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**SOLICITATION AMENDMENT**

**MODIFICATION DE L'INVITATION**

The referenced document is hereby revised; unless otherwise indicated, all other terms and conditions of the Solicitation remain the same.

Ce document est par la présente révisé; sauf indication contraire, les modalités de l'invitation demeurent les mêmes.

**Comments - Commentaires**

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11 Laurier St. / 11, rue Laurier

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K1A 0S5

<b>Title - Sujet</b> One (1) 11.2-11.6m aluminum workboa	
<b>Solicitation No. - N° de l'invitation</b> F7047-150012/A	<b>Amendment No. - N° modif.</b> 001
<b>Client Reference No. - N° de référence du client</b> F7047-150012	<b>Date</b> 2015-10-27
<b>GETS Reference No. - N° de référence de SEAG</b> PW-\$\$MC-024-25408	
<b>File No. - N° de dossier</b> 024mc.F7047-150012	<b>CCC No./N° CCC - FMS No./N° VME</b>
<b>Solicitation Closes - L'invitation prend fin</b> <b>at - à 02:00 PM</b> <b>on - le 2015-11-24</b>	
<b>F.O.B. - F.A.B.</b> <b>Plant-Usine:</b> <input type="checkbox"/> <b>Destination:</b> <input checked="" type="checkbox"/> <b>Other-Autre:</b> <input type="checkbox"/>	
<b>Address Enquiries to: - Adresser toutes questions à:</b> Pilon, Chantal	<b>Buyer Id - Id de l'acheteur</b> 024mc
<b>Telephone No. - N° de téléphone</b> (819) 956-4308 ( )	<b>FAX No. - N° de FAX</b> ( ) -
<b>Destination - of Goods, Services, and Construction:</b> <b>Destination - des biens, services et construction:</b> See herein	

**Instructions: See Herein**

**Instructions: Voir aux présentes**

<b>Delivery Required - Livraison exigée</b>	<b>Delivery Offered - Livraison proposée</b>
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<b>Name and title of person authorized to sign on behalf of Vendor/Firm</b> <b>(type or print)</b> <b>Nom et titre de la personne autorisée à signer au nom du fournisseur/ de l'entrepreneur (taper ou écrire en caractères d'imprimerie)</b>	
<b>Signature</b>	<b>Date</b>

Amendment 1:

This amendment is raised to replace the previous version of the TSOR with the attached, Version 2. Changes are identified on the second page.

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ALL OTHER TERMS AND CONDITIONS REMAINS THE SAME.



## DEPARTMENT OF FISHERIES AND OCEANS

### ANNEX A

#### Technical Statement of Requirements

Requisition number F7047-150012, provision of quantity one (1), 11.2 to 11.6 metre aluminum workboat, twin inboard diesel jet engines with cabin

October 26, 2015, Revision 2

TRANSPORT CANADA MARINE SAFETY BRANCH (TCMSB)  
TP1332 APPROVED CONSTRUCTION



## Document Control

### Record of Amendments

#	Date	Description	Initials
0	October 1, 2015	Original Issue	KA
1	October 10, 2015	Minor modifications	KA
2	October 26, 2015	Minor modifications to sections 4.1.15, 7.1.1 & 7.1.13	KA

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## **ABBREVIATIONS**

ABYC	American Boat and Yacht Council
AC	Alternating Current
ASTM	American Society for Testing and Materials
CFM	Contractor Furnished Material
<b>CSA</b>	<b><i>Canadian Shipping Act</i></b>
CSA	Canadian Standards Association
COLREGS	Collision Regulations
DC	Direct Current
FRP	Fibre/Glass Reinforced Plastic
GPS	Global Positioning System
GSM	Government Supplied Material
ISO	International Organization for Standardization
PVC	Polyvinylchloride
TA	Technical Authority (As defined by the Contract)
TCMS	Transport Canada Marine Safety
TSOR	Technical Statement of Requirements
UV	Ultraviolet
VHF	Very High Frequency
WMO	World Meteorological Organization

## **LIST OF REFERENCE DOCUMENTS**

<b>REFERENCE</b>	<b>TITLE</b>
ASTM F1166	Standard Practice for Human Engineering Design for Marine Systems, Equipment and Facilities
TP 1332	Construction Standards for Small Boats
TP 13430	Standard For Tonnage Measurement of Ships
TP 14070	Small Commercial Vessel Safety Guide
ISO 12217	Small Boat – Stability and Buoyancy Assessment and Categorization
Canada Shipping Act	Small Vessel Regulations
Canada Shipping Act	Collision Regulations (COLREGS)
ABYC	American Boat and Yacht Council Standards
Canadian Standards Association (CSA) CSA W47.2-M1987	Certification of Companies for Fusion Welding of Aluminium
(CSA) C22.2 No. 183.2-M1983 (R1999)	Standards for DC Electrical Installations on Boats
CT-043-EQ-EG-001-E	Canadian Coast Guard Welding Specification, March 2014

## **1.0 OVERVIEW**

### **1.1 REQUIREMENT**

- 1.1.1 **General Information: This vessel is intended to be built based on stock small working or commercial vessel hull forms with a minimum of customization as indicated herein. A Prototype hull will not be considered for this procurement.**
- 1.1.2 DFO buys, manages and operates numerous vessels in support of its Departmental programs and other missions.
- 1.1.3 This requirement is for one (1) aluminum workboat, twin inboard diesel jet engines with cabin in the 11.2 to 11.6 metre range.
- 1.1.4 The primary role of this vessel will be as a coastal research vessel in support of DFO's Great Lakes Science program through the Great Lakes Laboratory for Fisheries and Aquatic Science (GLLFAS) primarily based in Burlington, ON. The vessel will be expected to operate throughout the entirety of the Great Lakes in both the offshore and nearshore environments, while conducting both daylight and night-time operations between April and December each year. The primary tasks of the vessel will be towing arrays, trawling and conducting stationary point sampling of aquatic organisms.
- 1.1.5 . The vessel will be expected to operate both offshore and nearshore in shallow water throughout the Great Lakes.

## **2.0 DESIGN AND CONSTRUCTION REQUIREMENTS**

Unless stated otherwise all components, equipment and material must be Contractor supplied.

### **2.1 ERGONOMIC DESIGN – GENERAL**

- 2.1.1 Hazardous operating conditions must be prevented by arranging machinery and equipment in a safe manner; providing guards for all electrical, mechanical and thermal hazards to personnel; and providing guards or covers for any controls that might accidentally be activated by contact of personnel.
- 2.1.2 The vessel must be designed and constructed to accommodate both male and female crew from approx. 5' to 6' 4" in height, wearing cold weather clothing and equipment in accordance with ASTM F1166-07 Standard Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities.
- 2.1.3 Human engineering factors considered in design must include accessibility, visibility, readability, crew efficiency and comfort. All equipment must be accessible for use, inspection, cleaning and maintenance.
- 2.1.4 Equipment must be accessible for use, inspection, cleaning and maintenance as per ASTM F1166-07.

### **2.2 VIBRATION**

The vessel and all components must be free of local vibration that could endanger vessel personnel, damage vessel structure, machinery or systems, or interfere with the operation or maintenance of vessel machinery or systems.

- 2.2.1 Mounts for movable components, including items moved for stowage, towing or transport must be provided with resilient material as necessary to prevent rattling.

2.2.2 Loosening of fasteners under vibration must be prevented by the use of self-locking fasteners, as applicable.

### **2.3 EQUIPMENT PROTECTION**

The Contractor is responsible for the care of all equipment. All parts, especially those having working surfaces or passages intended for lubricating oil, must be kept clean and protected during manufacture, storage, assembly and after installation. Equipment must at all times be protected against dust, moisture or foreign matter and must not be subject to rapid temperature changes or extremes in temperature.

### **2.4 SITE CLEANLINESS**

During construction, all chips, shavings, refuse, dirt and water must be removed at the completion of the work shift or sooner. The Contractor must ensure measures are taken to avoid wear and damage incident to construction, and to prevent corrosion or other deterioration. Equipment subject to freezing must be kept drained, except during test and trials. Equipment must be kept clean and protected from the environment prior to installation.

### **2.5 STRUCTURAL STRENGTH**

All structures and components (hull, deck, seating, etc.) must be of sufficient strength to withstand the lateral and vertical impact-loading that equates to the conditions of the operational requirements. Hull scantlings at a minimum must adhere to requirements of TP1332.

### **2.6 STANDARDS**

2.6.1 The vessel must be designed, constructed, inspected, and certified to meet the requirements of the following standards, regulations and codes:

2.6.1.1 Transport Canada Marine Safety Regulation TP 1332 (current edition) Construction Standards for Small Boats. This standard references ISO and ABYC standards covering structure, fuel, electrical, stability and drainage requirements.

2.6.1.2 CSA C22.2 No. 183.2-M1983 (R1999) Standards for DC Electrical Installations on Boats and ABYC 'E' Electrical Standards.

2.6.2 The Contractor must supply the vessel as per this TSOR and where this TSOR interferes or contravenes the above standard; the above TCMSB TP 1332 standard will take precedence.

2.6.3 The Contractor must supply a certificate of approval insuring the proposed vessel complies with TCMSB TP 1332, to ensure compliance with the current Canadian Coast Guard, Maritime Services Policies.

2.6.4 The Contractor must arrange for Technical/Contracting Authority site visits, during all phases of the vessel's construction. The site visits are required to insure that all barges constructed under this TSOR comply with each standard addressed in this TSOR. The Contractor must supply an electronic copy and two (2) hard copies of all as-fitted drawings for the vessel design and construction drawings to the Technical Authority.

2.6.5 The Contractor must supply a signed letter insuring the barge complies with TCMSB TP 1332 and a completed Small vessel Compliance Form (available from the TCMSB web site), to ensure compliance with the current TCMSB requirements.

2.6.6 To facilitate proper inspection of material and workmanship, the Technical Authority / Inspection Authority must be permitted access, to the Contractor's facility at any time during construction.

2.6.7 The construction, outfit, machinery, equipment, fittings, systems, testing and trials must be to the satisfaction and approval of the Technical Authority / Inspection Authority.

## **2.7 MATERIALS**

2.7.1 All materials must be corrosion resistant and suitable for use in a salt water environment as detailed in the Operational Requirements. All materials normally subjected to sunlight must resist degradation caused by ultraviolet radiation. Galvanized materials are unacceptable.

2.7.2 Direct contact of electrolytically dissimilar metals is not allowed. Electrolytic corrosion must be prevented by insulating dissimilar materials from each other with gaskets, washers, sleeves, or bushings of suitable insulating material.

2.7.3 Stainless steel type 316L or 316 must be used for all stainless steel applications except as noted. Alloy 316L must be used in any welded underwater components.

2.7.4 Fittings and clamps must be stainless steel. Bolts used in all fittings must be Type 316 stainless steel.

2.7.5 Where flexible connections are required for steering and fuel systems, suitable hose with permanently crimped, detachable reusable type fittings must be used.

2.7.6 All materials and equipment must be stored installed and tested in accordance with the manufacturer's guidelines, recommendations and requirements.

## **2.8 FASTENERS**

2.8.1 All fasteners must be of corrosion resistant materials.

2.8.2 Cadmium plated parts and fasteners, including washers, must not be used.

2.8.3 Direct attachment of alloys containing copper to aluminium is not permitted except for an electrical bonding strap.

2.8.4 Where nuts will become inaccessible after assembly of the vessel, nuts must be captured or anchored to allow reassembly and prevent backing off.

2.8.5 Unless otherwise specified, self-locking nuts must be installed to prevent loosening of fasteners due to shock and vibration.

2.8.6 Fasteners in deck traffic areas must be flush-mounted to eliminate tripping and snagging hazards.

## **3.0 OPERATIONAL REQUIREMENTS**

### **3.1 GENERAL**

Unless otherwise stated, performance must be for conditions of zero sea state and no wind, in salt water with Normal Load and complement. The vessel must be designed and constructed for ease of maintenance and repair, long life, and to be easily supportable by local commercial facilities and suppliers. Unless otherwise stated, performance must be for conditions of zero sea state and no wind, in salt water with Normal Load Condition. The vessel is expected to have a service life of at least 12

years, with an expected usage of between 400 and 500 hours per year and meet the following minimum operational requirements:

- 3.1.1 Must meet ISO design category "B".
- 3.1.2 Maximum speed: Not less than 35 knots (at normal load condition);
- 3.1.3 Cruising speed: 30 knots;
- 3.1.4 Minimum range of 250 NM at cruising speed;
- 3.1.5 Endurance: maximum speed for two (2) hours. Run at 10 knots for 12 hours;
- 3.1.6 Capable of steering 15° from heading, in Beaufort Force 6, with seas from any direction;
- 3.1.7 Steer and manoeuvre effectively at 3 knots in Beaufort Force 6;
- 3.1.8 Maintain course, made good over ground, when proceeding at 3 knots with relative cross wind of 25 knots;
- 3.1.9 Operate carefully in depths of 1.6 meters; and
- 3.1.10 Basic manoeuvring in depths of 1.4 meters.

### **3.2 ENVIRONMENTAL CONDITIONS**

The vessel must be capable of operating day or night in the following conditions:

- 3.2.1 Average ambient air temperature range: -15°C to + 35°C
- 3.2.2 Average water temperature: 0°C to +20°C.
- 3.2.3 Wave heights of up to 4 meters (Beaufort Force 6).
- 3.2.4 Wind speeds of 22 - 27 knots.
- 3.2.5 Operate in freezing spray or freezing rain with accumulations of up to 6.0 mm while maintaining stability to allow for safe transit in Beaufort Force 6.

### **3.3 BEACHING**

- 3.3.1 The vessel must be capable of beaching on soft (sand, earth or clay) surfaces at a speed of up to five (5) knots without damage to the hull.

### **3.4 LAUNCHING, RECOVERY & TRANSPORTATION**

- 3.4.1 The vessel must be readily road transportable on a trailer, must be able to be launched and recovered using the trailer at existing launch ramps.
- 3.4.2 The vessel must be equipped with a four-(4) leg, webbing lifting bridle, which may require a spreader bar. The location and arrangement of lifting gear must be such that it does not pose a safety hazard to the operator or crew nor interfere with vessel operation. All bridle lifting lugs must be reinforced and proof tested in accordance with CSA Tackle Regulations. Lifting points must not be located below the deck or within lockers or compartments. Lifting points must be located so that the bridle does not snag on the vessel structure, outfit or machinery. Lifting slings provided must be webbing strap type certified to safely lift the vessel in the Normal Loaded condition. Test margin 150% for four straps, or per CSA if higher standard.

## **4.0 PHYSICAL CHARACTERISTICS**

### **4.1 VESSEL PARTICULARS**

- 4.1.1 Length overall between – 11.2 to 11.6 metres.
- 4.1.2 Maximum Breadth overall – 3.70 metres.
- 4.1.3 Design draft - between 0.6 to 0.7 meters.
- 4.1.4 Depth moulded, amidships - between 1.2 to 1.3 meters.

- 4.1.5 Maximum height for trailering (from the bottom of keel amidships to cabin top with mounted life-saving appliances, permanent navigation lighting and foldable mast) – 3.83 meters.
- 4.1.6 Hull form– The hull is to be a modified planning hull with a deep V bow design, reverse angle side chines. The deadrise at transom must be 18 degrees. Hull bottom to incorporate minimum two (2) lift strakes per side, which run out to the stem.
- 4.1.7 The hull is divided into four (4) water tight compartments:
  - 4.1.7.1 Forepeak, (watertight to main deck);
  - 4.1.7.2 Wheel house (watertight up to floor level);
  - 4.1.7.3 Storage void area (watertight to main deck); and
  - 4.1.7.4 Engine space (watertight to aft deck).
- 4.1.8 Hull and side plate – minimum 5/16” thick bottom plate and ¼” thick side plate.
- 4.1.9 The hull and decks are to be transversely framed and longitudinally stringered.
- 4.1.10 The hull shape must not impede water flow to the propulsion units and must direct spray and waves away from onboard personnel.
- 4.1.11 A full width swim grid is required; its minimum length to cover the jet outdrives and incorporate jet drive unit protection. A removable re-boarding ladder must be provided for the swim platform with a permanent storage location close to the aft end of the vessel.
- 4.1.12 The vessel must have a removable fold down or split hinged tail gate to allow access aft for trawling and scientific deployments via the ‘A’ frame.
- 4.1.13 The vessel must have bulwark access doors both port and stbd, located midships. Both doors must have a method of positive retention in the open and closed position.
- 4.1.14 Vessel cabin style – Walk around with 360 degree access from aft deck to foredeck.
- 4.1.15 Propulsion – Twin Volvo D6 435 WJ Diesels (tier 3 compliant) with Hamilton 322 jets outdrives or equal and bowthruuster, contractor supplied and installed.
- 4.1.16 Fuel capacity = Fuel capacity not less than 909 litres, but need not exceed 1100 litres.
- 4.1.17 Normal load condition:
  - 4.1.17.1 Crew of three (3) = 500kg;
  - 4.1.17.2 Fuel = Minimum 909 liters in one (1) or two (2) tanks (830kg);
  - 4.1.17.3 Equipment & supplies & 2 passengers = 800kg.

## **5.0 VESSEL CONFIGURATION**

Aluminum hull/cabin workboat with primary working deck aft, cabin to be centered amidships with a cuddy cabin below the fore deck.

### **5.1 GENERAL DECK ARRANGEMENT**

- 5.1.1 Open aft deck, minimum area of thirteen (13) square meters, self-bailing deck with “non-return” auto scuppers.
- 5.1.2 The cabin must be located forward of amidships with access from the aft deck and be forward raked. The cabin must include a forward cuddy maximised under the fore deck with a Bomar watertight escape hatch or equal on the

fore deck, the hatch must be sized to meet TC requirements for egress.

5.1.3 Below the aft deck there must be an aft engine room space for the twin inboard diesels with associated equipment. The engine room space must meet TP 11469, Class A-60 insulated and lined and in addition soundproofing insulation must be installed such that when the vessel is operational with engines and generator engaged the maximum decibel (dB) reading on the aft deck with all hatches closed must not exceed 90dB. Access to the engine room space must be provided using the following two (2) methods:

5.1.3.1 Two (2) flush watertight and dogged engine hatches, each hatch must be sized such that the installed and outfitted engine can be removed through it's own separate hatch opening for complete engine replacement, when required. The dog leavers for the hatches must be flush with the deck so as not to cause a tripping hazard.

5.1.3.2 One (1) Bomar watertight access hatch or equal on the aft deck on the forward end of the engine room, complete with a ladder for easy access. The hatch must be sized to meet TC requirements for egress.

5.1.4 The top of bulwarks around the perimeter of the vessel must be flat across their whole width.

## **5.2 CABIN – GENERAL**

5.2.1 The cabin interior length must be a minimum of 2.50m.

5.2.2 The cabin Interior must be insulated with a lining.

5.2.3 The cabin must have 198 centimetres of headroom internal clearance (6' 6") on centreline with walkthrough access to the cuddy cabin.

5.2.4 The cuddy cabin must have two (2) storage racks for scientific sampling gear, a light, and an access door from the main cabin. The cuddy must be insulated with an exterior lining.

5.2.5 There must be one (1) sliding weather tight access door on the aft end of the cabin and a bomar access hatch in the fore peak cuddy. The door must have a vertical sliding/locking aluminium framed window. The door and the bomar hatch must have positive retention in the open position with locksets. All locks and hardware must be of stainless steel construction. Aft door to slide to port and forward bomar hatch must be hinged on the forward side.

5.2.6 The cabin must be fitted with proven manufacturers' aluminum framed windows (with screens for sliders), ISO Category B certified and sized to maximize visibility, as follows:

5.2.6.1 Three (3) heated forward fixed windows;

5.2.6.2 Two (2) side sliding windows, one (1) in way of the operator position and a second mirrored to the port side;

5.2.6.3 Two (2) fixed side window assemblies, one (1) stbd and one (1) port maximised for operator and crew viewing; and

5.2.6.4 Two (2) fixed windows, aft bulkhead on either side of the sliding door.

## **5.3 CABIN – OUTFIT**

5.3.1 This vessel must be equipped with three (3) marine seats in the cabin. One (1) for the operator on the stbd side and two (2) crew located on the port side. As a minimum these seats must meet the requirements of a Grammer MSG85/722 seat with arm rests, head rest, rotation and slide functions.

- 5.3.2 There must be two (2) knockdown seats with cushions for two (2) passengers.
- 5.3.3 On the stbd side behind the operator's seat there must be a working table maximised for the area from behind the operator's seat to the aft bulkhead with sliding drawer cabinets underneath and a sink installed on top.
- 5.3.4 On the port side there must be a working table maximised for the area from behind the crew seats to the aft bulkhead, underneath there must be an electronics rack and sliding drawer cabinets.
- 5.3.5 Deck head structure must provide for mounting two 19" flat screen monitors to the roof of the cabin over both workstations.
- 5.3.6 There must be two (2) cableway glands from inside the cabin to the aft deck allowing the passage of sensor cables and connectors. Cableways must be at least 4" diameter, weather tight when not in use and to be fitted with an exterior closure hood a minimum 24" above aft deck level.
- 5.3.7 All cushions, bunks and back rests must be either ballistic nylon or other durable upholstery.
- 5.3.8 Opposite the helm station on the port side, a crew console must be installed on the port side and will be utilized in the forward facing position, the console must include a workstation for a computer monitor, keyboard and mouse.
- 5.3.9 The operator's console must have a forward face access hatch for the console dash in the cuddy cabin for electrical equipment and console electronics access.
- 5.3.10 An overhead console must be fitted at the operator's position with a lockable stowage compartment. The console must provide for the installation of radios, breakers and controls for lights/camera and instrument displays. The console must not protrude into the headroom of the operator.
- 5.3.11 There must be a lockable storage compartment along the port side near to the two forward seats and large enough for full size navigation charts.
- 5.3.12 A water closet must be fitted in the cuddy cabin, Jabsco electric flush toilet system or equivalent with a 30 gallon black water tank. It is required that we be able to quickly determine the current level of the tank via an easily accessible gauge. Cuddy door must be used for privacy. Sewage system and capacity must meet Transport Canada Vessel Pollution and Dangerous Chemicals Regulation section 90 (1).
- 5.3.13 Three (3) coat hooks must be installed in the cabin.
- 5.3.14 One (1) electronics rack with shock mounts must be supplied and located on the port side, under the working table, Schroff brand, Part number 15230-021A will meet this requirement. An accessible conduit for cabling must be provided on the outboard side.
- 5.3.15 This vessel must be equipped with a heating/air conditioning unit suitable to maintain the temperature at a manageable level, mounted to the top of the cabin. The unit must also be capable of producing heat and have a condensation collection pan for discharge overboard.
- 5.3.16 Grab Handles interior - There must be grab handles positioned as follows:
  - 5.3.16.1 Two (2) in way of the helm and crew consoles in the cabin;
  - 5.3.16.2 Two (2) overhead in way of the seats in the cabin. Located over foot space ahead of seats; and

- 5.3.16.3 Two (2) at the aft door exterior one (1) vertical on port side of door opening and one (1) at the door opening under the cabin top.
- 5.3.17 Grab handles are required around the exterior perimeter of the cabin top.
- 5.3.18 Flooring: All interior floor covering must be non-slip approx 3/8" shock and sound absorbing rubber with embossed tread pattern.
- 5.3.19 Interior Finish: The interior of the vessel must be in a speckled grey colour, Zolotone "Granite" or equal. All rough edges and sharp angled corners must be rounded and ergonomically adapted. The space between screwed on interior lining plates, and exterior plate, must be insulated between frames with thermal insulation. Frame faces must have thermal barrier strip isolating interior panels.
- 5.3.20 Foot rests - There must be two (2) footrests, one (1) for the operator and the second for the crew console, foldable footrests.
- 5.3.21 An exterior ladder must be supplied and installed for access to the cabin top from the aft deck.
- 5.3.22 Helm Station: The helm station must have a method of being isolated from within the cabin. This must be accomplished by installing a blackout curtain on an overhead curtain track that surrounds the helm station and operators seat. The curtain will be used in night operations and must be easily withdrawn, stowed or removed when required.
  - 5.3.22.1 The helm station will be on the stbd side of the console, with controls on stbd;
  - 5.3.22.2 The helm will incorporate a steering system, capable of handling the horsepower of the vessel, with manufacturers' engine controls designed for the power unit;
  - 5.3.22.3 There will be provision for an array of control gauges and electronic equipment at the helm position, see section 7.15;
  - 5.3.22.4 In addition, if not included with above gauge package, jetdrive trim gauge, and fuel level gauge(s) will be installed;
  - 5.3.22.5 There will be a console mounted magnetic compass, see 7.15.11;
  - 5.3.22.6 All lights switches and breakers must be within easy reach of the operator; and
  - 5.3.22.7 Trim tab controls must be provided.

#### **5.4 UTILITY LIGHTING & POWER**

##### **ALL LIGHTING IS TO BE LED POWER MANAGEMENT IS CRITICAL DUE TO VOLUME OF ELECTRONICS**

- 5.4.1 Lighting interior - All lights must have individual switches.
- 5.4.2 The interior cabin must be equipped with two (2) rows of three (3) overhead LED red/white lights, on port and stbd sides.
- 5.4.3 Two (2) LED red/white lights over each work station.
- 5.4.4 Two (2) chart lamps on flexible goosenecks, one (1) for the working surface on top of the electronics rack and one (1) for the crew console position on port side.
- 5.4.5 Exterior lighting; there must be two (2) flood lights fitted on the cabin top, facing the stern, Hella model 1GB-998-541-001 or equal. In addition one (1) remote control spotlight to be mounted on cabin top facing the bow, Guest

Model SPL 12W or equal. Vessel lighting that will project light from above eye level must not interfere with navigation lighting, such as the yellow tow light. There must be a wireless remote control ACR RCL-75 searchlight or equal on the forward cabin top, the control must have a cradle for the operator near the helm.

- 5.4.6 Three (3) 12 VDC power points required, one at the console for the operator and two (2) for the work stations.
- 5.4.7 An isolation transformer and galvanic isolators must be integrated into the vessel's electrical system.
- 5.4.8 There must be five (5) 110 VAC power receptacles in the main cabin in way of the work stations and two (2) in the cuddy cabin.
- 5.4.9 There must be two (2) weather resistant 110 VAC power receptacles located on the aft exterior bulkhead.
- 5.4.10 There must be two (2) shore power 110v receptacles, 30-amp connections, on aft exterior bulkhead of cabin. One (1) will service the block heaters and battery charger and the second will service the survey gear and cabin.
- 5.4.11 Ducts from the AC/Heater must be located in the cabin, at the operator and work station positions near the deck, and the window supply plenum(s) port and starboard.
- 5.4.12 A front windshield defroster(s) must have a variable three-speed fan and be ducted to multiple outlets to be capable of clearing the entire front windshield area of the vessel.
- 5.4.13 The front windshield defroster must be capable of blowing both cold and heated air.
- 5.4.14 The cabin must have at least two (2) variable speed fans capable of circulating the air in the cabin. A positive pressure intake fan with 'dorade' type intake protection must supply air to the cabin.
- 5.4.15 Two (2) wipers with pantograph arms must be installed on the port and starboard forward windows. A variable speed switch located on the operator's console must activate wipers individually.
- 5.4.16 Two (2) recessed bow lights that are spot /flood combination made by Rigid or equivalent, to be place on either side of the bow. Lights must not protrude from the hull and be weatherproof.

## **6.0 OUTFIT GENERAL**

### **6.1 HINGED MAST**

- 6.1.1 Vessel must be outfitted with a foldable, hinged mast for the appropriate navigation lighting, radar equipment and antennas. Vessel mast must be able to accommodate the display of day and night signals such as vessel towing/pushing, trawling, vessel with limited manoeuvrability and vessel conducting underwater operations. The Contractor must design the mast based on the requirements identified for Great Lakes lighting requirements

found in Canada shipping Act, Collision Regulations, Annex 1. The mast when folded down must not exceed the maximum trailer height (3.83m) as identified in section 4.1.5.

- 6.1.2 The mast must have a positive engagement lock system when in the operational position (upright) and when in the trailering position (folded). The Contractor must ensure that the mast will not be damaged in either position with effective use of shock mitigation.

## 6.2 WORKBOAT TASKS

For information and Contractor design purposes, the tasks to be conducted by this vessel include:

- 6.2.1 Towing a Sea Sciences Acrobat (<http://www.seasciences.com/acro.htm>)

6.2.1.1 Unit is 85 lbs in air.

6.2.1.2 Cable tension at surface-100lbs.

6.2.1.3 Cable tension at lower depth limit -50-60m depth-1000lbs at 25 degree angle down towing at 6 knots with 200m of cable.

6.2.1.4 Towed with a removable deck mounted winch AGO environmental-CSW-6. Winch weight is 250lbs with cable, requiring 1500 watts of 120VAC on start up.

(<http://www.agoenvironmental.com/Leadframe.htm>)

- 6.2.2 Lower trophic level sampling requiring the deployment of zooplankton nets, Van dorn samplers, and benthic samplers. Sampling devices need to be deployed to a depth of 250m from the science davit via a winch with the capability to measure both length of cable deployed (m) and the speed of retrieval (0.3-1 m/s ideal).

- 6.2.3 Bottom, mid-water, and surface trawling; Net specifications range between 6 to 12 m opening with 13 to 28 kg doors with 38-76 mm mesh and net lengths between 9 and 23 m. Max winch pull on the current vessel is 1000 lbs with 500m of cable.

- 6.2.4 Launching and retrieve gill nets aft or through bulwark doors;

- 6.2.5 Multibeam Hydro-Acoustic surveys with side mounted or towed arrays;

- 6.2.6 Small spar buoy deployments of less than 500 lbs using an powered A-Frame.

- 6.2.7 Power requirements for science equipment to be installed post manufacture:  
Max Watts: 2550; running Watts: 1300 at 120VAC. This includes an AGO winch, multiple computers with monitors, and multiple instrument controllers.

## 6.3 HULL OUTFIT

- 6.3.1 Bow Eye: A recessed system is to be designed and incorporated into the construction of the stem that allows for the bowline and or trailering hook to be attached to the bow. Port and starboard stainless steel trailering tie down points to be incorporated in transom.

- 6.3.2 Deck space aft of the cabin to be fitted with a removable tow post to be installed into the center of the aft deck athwartships. The tow post must be a cruciform style and extend 32" above the top of the deck. The bottom retaining socket must be integrated into the vessels bottom structure. The post and base are to be rated for the maximum pull of the vessel with a minimum rating of 4000 lb (1814 kg) Safe Working Load (SWL) and be permanently stamped into the tow post, clearly visible to the operator. When

the tow post is removed from the aft deck, the contractor must supply a tow post storage location under the bulwark of the aft deck to positively retain the tow post during transport and normal operations. There must be a watertight cover plate that can be easily removed or installed when the tow post is removed from the deck for storage.

- 6.3.3 A freshwater holding tank must be installed, minimum 30 gallon (115L) cold only freshwater system. Holding tank must have a method of determining current level via an easily accessible gauge with easy access to fill and empty.
- 6.3.4 The vessel must be equipped with spring-line cleats, three (3) on the port side and three (3) on the stbd side.
- 6.3.5 Forward of the cabin, the vessel must be equipped with removable aluminium or stainless steel side grab rails, split bow rail providing a minimum of 36" height from top of the foc'sle deck, both port and starboard sides.
- 6.3.6 Low profile pipe railing to be installed from the side bulwark door aft to the transom. Railings must be socket style removable and flush with top of bulwark when removed.
- 6.3.7 Pipe railings to be installed from the forward side bulwark door forward to break at bow.
- 6.3.8 Aft of the cabin, the vessel must be equipped with removable aluminium or stainless steel grab rails providing a minimum of 36" height from the inner deck to the top of the rail and that extend around the perimeter of the transom, continuing along the side of the vessel and allowing for a 610mm gap with no rail just aft of the cabin both port and stbd sides.
- 6.3.9 The vessel must be fitted with aluminium protective pipe bracket guard for the jets integrated with a swim platform across the full breadth of the transom. This assembly must be easily removed for ease of maintenance.
- 6.3.10 The vessel must be fitted with two (2) electro/hydraulic trim tabs with associated equipment. There must be two (2) rocker switches on the helm station for separate operation of these trim tabs with a synchro switch.

#### **6.4 DECK OUTFIT**

- 6.4.1 A 12V Anchor windlass with remote at helm; bow roller, chain rode only with CQR or Plough-style anchor appropriate to vessel size.
- 6.4.2 There must be a minimum of four (4) recessed deck tie downs on the aft deck and a minimum of four (4) recessed deck tie downs on the fore deck.
- 6.4.3 The Contractor will construct and install one (1) stowage locker on the aft deck, STBD side. The minimum size of the locker must be 0.9m L x 0.40m D x 0.45m h.
- 6.4.4 The Contractor must provide a deck doubler plate with support structure below installed on the aft deck, forward of the engine hatches to accommodate installation and mounting of the AGO environmental-CSW-6 winch (GSM).
- 6.4.5 The Contractor must install an inboard aft deck wash down system, Jabsco ultra max water pressure system or equal, complete with wash down hose and all accessories. The Contractor must provide a suitable storage location for the hose.

- 6.4.6 Davit - The vessel must have an electro/hydraulic and metered science davit winch combination. Metered variable speed winch is to have 300m of min 1/8" galvanized aircraft cable, with a bare drum speed of 1 m/s, line pull of 450lbs. The davit is to be located as close to mid-ship or mid aft deck as possible, when the arm of the davit is facing forward with items on load they must be able to be loaded through the bulwark door. The davit should rotate under load and is to be rated for 450 lb (205 kg) Safe Working Load (SWL) and be permanently stamped into the davit and be clearly visible to the operator. The davit must be capable of 360 degree rotation by hand with at least 8 lock positions. Davit must be removable and there must be receivers with power or hydraulic quick connections provided on both sides of the vessel.
- 6.4.7 "A" Frame – The vessel must be equipped with a hydraulically or electrically powered frame, capable of extending and retracting the frame fore and aft. Frame to have multiple eyes to attach blocks along the length of its vertical beam. The "A" Frame is to be rated for 2000 lb (905 kg) Safe Working Load (SWL) and be permanently stamped into the "A" Frame and be clearly visible to the operator. Hauler winches for mid-water or bottom trawl retrieval, used in conjunction with "A" frame must be provided. Winch(s) must provide a minimum of 1000lbs of pull and must have a minimum of 500m of galvanised aircraft cable (7x19).
- 6.4.8 Crane - The vessel must be equipped with a Small Knuckle boom articulating crane located on the starboard side forward of the science davit socket location. The crane is to be rated for a maximum 1000 lbs (+/- 10lbs) (450 kg) Safe Working Load (SWL) and be permanently stamped into the crane and be clearly visible to the operator. The crane must include a winch system with 20 m of cable. The crane should be located so that it does not interfere with aft deck operations. The crane will be used for loading supplies from dock to aft deck, transferring science davit from port to starboard, and assisting with trawl retrieval over the transom when necessary. The crane is not to be used over the side while at sea.
- 6.4.9 A Stainless steel, removable and storable table must be provided and be able to mount on the aft deck, attached to the rear wall of the cabin. The table must be capable of being mounted on the exterior cabin bulkhead with hook brackets at three (3) separate heights, 34", 36", 38", with adjustable front legs. Depth must be a minimum of 20 inches.
- 6.4.10 A generator must be installed below the aft deck, in the engine room to contain and operate a 15 kw, 120vac generator installed and operated in accordance with the engine manufacturer's recommendations on a shock mitigated foundation. The generator power system must be distributing 120vac pure sine wave (non-modified) to all duplex receptacles located within the cabin, but the requirement does not need to be met in other areas of the vessel. The generator must have the following Accessories/options:
- 6.4.10.1 Advanced digital control;
  - 6.4.10.2 Siphon break;
  - 6.4.10.3 Ship-to-shore power switch;

- 6.4.10.4 Remote digital gauge;
- 6.4.10.5 Oil pressure and water temperature sender;
- 6.4.10.6 Remote start panel;
- 6.4.10.7 Remote connection/extension harness;
- 6.4.10.8 12-Inch remote wiring harness;
- 6.4.10.9 Line circuit breakers;
- 6.4.10.10 Wet exhaust; and
- 6.4.10.11 Maintenance kit.

The compartment design must allow for full operation of the generator when the access lid is closed and must be suitable for all weather conditions; therefore a blower and air supply are required. The blower must have a dual switch to engage at the generator compartment or at the operator's console. When the generator is running the blower must be on continuously, locking out the switches. A remote digital gauge and ship / shore transfer switch must be provided. The compartment must be designed for quick access for full removal of the generator. To meet compliance with SVCP, the compartment must have a heat detector and a warning light must be installed at the operator's console.

## **6.5 LIFESAIVING & EMERGENCY EQUIPMENT**

The following items must be supplied and provided with stowage / securing arrangements (as appropriate for each item). All fittings, Contractor supplied, must be heavy duty, corrosion resistant stainless steel fittings. All items must be readily accessible:

- 6.5.1 Minimum of two (2) Fire extinguishers (Class B1, marine type);
- 6.5.2 Two (2) paddles;
- 6.5.3 One (1) manual bilge pump (built in), Whale Gusher type;
- 6.5.4 One (1) life buoy with heaving line not less than 15 meters;
- 6.5.5 One (1) watertight flashlight;
- 6.5.6 Six (6) pyrotechnics, three (3) Type A and three (3) Type B or C;
- 6.5.7 One (1) first aid kit;
- 6.5.8 One (1) boat hook, 8 feet long (retractable);
- 6.5.9 One (1) CQR plow anchor with chain/rope locker (or equal) suitable for this vessel with 6' chain and 100 ft. nylon rope;
- 6.5.10 One (1) drogue sea anchor and 100 feet of 1/2 " braided nylon line; and
- 6.5.11 Four (4) mooring lines of 30' X 5/8" braided nylon line with eye spliced into one end.
- 6.5.12 One (1), six (6) person life-raft (US Coast Gard approved) with hydrostatic release mounted on the cabin top by the Contractor.

## **7.0 SYSTEMS GENERAL**

### **7.1 PROPULSION**

The vessel must be fitted with a propulsion system consisting of two (2) diesel engines, transmissions with water jet propulsion & controls. The propulsion system must be installed under the aft working deck in accordance with the manufacturer's recommendations. The engine compartment must be fitted with a ventilation system that provides sufficient air for engine combustion and cooling. The arrangement and capacity must be in accordance with

the engine manufacturer's instructions. Calculations used to determine the ventilation system requirements for the engine space must be provided in the manuals. Clearance and access to machinery and equipment must be incorporated in the vessel design to allow unobstructed access to conduct routine inspections and service of the machinery and equipment.

- 7.1.1 DIESEL ENGINE REQUIREMENTS: Twin Marine Diesel Engines, with after coolers, and block heaters having a horsepower able to sustain cruising speed at 80% power. Twin Volvo Penta D6-435s WJ with HJ322 Jets, meets this requirement or equivalent model (to meet the operational requirements) with access to locally available parts and service for the area of operation within a 48 hr period. All shift actuator controls must be mechanical, electronic will not be acceptable.
- 7.1.2 The vessel must be fitted with twin marine grade engines designed to meet the performance requirements of this vessel. The engines must be a direct injected, turbocharged marine diesel engines, fitted with after-cooler, and a water cooled exhaust as recommended by the engine manufacturer.
- 7.1.3 Inboard engines must have a "Hot Start" plug in for winter starting.
- 7.1.4 Inboard engines must have a wet exhaust.
- 7.1.5 The engine room must have a FM200 fire suppression system installed, meeting the requirements of TP1332.
- 7.1.6 Inboard engines mounting must have an elastic suspension consisting of anti-vibration pads for dampening of sound and vibration.
- 7.1.7 Inboard engines must have an oil cooler.
- 7.1.8 The vessel must be fitted with a bow thruster, Imtra SE100 or equivalent, with integrated controls at the helm station.
- 7.1.9 The electrical system for the engine mounted electrical accessories must be ungrounded two (2) wire-insulated feed and return.
- 7.1.10 RUN-IN OPERATION - The new engines must be installed and operated in accordance with the engine manufacturer's recommendations. The use of engine manufacturer's approved accessories and equipment is required. The Contractor must not use equipment and components and or operate the engine in a way that would void the engine manufacturer's warranties.
- 7.1.11 ENGINE COOLING SYSTEM - The engines must be fresh water cooled via a closed loop system through a marine heat exchanger. Given the draft and operational conditions, the option of keel cooling would be acceptable for main engines and generator.
- 7.1.12 MARINE TRANSMISSIONS - Vessel must be fitted with two (2) marine grade transmissions, cooled by direct freshwater through a marine heat exchanger and temperature sending units fitted with remote readouts on the console. Marine gears must be fitted with neutral and reverse gears. The marine transmission models must be fully compatible with selected jet drive and engine.
- 7.1.13 WATER JETS - The water jet propulsion systems must be high thrust for towing operations. The water jet must be fully compatible with the selected marine transmissions and engines. Hamilton HJ322's are suitable or equivalent or as recommended by the waterjet manufactures to meet vessel

speed, performance criteria. The water jets must operate by a joystick control, Blue arrow by Hamilton Jet meets this requirement and provides easy maneuvering capability in all directions including sideways movement for docking. Controls must be located at the operator's helm seat. The controls must provide simple features that allow the new operator the ability to move the vessel in the desired direction by moving the stick in the same direction. The preferred method of clearing a fouled water jet must be by reversing the water jet drive through the marine transmission and for excessive fouling, a clean-out port must be provided. The marine cleanout must be accessible and capable of being opened under all conditions when the vessel is in the water with no water entering the vessel. Protective guards must be fitted over all exposed rotating components.

- 7.1.14 PROPULSION JET GUARDS – The vessel must be fitted with a welded 5 cm schedule 40, 6063 alloy aluminum pipe that extends out and around the jet drives to protect the units from impact. This guard must be fabricated to be easily removable to facilitate the removal of the jet drive units.
- 7.1.15 The propulsion control system installation must include a dual binnacle Engine controls located on the starboard side of the helm console. The controls must conform to engine manufacturer's recommendations and must not interfere with any of the other controls.
- 7.1.16 The engine package must incorporate a lanyard style automatic shutdown feature (kill switch) for the engines, to be mounted near the ignition switch.

## **7.2 ENGINES MONITORING AND ALARM SYSTEM**

7.2.1 The vessel must be fitted with an engine monitoring system that provides operating parameters via a numerical analogue gauge package installed at the helm position. The gauge panel must provide indications for the engine, as follows:

- 7.2.1.1 Engines RPM;
- 7.2.1.2 Jacket water temperature;
- 7.2.1.3 Lube oil pressure;
- 7.2.1.4 Lube oil temperature;
- 7.2.1.5 Exhaust water flow indicator; and
- 7.2.1.6 Engine hours

7.2.2 Each engine must be fitted with an audible and visual alarm for jacket water high temperature and low lube oil pressure. The alarms must be fitted to the operator console. Gauges must be backlit for night operation with an adjustable dimmer control located at the gauge panel.

7.2.3 All engine monitoring, alarm and electrical cabling must be shielded.

7.2.4 In addition to the analog gauges, the vessel's Navionics system must be connected to the engine monitoring system.

## **7.3 TRANSMISSION MONITORING AND ALARM SYSTEM**

The marine transmission must be fitted with sensors connected to an audible and visual alarm monitoring system, indicating low lube oil pressure and high temperature. The system must be connected to numerical analogue gauges at the wheelhouse console helm position for monitoring. All transmission monitoring, alarm and electrical cabling must be shielded.

#### **7.4 VERIFICATION OF INSTALLATION**

Installation of the propulsion, controls, lubrication and fuel systems, manometers, battery connections, are to be verified by an authorized technician. The engines are to be started by the authorized technician, who must provide a written report with a copy for the Technical Authority.

#### **7.5 PROPULSION BREAK-IN**

The Contractor is to respect the engine manufacturer's break-in procedures.

#### **7.6 PROTECTION OF CONTROLS**

All control cables, electrical wiring for the motor and the steering hydraulic hoses are to be installed in UV resistant plastic pipes (LOOM). These pipes are to be installed in such a manner as to ensure that no cable is immersed in water.

#### **7.7 STEERING**

Hydraulically operated water jet nozzles must provide the steering control.

Steering system must be remote hydraulic with self-contained oil reservoir, located in the helm pump and with replaceable seals on the rams. Hamilton jet Blue Arrow or equivalent control system is required. Hydraulic hoses must be of sufficient size and length to prevent pulsing. Hoses must be suitable for use in an exposed marine environment complete with stainless steel fittings.

7.7.1 All hydraulic steering hoses must be routed in such a manner that they are protected from physical damage and so that there is no pinch or chafing points on the hoses.

7.7.2 The hydraulic hoses must be of sufficient size and length to prevent pulsing. The hoses must be suitable for use in an exposed marine environment complete with stainless steel fittings.

7.7.3 The steering connection must be of robust construction, to eliminate fore and aft or lateral movement of fixture.

7.7.4 The steering system must be as recommended by the manufacture for this drive unit.

7.7.5 The steering wheel must be covered with an antishock material, with a removable stainless steel speed knob.

##### **7.7.6 TRIM TABS**

To control the trim of the workboat, hydraulically operated trim tabs of suitable size, based on vessel design, must be fitted at the transom. The power trim controls and position indicator must be located at the helm position. Trim tabs must be protected from the water jets when a full emergency stop is executed.

#### **7.8 ENGINE/JET BREAK IN**

The Contractor is to respect the engine/jet drive manufacturer's break-in procedures and must have the appropriate authorized technician present during the break in period.

#### **7.9 FUEL SYSTEMS**

ALL FUEL SYSTEM HOSES TO BE USCG A RATED.

7.9.1 The fuel system must meet with all requirements of TP 1332 "Construction Standards for Small Vessels", which reference the ABYC standards.

7.9.2 There must be inspection hatches (8") in the deck, to allow access to the fuel pick-ups, (with the required 'demand anti siphon' valve at the tank if flow

rates meet the manufacturer's requirement), vent, and fill connections, and tank level indicators.

- 7.9.3 Arrangements must be provided for the fuel tank(s) and associated lines, vents, fills, and on / off valves, to be fitted to the vessel.
- 7.9.4 Fuel lines from the required inboard shutoff valve or manifold to the engines to be protected against chafing and wear.
- 7.9.5 A fuel / water separator filter is to be mounted "in-line" to each engine with easy access to drain the sediment bowl.
- 7.9.6 Fuel shutoff maintenance valves are to be installed at filter/ manifold system and be easily accessible by vessel operators.
- 7.9.7 Fuel fills and vents to be located on the stbd side of the vessel, designed with a cofferdam so that fuel will not come on board during filling and must be properly labelled and lockable.
- 7.9.8 Valves and fittings used in the fuel system must be of non-corroding materials, and all fuel valves must be readily accessible and labelled.
- 7.9.9 Each fuel vent must be fitted with a ball check valve.

## **7.10 ELECTRICAL SYSTEM**

The electrical system design, component selection and installation must be in accordance with Canadian Standards Association C22.2 NO. 183.2-M1983 (R1999) "Standards for D.C. Electrical Installations on Boats", and TP1332 and/or ABYC 'E' as referenced by TP1332. All electrical equipment and hardware must be installed in accordance with the manufacturer's specifications

- 7.10.1 12V DC distribution system must be provided to power the engine starting and vessel service loads including:
  - 7.10.1.1 Navigation lights;
  - 7.10.1.2 Exterior lighting;
  - 7.10.1.3 Navigational equipment;
  - 7.10.1.4 Instrumentation;
  - 7.10.1.5 Bilge pumps;
  - 7.10.1.6 Electronics;
  - 7.10.1.7 Communications; and
  - 7.10.1.8 Ancillary Items.
- 7.10.2 All electrical equipment must be readily accessible for performing maintenance.
- 7.10.3 Four (4) marine quality 12V power outlets two (2) must be installed in the main cabin and two (2) in the cuddy. Also, there must be two (2) USB charging ports on the helm.

## **7.11 BATTERIES, CABLES AND CHARGING SYSTEMS**

- 7.11.1 Two (2) dedicated starting batteries for the engines. Dual-battery system with a minimum of 1100 cranking amps for each battery and dual-battery selector switch mounted in a recessed position that conforms to engine manufacturer's specifications.
- 7.11.2 One (1) battery, sized to meet the house load.
- 7.11.3 Batteries must be marine grade, 12 V, deep cycle maintenance free glass mat or gel type (no custom batteries), and with the ability to cross connect for inboard or outboard start-up of either engine from either battery where the

- system has a house battery in addition to the start batteries, the house battery must be able to be joined to the start batteries if necessary.
- 7.11.4 Battery switches must be Certification Agency, (CE, CSA, USCG, etc.) approved and must be mounted to prevent snagging or accidental switching.
  - 7.11.5 Battery compartment must be weather tight and fitted with a suitable means of gas venting including for 'sealed' batteries.
  - 7.11.6 Cables for all electrical distribution must be ample in size for the particular service, of marine grade tinned boat cable.
  - 7.11.7 The electrical system design, component selection and installation must be in accordance with TP1332 and/or ABYC 'E' as referenced by TP1332. All electrical equipment and hardware must be installed in accordance with the manufacturer's specifications.
  - 7.11.8 Breaker panels to be appropriately sized for the equipment detailed in this TSOR with a minimum of two (2) spares. All breakers must have toggle guards installed.
  - 7.11.9 One (1) remote 12V marine grade accessory plug must be supplied and installed near the operators.
  - 7.11.10 All fitted electrical equipment must be capable of operating simultaneously with any other fitted electronics equipment without causing interference to any electronic equipment or to the magnetic compass.
  - 7.11.11 All operation switches for equipment must be labelled.
  - 7.11.12 A battery charger is to be supplied and installed on the vessel. It must be used to charge both battery banks when the vessel is on shore power.
  - 7.11.13 A shore power connection must be fitted complete with a marine grade service rated 30-ft shore power cable, capable of supplying 120V AC, 30 ampere, single-phase service on the vessel.

## **7.12 CABLING INSTALLATION**

**PROTECTION OF CONTROLS** - All control cables, electrical wiring for the engines and the steering hydraulic hoses are to be installed in UV resistant plastic pipes (LOOM) or equal. These pipes are to be installed in such a manner as to ensure that no cable is immersed in water.

- 7.12.1 Cables must be grouped into wiring harnesses wherever possible. All wiring harnesses must be routed through protective conduit pipe. Where impractical cables and conductors must be supported with clamps or straps at least every 18 inches on horizontal runs and every 14 inches on vertical runs.
- 7.12.2 Cabling / conductors passing through watertight boundaries, decks, bulkheads or other exposed surfaces must be installed to maintain watertight integrity of the structure. Cable entry into watertight enclosures must be through watertight marine glands of suitable size.
- 7.12.3 Cabling / conductors passing through structures without watertight glands, must be protected against chafing by the use of abrasive resistant grommets.
- 7.12.4 Routing cables through foamed spaces must be avoided wherever possible. Cables that must be routed through foamed spaces must be run in PVC conduit pipe. The pipe must be arranged in a manner that prevents water from becoming entrapped in the pipe.

### **7.13 NAVIGATION LIGHTING & EQUIPMENT (COLREGS)**

[www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/010/csa014/csa14.html](http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/010/csa014/csa14.html)

- 7.13.1 Navigation lighting fixtures must be of such a design as to resist the effects of vibration and moisture and must be provided with adequate protection from damage.
- 7.13.2 Particular COLREGS rules to note (vessels under 12 M.); Rules 22, 23, and Annex 1, rules 2, 9, and 10. (NOTE: The lights must be installed parallel to the "Normal Load" waterline that often may not be parallel to the deck. Vessel will be primarily based on the Great Lakes and must meet specific great lakes vessel requirements such as having zero horizontal sector obscurement (Annex 1, 9 (c)).
- 7.13.3 The navigation lights must be mounted so as not to interfere with vision of the operator.
- 7.13.4 LED lighting must be used where available
- 7.13.5 Navigation lights must be permanently fitted to vessel with protected wiring and must be waterproof.
- 7.13.6 The fixtures must be of such a design as to resist the effects of vibration and must be provided with adequate protection from damage that may occur when lying alongside a vessel or a pier. (The Hella NaviLED Series of lights, including the NaviLED 360 all-round light , and NaviLED side lights meet this requirement.)
- 7.13.7 Non-white lighting must be wired together on a separate breaker of the 12 volt DC electrical system. All lighting must be clear above or not interfere with the radar scanner. One (1) three way rocker switch, labelled "NAV" which turns on all Nav lights. When switched to the "ANC" side, only the anchor light is on.

### **7.14 ELECTRONIC AND NAVIGATION EQUIPMENT**

The Contractor must supply and install the following electronics and integrate a NMEA2000 bus to interconnect the Simrad equipment. All antennas must be mounted on cabin top with fold down connections for road travel. All cable penetrations must pass through watertight glands:

- 7.14.1 Simrad NSE 12 MFD, c/w GPS, Sonar and radar capabilities. The system must be able to interface with Regulus II BSB charts;
- 7.14.2 4G Broadband Radar for Simrad NSE series includes Scanner, scanner cable 20m (66 ft), R110 interface box, Yellow Ethernet cable- 1.8m (6ft);
- 7.14.3 Simrad BSM-1 Sounder module with Airmar B164 Bronze tilted element Thru Hull 50/200Khz;
- 7.14.4 Simrad auto pilot system, AP70 thruster pack;
- 7.14.5 DST800 SimNet sensor with an IS20 wind vane connected to an IS20 combi analog instrument screen to be mounted on the helm console.
- 7.14.6 NAIS 400 AIS transmit/receive/ gamss 2 Antenna;
- 7.14.7 Navionics Gold 2XG Canada Charts;
- 7.14.8 GS-25 antenna/N2k Kit (for radar overlay);
- 7.14.9 Flir M625L, thermal imaging with joystick control unit to be supplied and installed with interface to the operator screens.

- 7.14.10 Two (2) Standard Horizon GX 5500S VHF with DSC capabilities radios. Complete with loud hailer/intercom function plumbed to Radio. VHF must be connected to GPS via NMEA to complete DSC capabilities;
- 7.14.11 Antenna, specification is Comrod AV60P-8 and Shakespeare 4187 -HD SS ratchet mount and 408 stand-off bracket;
- 7.14.12 Clarion 437 M309 CD AM/FM stereo with two (2) 6.5" waterproof speakers;
- 7.14.13 The Contractor must supply and install an electric horn that meets the requirements of the Canadian Standards Association (CSA) Collision Regulations. The horn must be operated by a spring-loaded switch located on the operator's console; and
- 7.14.14 The Contractor must provide and install a direct read compass with light on the vessel. The magnetic compass must be mounted on the centreline of the operator stations, in easy view of the operator when facing forward. Deviation card development is the Contractors responsibility. (The Ritchie Explorer meets this requirement.)
- 7.14.15 Externally Mounted EPIRB ACR RLB-35.
- 7.14.16 The Contractor must supply and install two Trimble Zephyr GPS antennas with mounts (retractable for transport) on the cabin top on the centreline space at 2m apart and at the same vertical height.

#### **7.15 DRAINAGE & BILGE SYSTEMS**

- 7.15.1 An electric bilge pump with 2000 gph capacity must be fitted in the main hull or largest watertight division as well as a fixed manual operated bilge pump of the diaphragm type. The bilge pump(s) must be located so that they take suction from the lowest point of the hull. Piping must be installed which will allow the bilge pump(s) to discharge directly overboard. Any additional watertight division of the hull will be serviced by a bilge pump of 1500 GPH capacity. The wire gauge for all bilge pumps must be a minimum of 10 gauge.
- 7.15.2 An automatic level sensor control must be fitted that turns on the electric bilge pump (Non-Pedal type) when water is present in the bilge. The electric bilge pump control switch must be located on the operator's console, with settings for 'momentary on', 'off', and 'automatic' operation. An indicator light must be provided at the control that lights when the bilge pump is operating.
- 7.15.3 High water alarm for the engine installation space and every other space serviced by a bilge pump.
- 7.15.4 Hull drainage - a brass or stainless steel threaded plug must be provided in the lowest point to drain the hull when out of the water.
- 7.15.5 Valves and handles must be made of non-corroding materials and must be located where they are readily accessible for operation, maintenance or removal.
- 7.15.6 GENERAL - Any forward water retaining compartment without pump must have a piped drain to the aft bilge with a stainless steel ball valve. The valve must be readily accessible for testing or draining the forward bilge to the aft pump.

#### **7.16 PAINTING AND CORROSION PROTECTION**

Aluminium components must have a clear coat painted finish on all specified exterior and interior surfaces, comprised of suitable etch, primers, and topcoat per the Vessel Particulars. Typical single coat paint systems can be applied in the 5 to 7-mil thickness range per coating set. Typical system components would be: a) etch-primer; b) two (2) coats of primer; and c) minimum two (2) topcoats.

7.16.1 The standard color of the console of the vessel must be international F000, Mist grey. All upholstery must be grey.

7.16.2 Hull above the water line: Sharkskin seal or equal.

7.16.3 Superstructure: Sharkskin seal or equal.

7.16.4 Exterior decks and top of bulwarks (around the perimeter of the vessel): Anti-slip, Sure-Foot grey.

7.16.5 Underwater hull antifouling for Aluminum Trilux II color: Black

7.16.6 Prior to delivery, the Contractor must ensure that all non-painted interior or exposed surfaces are free of cosmetic blemishes, including all construction marks, scratches, gouges and stains.

## **8.0 TESTS & TRIALS**

The Contractor must conduct their own inspections, tests and trials to verify successful completion of the Work in accordance with this TSOR and the proper operation of the vessel and all associated equipment. The requirements for inspections, tests and trials and associated deliverable documentation are defined in the Contract and Annexes to the Contract including any test, trials or sample reports attached thereto. All discrepancies identified through the inspection, test and trials processes must be corrected prior to delivery.

### **8.1 TESTS - GENERAL**

8.1.1 The Contractor must inspect and test the following items, as a minimum, for adherence to the contract requirements and proper operation (proper operation means that the equipment can be started, operated, connected together and demonstrated to function in a normal fashion, as applicable). All discrepancies must be corrected prior to delivery. The required inspections and tests are minimums and are not intended to supplant any controls, examinations, inspections or tests normally employed by the Contractor to assure the quality of the vessel:

8.1.1.1 Weight;

8.1.1.2 Construction quality;

8.1.1.3 Lifting gear;

8.1.1.4 Propulsion engines, including starting;

8.1.1.5 Steering system;

8.1.1.6 Fuel system;

8.1.1.7 Electrical system; and

8.1.1.8 Electronics.

### **8.2 SEA TRIALS - GENERAL**

8.2.1 Sea trials must be conducted by the Contractor to demonstrate the vessel and their equipment conform to the requirements as stated in the Contract. All expenses incident to the trials must be borne by the Contractor, including fuel unless otherwise specified. A crew provided by the Contractor must

- operate the vessel during sea trials. The minimum acceptable sea trial are identified in Appendix A.
- 8.2.2 All Sea Trial instrumentation and equipment must be furnished and operated by the Contractor. Trial instrumentation, where applicable, must not replace the vessel's instruments.
- 8.2.3 The Contractor must submit a Test & Trials Plan, including a description of all of the acceptance trials to be performed for the vessel. The vessel must operate in the Normal Loaded Condition. As a minimum, the following trials must be conducted for the vessel:
- 8.2.3.1 Speed Trials - The speed trials must be done over a course at least one (1) nautical mile in length. Two (2) runs must be made over the course, one (1) in each direction with the speeds for the two (2) runs averaged. The use of GPS data (averaged) is acceptable;
- 8.2.3.2 Endurance Trial -The vessel must operate in the Normal Loaded Condition, at maximum speed for no more than the maximum time allowed if it has not operated for the minimum break-in period (typically five (5) hours);
- 8.2.3.3 Astern Propulsion - The vessel must be operated and manoeuvred using astern propulsion to establish the astern performance. During the backing performance tests the throttles must be set to provide 1/3 of the rated engine horsepower; and
- 8.2.3.4 Steering Gear - Tests must be conducted on the steering gear to demonstrate the adequacy of the steering system under all operations. Manoeuvring tests must be performed to ensure that the vessel meets the stated requirements. Manoeuvring trials must be conducted in the Normal Load Condition and repeated in the Full Load Condition.
- 8.2.4 The Contractor must provide a Tests & Trials Sheet, (Appendix A) for the vessel and include this sheet in the technical publications (see section 9.4).
- 8.2.5 The Contractor must notify the Contracting Authority and the Technical Authority no less than two (2) weeks prior to sea trials. At a minimum, the Technical Authority will witness and attend the sea trials. Sea trial results must be forwarded to the Technical Authority prior to the delivery of the vessel.
- 8.2.6 At the conclusion of the sea trials, the vessel must be thoroughly cleaned and inspected. The engine cooling system must be flushed through with fresh water. The Contractor must repair any damage to the vessel or ancillary equipment resulting from sea trials to the satisfaction of Canada.
- 8.2.7 For the purpose of the trials, Normal Loaded Condition must be considered to be the basic vessel, fitted with all normal equipment, full fuel, with complement and loads per Vessel Particulars, section 4.1.
- 8.2.8 Final Inspection prior to delivery must not be performed until all tests have been satisfactorily completed with data available for review. The vessel must be ready for delivery in all respects, except for final preparation for shipment. The Contractor must provide personnel, as required, to resolve questions and to demonstrate equipment operation maintenance accessibility, removal and installation. The Contractor must document the

results of the inspection prior to the delivery and provide these results to the Technical Authority and the Contracting Authority. Where applicable, serial numbers and other identifying information must be recorded for the vessel, trailer and engines and supplied to the Contracting and Technical Authorities for Acceptance of the vessel.

8.2.9 Stability examination per TP1332 will require the Contractor to record all stability calculation and provide a copy for the vessel produced as per Section 9.4.1.

8.2.10 Final Inspection after delivery - Upon delivery, the Technical Authority, or a representative of the Technical Authority will conduct the final delivery inspection. The Contractor must document the results of the delivery and provide these results to the Technical Authority and the Contracting Authority for Acceptance as per the Contract. The Contractor must repair any damage to the vessel/equipment resulting from shipping to the satisfaction of Canada.

## **9.0 DOCUMENTATION**

### **9.1 GENERAL**

All documentation to be included in the Technical Publications must be provided in both official languages (French and English).

### **9.2 NATIONAL ASSET CODE**

9.2.1 The NAC for this vessel is **VZA94**. The Contractor must add this five (5) character code to the builder's plate of the vessel with the prefix "National Asset Code".

### **9.3 BUILDER'S PLATE**

9.3.1 A Builder's plate must be affixed to each asset in a readily visible location, e.g. for a vessel, in way of the operator position, for a trailer on the left side of the tongue.

9.3.2 The plate must be made of a weather resistant material compatible with that to which it is affixed.

9.3.3 The dimensions of the plate must be not less than 200mm x 125mm

9.3.4 The plate must contain the following information, permanently etched:

9.3.4.1 National Asset Code;

9.3.4.2 Builder;

9.3.4.3 Hull Number;

9.3.4.4 Year of Construction; and

9.3.4.5 Lightship Weight in kilograms.

### **9.4 TECHNICAL PUBLICATIONS**

The Contractor must provide, upon delivery of the vessel, complete sets of technical publications of a comprehensive owner/operator manual that provides a physical and functional description of the craft, it's machinery and equipment, as well as delivery testing and sea trial result documentation. The manual must include but not be limited to sections such as: General Information, Technical Information, and Spare Parts List.

9.4.1 The Contractor must provide copies of the technical publications as follows:

- 9.4.1.1 One (1) complete hard copy and one (1) complete USB stick electronic copy set of technical publications for the operator, to be delivered with the vessel.
- 9.4.1.2 One (1) complete hard copy and one (1) complete USB stick electronic copy set of technical publications to be delivered to the Technical Authority at the address identified in the Contract.
- 9.4.2 General Information Section: The General Information Section must include a description of the arrangement and function of all structures, systems, fittings and accessories that comprise the vessel, with illustrations as appropriate:
  - 9.4.2.1 Operating procedures;
  - 9.4.2.2 Basic operating characteristics (such as temperatures, pressures, flow rates);
  - 9.4.2.3 Installation criteria and drawings, assembly and disassembly instructions with comprehensive illustrations showing each step;
  - 9.4.2.4 Recommended planned maintenance; and
  - 9.4.2.5 Complete troubleshooting procedures.
- 9.4.3 Technical Information Section: The Technical Information Section must include a complete set of detailed owners/operators manuals, drawings, parts lists and supplemental data for all components of the vessel (whether acquired from external sources or custom-manufactured), including:
  - 9.4.3.1 Initial Spares Parts List; The list must include the name, part number and serial number if applicable of the parts, items or components and must indicate the supplier (name, address, phone number, email address) of this part, equipment or component and in which part of the specification the item appears.
  - 9.4.3.2 Hull; including hull data, serial or manufacturers' numbers, and equipment warranty cards.
  - 9.4.3.3 Pre-trial shop Testing Check Sheet.
  - 9.4.3.4 Engine(s) and equipment: including engine and propulsion serial numbers.
  - 9.4.3.5 Electronics, (if applicable): including model and serial numbers.
  - 9.4.3.6 Regulatory and Stability information: as required per TP 1332
  - 9.4.3.7 All components fitted to the vessel must have the Maintenance Data Sheet, completed before acceptance of the vessel from the Contractor. This information will be used to populate the data base for the maintenance of the vessel.
  - 9.4.3.8 Acceptance Certificates, and compliance sheets or certificates distributed with equipment i.e. life-saving appliances, lifting appliances, engine test reports, calibration certificates, Nav light certificates, Fire suppression material certificates, flotation foam rating sheets. The initial inspection of the vessel after delivery, by TCMS, will establish TP 1332 compliance.
  - 9.4.3.9 The Technical Publications must also include a list of recommended initial onboard spare parts to be stocked for the craft. At a minimum this list must include the following items (as applicable):
    - 9.4.3.9.1 Propulsion: Propellers, filters, water pump impeller, batteries, throttle and shift cables, special engine tools.
    - 9.4.3.9.2 Electrical: panel breakers, fuses, light bulbs;

9.4.3.9.3 Vessel Structures and Fittings: Miscellaneous commonly used fasteners.

## **9.5 ADDITIONAL DELIVERABLE DOCUMENTATION**

9.5.1 The following additional documentation must be supplied in the manuals delivered (defined in 9.4.2) for the vessel:

9.5.1.1 Tonnage Registration Certificate in accordance with TP 13430 - <http://www.tc.gc.ca/eng/marinesafety/svcp-gt-3948.htm> ;

9.5.1.2 Registration to the Small Boat Compliance Program SVCP Website: <http://www.tc.gc.ca/eng/marinesafety/svcp-menu-3633.htm> ;

9.5.1.3 Bill of Sale; and

9.5.1.4 A valid Motor Vehicle Registration Certificate for the relevant Province, for the trailers.

## **10.0 SHIPPING AND DELIVERY**

**10.1** Prior to shipping, the vessel must be secured on it's respective trailer, cleaned, preserved and covered in accordance with this section. All areas of the vessel are to be cleaned prior to covering for shipping. Bilges are to be dry and free of oil and debris and the fuel tanks must be full with fuel stabilizer added.

**10.2** The propulsion system must be preserved in accordance with the manufacturer's recommendations for storage of up to one (1) year in an environment that will be subjected to freezing temperatures.

**10.3** The batteries are to be disconnected. A warning plate is to be tied to the steering wheel with a wire indicating that the vessel has been protected for shipping and storage and must not be started until the propulsion machinery has been reactivated.

**10.4** All contact points with the vessel are to be padded. A shrink wrap cover is to be provided to protect the vessel during shipping and storage.

**10.5** Means of Delivery: The Contractor must deliver the vessel/trailer combination, the trailer supplied for the vessel must not be utilized as means of delivery.

## **11.0 SERVICE PROVISIONS**

### **11.1 COMPONENTS AND EQUIPMENT SUPPORT**

All components and all mechanical, auxiliary, electronic and electrical equipment installed on the vessel must be supportable by parts and service in Canada within 30 days.

# APPENDIX A

## SMALL BOAT / VESSEL TESTS & TRIALS SHEET

CONTRACT # F7047-150012

<b>Small Boat / Vessel Builder:</b>			
<b>Small Boat / Vessel Description:</b>			
<b>Hull Identification Number:</b>			
<b>National Asset Code:</b>			
<b>Date of Trials:</b>			
<b>Personnel in Attendance:</b>			
<b>Builder</b>			
<b>PWGSC</b>			
<b>DFO</b>			
<b>DFO</b>			
<b>Time: _____ hrs Departing from _____</b>			
<b>Small Boat / Vessel Weights:</b>	Dry Weight of Hull with cabin:	_____ lbs/ _____ kg	
	Furnishings & Fittings:	_____ lbs/ _____ kg	
	Engines & Equipment:	_____ lbs/ _____ kg	
	Fuel: _____ Imp gal	Fuel: _____ Litres	_____ lbs/ _____ kg
	<b>Total Weight of Small Boat/Vessel:</b>		_____ lbs/

		_____ kg
	Number of Crew _____ and operating equipment:	_____ lbs/ _____ kg
	<b>Test Total Laden Weight:</b>	_____ lbs/ _____ kg
	<b>Trailer weight:</b>	_____ lbs/ _____ kg
	<b>Boat &amp; Trailer weight:</b>	_____ lbs/ _____ kg
<b>Motors: Starting - Operation</b> "IDENTIFY INBOARD/OUTBOARDS"	<b>Port</b>	<input type="radio"/> Immediate, Yes / No
	<b>Starboard</b>	<input type="radio"/> Immediate, Yes / No
<b>Propellers/Impellers</b>	<b>Pitch</b>	_____
	<b>Diameter</b>	_____
	<b>No. of Blades</b>	_____
	<b>Stainless Steel or Aluminum</b>	<input type="radio"/> S/S ___ AL
<b>Static Attitude &amp; Trim:</b>		
<b>Weather Conditions: Refer to attached Beaufort Wind Scale. BWS No. _____</b>		
<b>Speed Trials</b>	<b>Speed Required _____ - _____ knots</b>	
	Cruising Speed: measured mile 1 way	_____ kts @ _____ rpm
	Cruising Speed: measured mile return	_____ kts @ _____ rpm
	<b>Averaged Cruising Speed:</b>	_____ kts @ _____ rpm

	Maximum Speed: measured mile 1 way	_____ kts @ _____ rpm
	Maximum Speed: measured mile return	_____ kts @ _____ rpm
	<b>Average Maximum Speed</b> _____ kts @ _____ rpm	
<b>Full Throttle</b>	From dead stop to plane	_____ seconds
	From dead stop to 30 knots	_____ seconds
<b>Astern Propulsion:</b>	Straight line to 2000 rpm	<input type="radio"/> Issues, Yes / No
	Hard a-port	<input type="radio"/> Issues, Yes / No
	Hard a-starboard	<input type="radio"/> Issues, Yes / No
	Emergency stop	_____ seconds
<b>Tubes (if applicable)</b>	No. of Chambers	_____
	Semi-auto fill system	<input type="radio"/> Yes / No
	Time to fill all chambers	_____ seconds
<b>Endurance Trials:</b> X = gallons or Litres	<b>Fuel consumption</b>	
	Port & Starboard Motor: at cruise:	_____ X/hr @ _____ rpm
	Port & Starboard Motor: at full throttle:	_____ X/hr @ _____ rpm
<b>Steering:</b> Acceptable Y / N	Straight line	<input type="radio"/> Yes / No
	Hard-Port radius of turn. Full Throttle	_____ feet
	Hard-Stbd radius of turn. Full Throttle	_____ feet
	Lock to lock = 35 degrees pt. & stbd	<input type="radio"/> Yes / No
	Effective steering 0-5 knots	<input type="radio"/> Yes / No

	5-10 knots	<input type="radio"/> Yes / No
	20-30 knots	<input type="radio"/> Yes / No
	Full speed	<input type="radio"/> Yes / No
<b>Outboard/Inboard Leg Trim Control:</b>	From fully raised to fully lowered.	<input type="radio"/> Acceptable Yes / No
<b>Trim Tab Operation:</b>	Fully raised, fully lowered.	<input type="radio"/> Acceptable Yes / No
<b>Engine Controls:</b>	Start	<input type="radio"/> Issues, Yes / No
	Shift	<input type="radio"/> Issues, Yes / No
	Throttle	<input type="radio"/> Acceptable Yes / No
<b>Engine Gauges:</b>	Tachometer	<input type="radio"/> Acceptable Yes / No
	Fuel gauges	<input type="radio"/> Acceptable Yes / No
	Trim gauges	<input type="radio"/> Acceptable Yes / No
<b>Engine Gauges:</b>	Oil pressure	<input type="radio"/> Acceptable Yes / No
	Voltmeter	_____ volts
<b>Cabin Sound Levels:</b>	Cruising speed- door & windows closed	_____ dbA @ _____ rpm
	Cruising speed- door & windows open	_____ dbA @ _____ rpm
	Full speed- door & windows closed	_____ dbA @ _____ rpm
	Full speed- door and windows open	_____ dbA @ _____ rpm
<b>Outboard/Inboard engine operation:</b>	Starting	<input type="radio"/> Acceptable Yes / No
	Shifting	<input type="radio"/> Acceptable Yes / No
	Throttle	<input type="radio"/> Acceptable Yes / No

	Raise	<input type="radio"/> Acceptable Yes / No
	Lower	<input type="radio"/> Acceptable Yes / No
<b>Loaded Vessel Drop Test:</b>	<b>If applicable</b>	<input type="radio"/> Acceptable Yes / No
<b>Lifting Bridle Certified:</b>	<b>If applicable</b>	<input type="radio"/> Acceptable Yes / No
<b>Rollover test</b>	<b>If applicable</b>	<input type="radio"/> Acceptable Yes / No

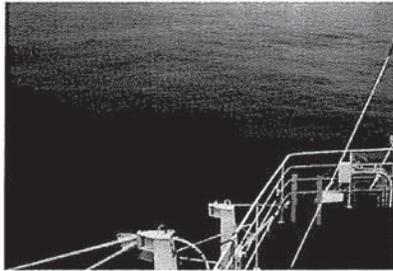
<b><u>NOTES</u></b>

## Beaufort Wind Scale Identifier

Force	Wind Speed		Descriptive Term	Effects Observed at Sea	Effects Observed on Land
	Km/h	Knots			
0	Less than 1	Less than 1	Calm	Sea surface like a mirror, but not necessarily flat.	Smoke rises vertically.
1	1 - 5	1 - 3	Light air	Ripples with the appearance of scales are formed, but without foam crests.	Direction of wind shown by smoke drift, but not wind vanes.
2	6 - 11	4 - 6	Light breeze	Small wavelets, still short but more pronounced. Crests do not break. When visibility good, horizon line always very clear.	Wind felt on face. Leaves rustle. Ordinary vane moved by wind.
3	12 - 19	7 - 10	Gentle breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered whitecaps.	Leaves and small twigs in constant motion. Wind extends light flag.
4	20 - 28	11 - 16	Moderate breeze	Small waves, becoming longer. Fairly frequent whitecaps.	Raises dust and loose paper. Small branches are moved.
5	29 - 38	17 - 21	Fresh breeze	Moderate waves, taking a more pronounced long form. Many whitecaps are formed. Chance of some spray.	Small trees with leaves begin to sway. Crested wavelets form on inland waters.
6	39 - 49	22 - 27	Strong breeze	Large waves begin to form. The white foam crests are more extensive everywhere. Probably some spray.	Large branches in motion. Whistling heard in telephone wires. Umbrellas used with difficulty.
7	50 - 61	28 - 33	Near gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.	Whole trees in motion. Inconvenience felt in walking against wind.
8	62 - 74	34 - 40	Gale	Moderately high waves of greater length. Edges of crests begin to break into the spindrift. The foam is blown in well-marked streaks along the direction of the wind.	Breaks twigs off trees. Generally impedes progress. Walking into wind almost impossible.
9	75 - 88	41 - 47	Strong gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility.	Slight structural damage occurs, e.g. roofing shingles may become loose or blow off.
10	89 - 102	48 - 55	Storm	Very high waves with long overhanging crests. Dense white streaks of foam. Surface of the sea takes a white appearance. The tumbling of the sea becomes heavy and shock-like. Visibility affected.	Trees uprooted. Considerable structural damage occurs.
11	103 - 117	56 - 63	Violent storm	Exceptionally high waves. Sea completely covered with long white patches of foam. Visibility affected.	Widespread damage.
12	118 - 133	64 - 71	Hurricane	Air filled with foam and spray. Sea entirely white with foam. Visibility seriously impaired.	Rare. Severe widespread damage to vegetation and significant structural damage possible.



**BEAUFORT FORCE 0**  
WIND SPEED: LESS THAN 1 KNOT  
SEA: SEA LIKE A MIRROR



**BEAUFORT FORCE 1**  
WIND SPEED: 1-3 KNOTS  
SEA: WAVE HEIGHT 1M (25FT), RIPPLES WITH THE APPEARANCE OF SCALES, BUT WITHOUT FOAM CRESTS



**BEAUFORT FORCE 2**  
WIND SPEED: 4-6 KNOTS  
SEA: WAVE HEIGHT 2-3M (5-10FT), SMALL WAVELETS, CRESTS HAVE A GLASSY APPEARANCE AND DO NOT BREAK



**BEAUFORT FORCE 4**  
WIND SPEED: 11-16 KNOTS  
SEA: WAVE HEIGHT 1-1.5M (3.5-5FT), SMALL WAVES BECOMING LONGER, FAIRLY FREQUENT WHITE HORSES



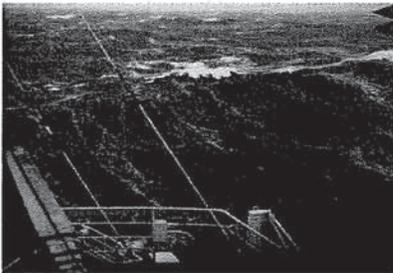
**BEAUFORT FORCE 5**  
WIND SPEED: 17-21 KNOTS  
SEA: WAVE HEIGHT 2-2.5M (6-8FT), MODERATE WAVES TAKING MORE PRONOUNCED LONG FORM, MANY WHITE HORSES, CHANCE OF SOME SPRAY



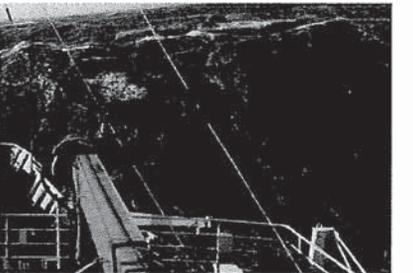
**BEAUFORT FORCE 6**  
WIND SPEED: 22-27 KNOTS  
SEA: WAVE HEIGHT 3-4M (9.5-13 FT), LARGER WAVES BEGIN TO FORM, SPRAY IS PRESENT, WHITE FOAM CRESTS ARE EVERYWHERE



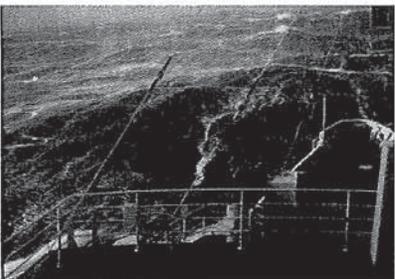
**BEAUFORT FORCE 7**  
WIND SPEED: 28-33 KNOTS  
SEA: WAVE HEIGHT 4-5.5M (13.5-19 FT), SEA HEAPS UP, WHITE FOAM FROM BREAKING WAVES BEGINS TO BE BLOWN IN STREAKS ALONG THE WIND DIRECTION



**BEAUFORT FORCE 8**  
WIND SPEED: 34-40 KNOTS  
SEA: WAVE HEIGHT 5.5-7.5M (18-25FT), MODERATELY HIGH WAVES OF GREATER LENGTH, EDGES OF CREST BEGIN TO BREAK INTO THE SPINDRIFT, FOAM BLOWN IN WELL MARKED STREAKS ALONG WIND DIRECTION.



**BEAUFORT FORCE 9**  
WIND SPEED: 41-47 KNOTS  
SEA: WAVE HEIGHT 7-10M (23-32FT), HIGH WAVES, DENSE STREAKS OF FOAM ALONG DIRECTION OF THE WIND, WAVE CRESTS BEGIN TO TOPPLE, TUMBLE, AND ROLL OVER, SPRAY MAY AFFECT VISIBILITY.



**BEAUFORT FORCE 10**  
WIND SPEED: 48-55 KNOTS  
SEA: WAVE HEIGHT 9-12.5M (29-41FT), VERY HIGH WAVES WITH LONG OVERHANGING CRESTS, THE RESULTING FOAM, IN GREAT PATCHES, IS BLOWN IN DENSE WHITE STREAKS ALONG WIND DIRECTION, ON THE WHOLE, SEA SURFACE TAKES A WHITE APPEARANCE, TUMBLING OF THE SEA IS HEAVY AND SHOCK-LIKE, VISIBILITY AFFECTED.



**BEAUFORT FORCE 11**  
WIND SPEED: 56-63 KNOTS  
SEA: WAVE HEIGHT 11.5-16M (37-52FT), EXCEPTIONALLY HIGH WAVES, SMALL-MEDIUM SIZED SHIPS MAY BE LOST TO VIEW BEHIND THE WAVES, SEA COMPLETELY COVERED WITH LONG WHITE PATCHES OF FOAM LYING ALONG WIND DIRECTION, EVERYWHERE, THE EDGES OF WAVE CRESTS ARE BLOWN INTO FROTH.



**BEAUFORT FORCE 12**  
WIND SPEED: 64 KNOTS  
SEA: SEA COMPLETELY WHITE WITH DRIVING SPRAY, VISIBILITY VERY SERIOUSLY AFFECTED, THE AIR IS FILLED WITH FOAM AND SPRAY