring Capability

The new cycloconverters shall have virtual diagnostics capability to provide virtual OEM technician assistance while the vessel is at sea. The converters are to be virtual assistance ready. The CCG shall provide the connection to the existing vessel infrastructure.

2.3.9 Cycloconverter Space Alarm and Monitoring Integration

The following system refers to the CCGS Sir William Alexander. All of the Type 1100 alarm and monitoring systems are of similar architecture to the following example:

The new cycloconverters shall communicate to the existing Trihedral VTScada (VTS) alarm and monitoring system via an Ethernet drop (provided by others). A list of supported protocols can be found at https://www.trihedral.com/device-driver-list . The contractor shall choose an accepted protocol and provide any additional modules needed to interface with the Ethernet drop.

The following parameters shall be integrated into the VTS system:

- Class 1, 2, and 3 Faults and associated reason as determined by the fault finding software
- Input Voltage Phase A,B,C
- Input Current Phase A,B,C
- Input Frequency
- Exciter Volts and Amps
- Stator Volts / Amps Phased A. B, C
- Control Lever reference and direction
- kVA Limit (#Gen Online)
- kVA Limit in real time (Plant Limit)
- Torque Demand in %

- Shaft speed
- Converter(s) temperature
- Converter Room ambient temperature

2.3.10 Harmonic Filter Replacement

The contractor shall provide port and starboard* replacement harmonic filters for the CCGS Ann Harvey. Each filter shall consist of capacitors and reactors designed to limit the voltage distortion caused by the cycloconverters. The replacement filters shall be designed to the same values as the original filters.

*Note – The port and starboard harmonic filters are tuned differently. The port filter is tuned for the 4.6^{th} and the starboard for the 9^{th}.

2.3.11 Dynamic Brake Replacement

The Contractor shall provide 2 dynamic brakes for the cycloconverters to achieve the crash reversal times as stated within the functional requirements. The units shall be mounted in self-ventilated splash proof metal enclosures.

Each unit shall be equipped with the following:

- Stainless Steel dynamic braking resistors for marine service, adequately rated, with a duty cycle of 5 seconds on and 175 seconds off.
- One High Voltage contactor per unit mounted within the enclosure
- Rating – 600 Amps Total

2.3.12 Cycloconverter Excitation Transformers

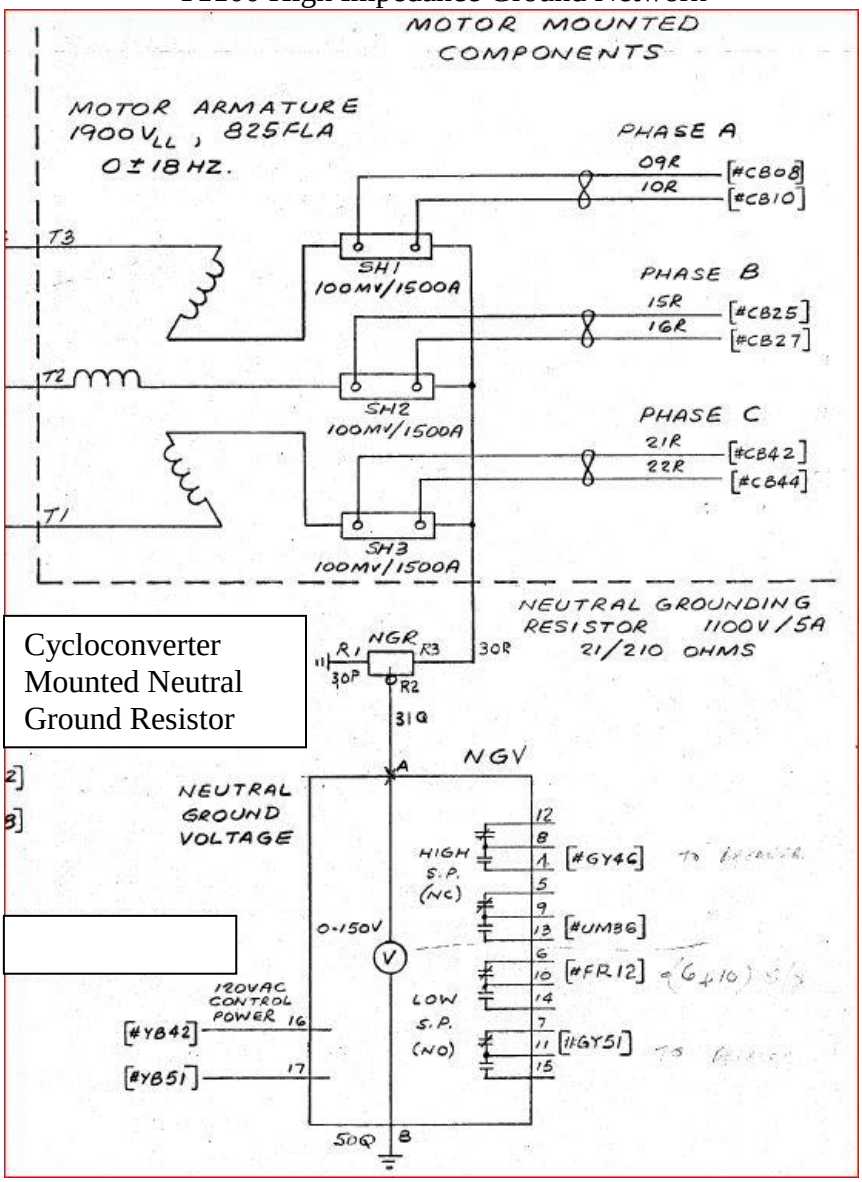
The Contractor shall replace the 2 cycloconverter excitation transformers mounted within the cycloconverter. The existing transformers have the following nameplate data:

Manufacturer – Hammond
Catalog Number – 126420
Type - J
KVA – 100
HZ – 60
% Imp – 2.73% at 90^0C
Weight – 880lbs
Temperature Rise – 70^oC
Insulation Class – 220^oC
High Voltage – 600 Delta
Low Voltage – 600 Delta
Taps – 105%, 102.5%, 100%, 97.5%, 95%
Classification Society – Lloyds Register

2.3.13 Neutral Ground Resistor

The T1100 vessels are fitted with propulsion motors designed for a high impedance ground detection system. This system shall be recreated within the new cycloconverters. The Contractor shall supply a neutral ground resistor for each motor that will be used for the ground detection. The existing motor 100mV/1500A shunts can be re-used.

T1100 High Impedance Ground Network



2.3.14 Medium Voltage Cable Replacement

The Contractor shall supply all the medium voltage cabling used from the secondary of the propulsion transformers into the cycloconverters and from the cycloconverters to the propulsion motors. Contractors shall bid on the supply of 750 meters of Class approved 600 MCM 5kV marine rated cabling. A unit price per 10 meters of supply shall also be provided for cost adjustment.

Example: Sir William Alexander Cable Schedule

Shaft	Designation	From	To	Size	Length		Shaft	Designation	From	To	Size	Length
Port	PP-1101-T11	xfmr	ccv	1 x 600MCM 5kV	8		Stbd	PS-1101-T11	xfmr	ccv	1 x 600MCM 5kV	18
Port	PP-1101-T21	xfmr	ccv	1 x 600MCM 5kV	8		Stbd	PS-1101-T21	xfmr	ccv	1 x 600MCM 5kV	18
Port	PP-1101-T31	xfmr	ccv	1 x 600MCM 5kV	7		Stbd	PS-1101-T31	xfmr	ccv	1 x 600MCM 5kV	17
Port	PP-1101-T12	xfmr	ccv	1 x 600MCM 5kV	8		Stbd	PS-1101-T12	xfmr	ccv	1 x 600MCM 5kV	18
Port	PP-1101-T22	xfmr	ccv	1 x 600MCM 5kV	8		Stbd	PS-1101-T22	xfmr	ccv	1 x 600MCM 5kV	18
Port	PP-1101-T33	xfmr	ccv	1 x 600MCM 5kV	7		Stbd	PS-1101-T33	xfmr	ccv	1 x 600MCM 5kV	17
Port	PP-1102-T11	xfmr	ccv	1 x 600MCM 5kV	8		Stbd	PS-1102-T11	xfmr	ccv	1 x 600MCM 5kV	17
Port	PP-1102-T21	xfmr	ccv	1 x 600MCM 5kV	8		Stbd	PS-1102-T21	xfmr	ccv	1 x 600MCM 5kV	17
Port	PP-1102-T31	xfmr	ccv	1 x 600MCM 5kV	7		Stbd	PS-1102-T31	xfmr	ccv	1 x 600MCM 5kV	16
Port	PP-1102-T12	xfmr	ccv	1 x 600MCM 5kV	8		Stbd	PS-1102-T12	xfmr	ccv	1 x 600MCM 5kV	17
Port	PP-1102-T22	xfmr	ccv	1 x 600MCM 5kV	8		Stbd	PS-1102-T22	xfmr	ccv	1 x 600MCM 5kV	17
Port	PP-1102-T33	xfmr	ccv	1 x 600MCM 5kV	7		Stbd	PS-1102-T33	xfmr	ccv	1 x 600MCM 5kV	16
Port	PP-1103-T11	xfmr	ccv	1 x 600MCM 5kV	9		Stbd	PS-1103-T11	xfmr	ccv	1 x 600MCM 5kV	16
Port	PP-1103-T21	xfmr	ccv	1 x 600MCM 5kV	9		Stbd	PS-1103-T21	xfmr	ccv	1 x 600MCM 5kV	16
Port	PP-1103-T31	xfmr	ccv	1 x 600MCM 5kV	8		Stbd	PS-1103-T31	xfmr	ccv	1 x 600MCM 5kV	15
Port	PP-1103-T12	xfmr	ccv	1 x 600MCM 5kV	9		Stbd	PS-1103-T12	xfmr	ccv	1 x 600MCM 5kV	16
Port	PP-1103-T22	xfmr	ccv	1 x 600MCM 5kV	9		Stbd	PS-1103-T22	xfmr	ccv	1 x 600MCM 5kV	16
Port	PP-1103-T33	xfmr	ccv	1 x 600MCM 5kV	8		Stbd	PS-1103-T33	xfmr	ccv	1 x 600MCM 5kV	15
Port	PP-1900-T11	ccv	motor	1 x 600MCM 5kV	17		Stbd	PS-1900-T11	ccv	motor	1 x 600MCM 5kV	17
Port	PP-1900-T21	ccv	motor	1 x 600MCM 5kV	17		Stbd	PS-1900-T21	ccv	motor	1 x 600MCM 5kV	17
Port	PP-1900-T31	ccv	motor	1 x 600MCM 5kV	17		Stbd	PS-1900-T31	ccv	motor	1 x 600MCM 5kV	17
Port	PP-1900-T12	ccv	motor	1 x 600MCM 5kV	17		Stbd	PS-1900-T12	ccv	motor	1 x 600MCM 5kV	17
Port	PP-1900-T22	ccv	motor	1 x 600MCM 5kV	17		Stbd	PS-1900-T22	ccv	motor	1 x 600MCM 5kV	17
Port	PP-1900-T32	ccv	motor	1 x 600MCM 5kV	17		Stbd	PS-1900-T32	ccv	motor	1 x 600MCM 5kV	17
				Port Total							Stbd Total	
				Meters	**246**						Meters	**402**

2.4 Propulsion System Spares

The Contractor shall supply the following spares for the GES, PCL, and CCV systems:

a) 1 spare voltage regulator (AVR) for the main generators;
b) 2 spare bridge propulsion control levers, 1 port, 1 stbd;
c) 1 spare PLC used for propulsion control levers;
d) 1 Spare of each different type of HMI used;
e) 1 full set of power thyristors(12) as used on the new CCV to renew 1 phase;
f) 2 spare CCV digital input modules;
g) 2 spare CCV digital output modules;
h) 2 spare CCV analog input Modules;
i) 2 spare CCV analog output modules;
j) 1 spare CCV Application or Integration Controller;
k) 1 Spare CCV Drive Master Controller;
l) 1 Spare CCV Gating Unit including Isolation module;
m) 1 box (100) Din Rail mounted Terminal Blocks used in CCV;
n) A minimum of 10 fuses of every size and current rating
o) 2 Breakers of every size used;
p) 1 position encoder and speed feedback unit;
q) 10 spare capacitors of each type and capacity used;
r) 10 spare resistors of each denomination and power rating used;
s) 2 spare shaft bridge RPM gauges, 1 port, 1 stbd;
t) 2 spare of every type of switch or pushbutton, including switch blocks;
u) 50 lamps for each type of illumination used;
v) 2 spare power supplies of every different type;
w) 2 spare of every type of RTD or thermocouple;
x) If cooling pumps are used, at least 1 spare pump/motor combinations;
y) 2 spare cooling fans of every type;
z) 2 full sets of any air filters if used , enough to renew both cycloconverters;

3.0 CONTRACT DELIVERABLES

3.1.1 Preliminary Design Package Part 1 (PDP1) Deliverables

- Preliminary Design Package 1 Details

  The Contractor shall submit the following documentation and design details to the Canadian Coast Guard for approval. All sections of the PDP1 must be approved by the Technical Authority prior to starting the next phase:

  a) Project schedule including design, production, testing and delivery of the cycloconverter, GES, and PCL systems;
  b) Integration Management Plan for new and retained systems and components;
  c) Operator station layouts and bills of materials;
  d) Systems bills of Materials;
  e) Cycloconverter GES, and PCL Control system philosophy descriptions;
  f) General arrangements;
  g) Cycloconverter GES, and PCL Control system functional descriptions;
  h) Systems block diagrams;
  i) User interface documentation;
  j) Power supply arrangement;
  k) Safety functions, including slowdowns, shut downs, and overrides;
  l) Environmental specifications of all components and assemblies to be used.

3.1.2 Preliminary Design Package Part 2 (PDP2) Deliverables

- Preliminary Design Package 2 Details

  The Contractor's PDP2 shall submit the following documentation and design details to the Canadian Coast Guard for approval:

  m) Refit specifications and drawings;
  n) Document and Drawing Management Plan;
  o) Speed and Load curves for all propulsion modes and configurations;
  p) Component and system installation, operation and maintenance manuals;
  q) Training regime for both operators of the system and those required to perform maintenance;
  r) Software quality plan.

- Preliminary Design Package 2 Refit Specification used for Subcontractors

  The Contractor's PDP2 shall include the following minimum refit installation specification requirements:

  s) Utilize a mutually acceptable numbering format and subject headers as this specification will be tendered as part of a larger specification package, and;
  t) Provide details of the renewal of all control consoles (bridge and engine room) to allow for well laid out control stations with the integration of the new Cycloconverter and PCL controls and existing control equipment.

- Preliminary Design Package Refit Drawings

  The Contractor's PDP shall include the following minimum Refit Installation Drawing requirements:

  u) Details of all removals and installation of all equipment and cabling. It is anticipated that the successful subcontractor will perform cable runs;
  v) A list of refit installation drawings, and;
  w) The specific drawing standard that will be utilized for the refit installation drawings.

- Quality Assurance Inspections

  The Contractor shall submit with the working drawings a QA Inspections, Tests, and Trials Plan for the installation phase of the project.

3.1.3 Approval Design Review Deliverables

The Contractor shall submit an Approval Design Review package to the IA and TA for approval. This submission shall include the PDP incorporating the latest revisions as well as the new requirements listed below.

- Approval Design Review Details

The Contractor's Approval Design Review shall include details of the following:

a) Specific details of the Factory Acceptance Test regime which shall include a full physical layout of components as they will be installed on the ship;
b) Details of a Failure Modes and Effect Analysis (FMEA) for the Cycloconverter;
c) Specific details of the communication interconnection of the supplied system with existing machinery and monitoring equipment;
d) Dock trials, and Sea Trials test programs;
e) All revised alongside installation refit specifications and drawings that were produced during the PDP2 phase;
f) A list of additional critical spare parts as identified by the design phase or FMEA;
g) Ability of the proposed system to allow for future expansion of both sensor inputs or programming additions, and;
h) Warranty details.

3.2 Deliverables – General

3.2.1 Equipment and Systems Delivery

The Contractor shall deliver all equipment to the Canadian Coast Guard for installation into the specified vessel no later than 48 weeks of contract award. This shall include all components for installation. The Contractor shall indicate in their proposal if they are able to improve on the delivery and installation timeline as mentioned above.

3.2.2 Training

The Contractor shall deliver training conducted by the Contractor's personnel specialized in the design and operation of the cycloconverter, GES, and PCL systems. The Contractor shall provide all software, hardware, facilities and licensing required to complete this training. The Contractor shall provide the course syllabus and schedule, the training manuals and materials to Canada one week prior to the training period to allow the Coast Guard personnel time to familiarize themselves with the systems. The training materials shall be specific to the cycloconverter, GES, and PCL systems installation on the vessel. The training materials and instruction shall be provided in English. The training shall be conducted as follows:

a) Hands On training for Coast Guard personnel shall be conducted for a period of no less than 40 hours of contact time. This training shall include, as a minimum, the instruction of the Coast Guard personnel on all testing procedures as well as instruction on components and functions, operating modes, instruments, safety system activation and operation, alarms, system troubleshooting and hands-on operation training.

4.0 DOCUMENTATION

4.1 Documents

4.1.1 Document Deliverables

The successful Contractor shall provide the following documentation over the course of the contract:

a) Three (3) paper copies and one (1) electronic copy on CD ROM or USB format of the Refit Installation Specification. These shall be in Microsoft Office compatible electronic format (Word, Excel, etc.);
b) The Class Certification and TCMS Approval documentation for the systems, and certificates for all materials and machinery;

4.1.2 Electronic Protection

Drawings and documents shall not be electronically protected so as to be Read Only files.

4.1.3 Electronic Labelling

All electronic media shall be clearly labelled with the CCG project number, file names and drawing numbers. If a complete listing exceeds the label size, a "readme.txt" file in ASCII format shall be provided with each disk. A printed copy of the Readme file shall accompany each disk.

4.2 Drawings

The contractor shall update the following drawings for the CCGS Sir William Alexander. All T1100 vessels shall be priced based on the below list. A ship specific list shall be provided prior to starting the PDP phase for each vessel:

Sir William Alexander Drawing Update List

Drawing Number	**Description (PDF of TIFF unless stated)**	**Number of Drawings**	To be updated with new
M7066A-36B	Main Gen#1 Excitation System	1	Yes
M7066A-37B	Main Gen#1 Excitation System	1	Yes
M7066A-38B	Main Gen#1 Excitation System	1	Yes
0233B1324 SHEET 02EG	Telegraph	1	Yes
0233B1324 SHEET 02EH	Telegraph	1	Yes
0233B1324 SHEET 02EJ	Telegraph	1	Yes
016.00755.15	Wiring Diagram for Wrong Way Alarm System	1	Yes
M7066D-310A1	Metering and Control	1	Yes
M7066D-326A1	Port Wing Console Schematic Diagram	2	Red Line
M7066D-351A1	Wheelhouse Central Console Schematic Diagram	2	Red Line
358-10 sheet 1 to 33/33	Propulsion System Connection Diagrams	25	Yes
351-12 Sheets 4 & 5	Details of Multi-Cable Feeders	2	Yes
358-02	LIST OF CABLES PROPULSION SYSTEM	1	Yes
358-07	PROPULSION SYSTEM TANK TOP BETWEEN FR 30 AND 70	1	Yes
358-08	PROPULSION SYSTEM TANK TOP BETWEEN FR 70 AND 126	1	Yes
07277E01ECSWA	Cycloconverter One-Line Diagram	1	Yes
0233B1321 Sheets 1 to 388	CGE Cycloconverter Elementaries	N/A	Yes
465-01	CENTRAL COOLING WATER SYSTEM DIAGRAM (CAD)	1	Yes
M7066A-8A2	STAR PROPROPULSION BKR DIAGRAM	1	Red Line
M7066A-13A2	PORT PROPULSION BKR DIAGRAM	1	Red Line
352-04 1 to 91	MCC Separate Motor Starters	11	Yes
977-53	Converter Room Arrangement	1	Yes
977-81	Composites Motor Room, Purifier Room, Converter Room	2	Red Line

218-03	SEAT FOR SS TRANSFORMER, CYCLO CONVERTER	1	Yes
218-03	SEAT FOR MCC #3 HARMONIC FILTER, SHORE POWER	1	Yes
460-01	MACHINERY ARRGT_1OF2	1	Red Line
460-01	MACHINERY ARRGT_1OF2	1	Red Line

4.2.1 Drawing Formats

The successful Contractor shall provide three (3) paper copies and one (1) electronic copy on CD ROM or USB format of the following drawings over the course of the contract:

- All new drawings shall be standard ANSI paper size and shall be in AutoCAD DWG and PDF format.

- All electronic versions of drawings shall be given a name such that the user does not have to open the drawing to establish the purpose of the drawing. The beginning of the name shall use the vessel's asset code.

  e.g.
  SWA0077343CA.DWG verses

  VNDJ2_CNVTR_120V _OUT_7343CA.DWG

- All DWG versions shall contain two monochrome layout tabs with the drawing centered in each. One shall be the ANSI sheet size with the correct aspect ratio and precision for the drawing and the other shall be tabloid 11x17.

4.3 System Manuals

The contractor shall provide system manuals for each of the 3 main systems provided in this contract; generator excitation, propulsion control levers, and cycloconverters. The system manuals shall be specific to the as-fitted system systems supplied to the T1100 vessels. Generic component manuals combined in a binder will not be accepted. Each system manual shall be constructed to the IACS Recommendation 71- *Guide for the Development of Shipboard Technical Manuals*, and must provide all of the following sections:

a) Purpose and planning (what is the system/equipment for);
b) Handling, installation, storage and transit (how to prepare it for use);
c) Technical description (how it works);
d) Operating Instructions (how to use it);
e) Fault action list (how to restore operating condition)
f) Maintenance instructions (how to keep it working);
g) Maintenance schedules (what is done when);
h) Parts list (what it consist of);
i) Modification instructions (how to change it),
j) Disposal instruction (how to dispose of it).

5.0 INSPECTIONS, TEST AND TRIALS

5.1 Factory Acceptance Test

The Contractor shall conduct Factory Acceptance Tests of the cycloconverter and propulsion control lever systems with the TCMS Approved trials schedule. The contractor shall conduct these Tests and Trials at the contractor's facility in the presence of the attending Class surveyor, the IA, the TA, and TCMS (where available). The cycloconverter and propulsion control levers systems shall be integrated and tested while the IA and TA are present.

6.0 PAYMENT SCHEDULE

Each vessel shall be paid according to the following milestones:

Milestone 1: Completion of Sea Trials (5% - holdback)
Milestone 2: Completion of Cycloconverter engineering (20% - holdback)
Milestone 3: Submission of Preliminary Design package phases (10% - holdback)
Milestone 4: Submission of Approval Design package (10% - holdback)
Milestone 5: Completion of Cycloconverter FAT (10% - holdback)
Milestone 6: Cycloconverter equipment arrives at CG/Shipyard (20% - holdback)
Milestone 7: Completion of Installation / Initial Commissioning (10% - holdback)
Milestone 8: Completion of Sea Trials (5% - holdback)
Milestone 9: Completion of Performance Period (10%)