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Pêches et Océans Canada

Canadian Coast Guard
Garde côtière canadienne

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ANNEX "B"

Medium Plastic Coastal/Harbour Buoys

Canadian Coast Guard

Performance Specification

Canada

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Document Management

1. Authority

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i) be clear and concise; and

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Foreword

1. Scope

This specification states the requirements for the Canadian Coast Guard's '*Commercial- Off The Shelf*' (COTS) plastic replacement for its medium coastal / harbour steel buoys for marine navigational purposes.

The buoys shall be capable of displaying all existing standard Canadian Coast Guard (CCG) characteristics for marine aids-to-navigation as described in Table 1-5 reference [21].

In keeping with the CCG's concept of extending the service cycle for buoys, the goal for periodic service is a 5-year schedule.

Chapter 1 GENERAL

1.1 PRIORITY OF DOCUMENTS

In the event of any conflict in documents or drawings associated with ordering requirements, the following order of priorities shall prevail:

c) the contract;

d) the specification; and

e) the drawings.

In the event of any conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been made.

1.2 REFERENCE DOCUMENTS

Some of the documents listed in this section are to be referenced to Chapter 2 and Chapter 3 of this specification. This section does not include documents cited in other sections of this specification recommended for additional information or as examples. While every effort has been made to ensure completeness of the list, document users are cautioned that they must meet all specified requirements cited in Chapter 2 and Chapter 3 of this specification.

Table 1-1: Referenced Standards and Tests for Plastic

1.	ASTM D4020	Standard Specification for Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials ASTM http://www.astm.org
2.	MIL-P-21929C(1)	Plastic Material, Cellular Polyurethane, Foam in Place, Rigid Void Filler, Foam-in-place Large scale and installation of (10 Feb 1967) Military Standards Website; http://www.mil-standards.com/
3.	ASTM D3575-1993	Flexible Cellular Materials Made from Olefin Polymers (IONOMER) ASTM Website: http://www.astm.org
4.	ASTM D2341	Standard Specification for Rigid Urethane Foam ASTM Website: http://www.astm.org
5.	ASTM D4976-00b	Standard Specification for Polyethylene Plastics Moulding and Extrusion Materials ASTM Website: http://www.astm.org
6.	ASTM D3935-94	Standard Specification for Polycarbonate (PC) Unfilled and Reinforced Material

		ASTM Website: http://www.astm.org
7.	ISO 9532	Standard Specification for the Abrasion Properties of Rigid Plastics

Table 1-2: Referenced Standards for Metals

8.	ASTM A36	Standard Specification for Structural Steel. ASTM Website: http://www.astm.org
9.	ASTM A666	Annealed or Cold Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar. ASTM Website: http://www.astm.org
10.	ASTM A276	Standard Specification for Austenitic Stainless Sheet, Strip, Plate, and Flat Bar Pressure Vessels. ASTM Website: http://www.astm.org
11.	ASTM B209	Aluminium and Aluminium-Alloy Sheet and Plate ASTM Website: http://www.astm.org
12.	ASTM B221	Aluminium and Aluminium-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes ASTM Website: http://www.astm.org

Table 1-3: Referenced Standards for Concrete

13.	CAN/CSA –A23.1	Concrete Materials and Methods of Concrete Construction CSA Standards Website: http://www.csa.ca/
14.	ASTM C33	Standard Specification for Concrete Aggregates ASTM Website: http://www.astm.org
15.	ASTM C150	Standard Specification for Portland Cement ASTM Website: http://www.astm.org

Table 1-4: Referenced Standards for Colour

16.	IALA E-108	Recommendations for the surface colours used as visual signals on aids to navigation. IALA Website: http://site.ialathree.org/
17.	ASTM D2244	Calculation of Colour Differences ASTM Website: http://www.astm.org
18.	ASTM D2565	Standard Practice for Operating Xenon ARC-Type Light-Exposure with and without water for Exposure of Plastics ASTM Website: http://www.astm.org
19.	FED-STBD-595B	U.S. Federal Standard, Colours used in Government Procurement
20.	IALA V-128	Technical Performance Requirements for VTS Equipment IALA Website: http://site.ialathree.org/.

Table 1-5: Miscellaneous Departmental Publications

21.	TP-968 E/F	The Canadian Aids to Navigation System. (Revised 2011) http://www.ccg-gcc.gc.ca/folios/00020/docs/CanadianAidsNavigationSystem2011-eng.pdf

1.3 SOURCE OF DOCUMENTS

Documents may be obtained from the following sources:

1.3.1 Canadian Government Documents

TP 968 E/F	Aids to Navigation Program Canadian Coast Guard Fisheries and Oceans Canada Ottawa, ON. K1A 0E6 Cat. No. T31-29/2012E-PDF ISBN 978-1-100-15842-6 MPO/2012-1704
Canadian General Standards Board (CGSB)	CGSB Sales Centre Place du Portage III - 6B1, 11 Laurier Street, Hull, (Quebec) K1A 1G6

1.3.2 U.S. Government Documents

Standardization Documents Order Desk
Building 4, Section D
700 Robins Avenue
Philadelphia, PA 19111-5094

1.3.3 Industry Documents

Canadian Standards Association (CSA)
5060 Spectrum Way, Suite 100
Mississauga, Ontario L4W 5N6

International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA)
20 Rue Schnapper
78100 St Germain-en-Laye
France

American Society for Testing and Materials (ASTM)
1916 Race Street
Philadelphia, PA 19103-1187

Society of Automotive Engineers (SAE)
400 Commonwealth Dr.
Warendale, PA 15096

1.3.4 Definitions

Table 1-1: Definitions: General

Draft	The vertical distance between the waterline and the bottom most part of the buoy, usually expressed in meters. Maximum draft is obtained when the *Reserve Buoyancy* is zero. (See Figure 1-1).
Operational Surcharge Load	Sum of all loads incurred in service, i.e. marine growth and ice accumulation. Maximum values to be used for design are defined in Annex A for each buoy type.
Operational Reserve Buoyancy (Rb)	Defined as amount of internal buoyancy between minimum and maximum design waterline levels or mooring weight conditions.
Plastic	Synthetic organic polymer material capable of being moulded, formed, extruded, or cast into various shapes.
Safe Working Load (SWL)	The SWL is the maximum design load for the life of the item, with a value of 20% of breaking strength.
Survival Environmental Conditions	Environmental conditions over and above the performance requirements such that the buoy is capable of functioning once operational conditions return without significant damage.
Visible Height	The vertical distance from the waterline to the top of the buoy (See Figure 1-1). *Maximum Visible Height* is achieved when the minimum mooring weight is used. *Minimum Visible Height* is achieved when the recommended maximum mooring weight is used.
Waterline	The line of water along the buoy hull when deployed located between the minimum to maximum limits (See Figure 1-1).

Table 1-2: Definitions: Hardware

Handling Lug	An attachment point above the water line that may be part of or separate from the buoy hull, and facilitates buoy handling activities.
Lifting Lug	An attachment point above the water line rated to lift the maximum buoy and mooring assembly loads as defined in Section 2.3.3.1.1.
Mooring Lug	An attachment point below the water line, to which the mooring is connected, rated to lift the maximum buoy and mooring assembly loads as defined in Section 2.3.3.1.1.
Lifting Assembly	The lifting assembly is composed of the *Lifting Lug(s)*, the *Mooring Lug*, and a mechanical linkage connecting the two or more components. The full assembly is rated to lift the maximum loads as defined in Section 2.3.3.1.1.

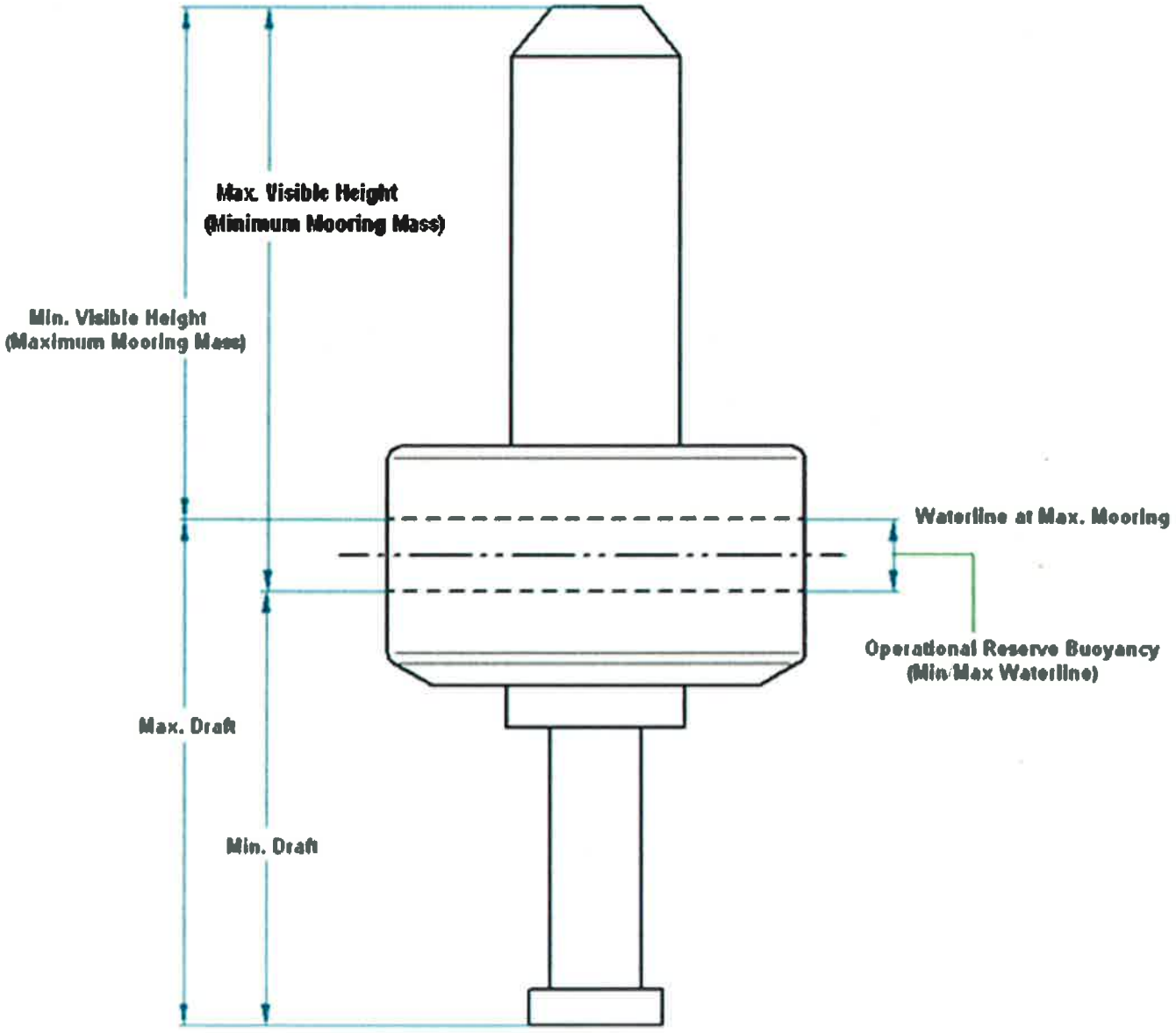

Figure 1-1: Buoy Terminology

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Chapter 2 PERFORMANCE REQUIREMENTS

2.1 GENERAL

The buoy hull shall be made of lightweight, buoyant and durable materials. The buoy shall be water tight and capable of unattended operation for 5 years and require no preventive maintenance, other than periodic cleaning of external surfaces. If a tower mast atop of the hull is provided it too shall be made of durable materials. The buoy shall be resistant to degradation in their operating, deployment, retrieval and storage environments including exposure to the elements.

2.1.1 Buoy Categories

To satisfy the various operational requirements of the Canadian Coast Guard two different buoy categories will be required as defined in detail in Annex A of this specification.

2.2 OPERATIONAL REQUIREMENTS

The buoys shall meet the requirements of this section.

2.2.1 Areas of Operation

The buoys that will be deployed in Canadian Navigational Waters are principally used in rivers, sheltered waters and partially protected waters.

2.2.2 Environmental Conditions

The buoys **shall** either operate in or survive the following environmental conditions and those listed in Annex A. The operational conditions are considered when assessing a buoy's ability to function as and aid to navigation. The survival conditions are used to establish pre-failure limitations.

2.2.2.1 Water Temperature

The buoys will operate in and survive exposure to water temperatures of -2-°C to +30°C.

2.2.2.2 Air Temperature

The buoys will operate in and survive exposure to air temperatures of -40-°C to +40°C.

2.2.2.3 Water Types

The buoys will withstand exposure of continuous fresh, or saline or brackish waters for the duration of the life cycle expectancy of the buoy as defined in Section 2.2.4.

2.2.2.4 Operational Wind Speed

The buoys will operate in wind speeds as listed in Annex A.

2.2.2.5 Survival Wind Speed

The buoys will survive the wind speeds listed in Annex A.

2.2.2.6 Maximum Operational Wave Height

The buoys will operate in a wavy environment, as described in Annex A-.

2.2.2.7 Operational Current Speed

The buoys will operate in water currents listed in Annex A.

2.2.2.8 Survival Current Speed

The buoys will survive the current speeds listed in Annex A.

2.2.2.9 Maximum Buoy Tilt Angle at Maximum current

At maximum operational current (listed in Annex A), the buoys will show a tilt angle equal or less than **6°**.

2.2.2.10 Humidity

The buoys will withstand exposure to relative humidity levels from 0 to 100%.

2.2.2.11 Salt Air and Seawater Spray

The buoys will withstand exposure of continuous salt air and seawater spray for the duration of the life cycle expectancy of the buoy as defined in Section 2.2.4.

2.2.2.12 Ultraviolet Exposure

The buoys will operate under conditions of continuous exposure to ultraviolet (UV) light typical as defined in Section 2.3.6.3.

2.2.2.13 Marine Growth

The buoys must be able to withstand an accumulation of marine growth on its underwater portion during operational and survival conditions as listed in Annex A.

2.2.2.14 Ice Exposure

The buoys will be subjected to the ice exposures as listed in Annex A.

2.2.2.15 Impact Resistance

The buoys will be subjected to occasional impacts due to drifting ice floes, logs, floating debris as well as impacts incurred during retrieval and deployment handling. The buoys are expected to survive these conditions for the duration of the life cycle expectancy of the buoy as defined in Section 2.2.4.

2.2.2.16 Abrasion Resistance

The buoys will be subjected to occasional abrasion due to wall friction resulting from close contact with ice, wood or any other debris as listed in Annex A. The buoys are expected to survive these conditions for the duration of the life cycle expectancy of the buoy as defined in Section 2.2.4.

2.2.3 Operational Service

The buoys shall be capable of unattended operation and will be subjected to the following operational conditions.

2.2.3.1 Deployment and Retrieval

The buoys and all of its components will be exposed to static and dynamic loads associated with buoy deployment and retrieval operations. The buoys are expected to survive these conditions for the duration of the life cycle expectancy of the buoy as defined in Section 2.2.4.

2.2.3.2 Maintenance

The service period for the buoy will be five (5) years. Maintenance activities will be limited to:

a) pressure washing up to 2 MPa (3 ksi) to remove fouling;

b) the removal of ice accumulation with the use of a non-metallic mallet (e.g. wood or rubber);

c) visual inspection of the buoy's surface, seams, fittings, lifting assembly and other auxiliary components;

d) the securing of loose fasteners due to expanding and contracting of mating surfaces.

Manufacturer recommended repair procedures and kits shall be available in the event damage is found in the areas described in c).

2.2.3.3 Buoy Storage

The buoys must survive typical storage conditions without any damage when not is service. The buoy may be stored outdoors, and exposed to seasonal elements such as UV, heat, cold weather, wind, etc. The buoy may also be stored on dirt, concrete, wood or asphalt surfaces.

2.2.4 Life Expectancy

Aside from the need for periodic cleaning, the buoys **shall have a maintenance--free service life of at least five (5) years**, based on year-round operation. A total service life of fifteen (15) years is expected. At the end of its life, the buoy shall still be recognizable as an aid to navigation as prescribed in [21].

2.2.5 Table 1-5Operational Criteria (Level of Service)

The buoys are required to meet the functional criteria described herein.

2.2.5.1 Visual Range

The buoys shall meet the visual range criteria specified within Annex A when subjected to the manufacturer's maximum mooring mass (includes external ballast, chain and any counterweight).

2.2.5.2 Radar Range

The buoys shall have a radar reflector with a minimal cross sectional area in accordance with Table 3.1 of reference [20] '*Buoys and beacons with radar reflector*-Technical Performance Requirements of VTS equipment) for X band Radar and have sufficient operational reserve buoyancy to ensure that it meets the target height requirements of this table.

2.2.5.3 Visible Height

The buoys shall have sufficient operational reserve buoyancy to ensure that it meets the minimum visible height criteria specified within Annex A.

2.2.5.4 Buoy Type

The buoys that will be used as navigational aids in this specification shall be of the type lateral, cardinal or special conforming to the requirements of Table 1.5 reference [21], "The Canadian Aids to Navigation System". Colour requirements are defined in Section 2.3.6.

2.2.5.5 Lantern Mounting

The buoys shall be capable of mounting lanterns and shall have a flat surface and be fitted with stainless steel inserts. The lantern mounting needs are defined within the *Equipment Requirements* portions of Annex A. The required LED lantern mounting bolt circle diameter patterns are shown in Figure A-2 .

2.2.6 Stability Criteria

The buoys are required to meet the stability criteria described herein. Stability is to be assessed such that the buoy is able to meet the operational criteria defined in Section 2.2.5 under the minimum and maximum limiting operational environmental conditions defined in Sections 2.2.2 (general) and Annex A (buoy specific).

2.2.6.1 Stability – Undamaged Condition

In the *undamaged condition the buoys shall remain upright at all times. The buoy shall not list in calm waters. This criterion is to be met considering all required payload items (e.g. LED lanterns, mooring) and minimum and maximum surcharge items (e.g. marine growth).

* Undamaged means a buoy in good condition retaining its original shape and a watertight hull. The buoys must be recognizable as an aid to navigation in all operational conditions defined herein. Normal superficial wear may be present.

2.2.6.2 Stability – Damaged Condition

In the damaged† condition the buoys shall remain afloat at all times.

† Damaged means a buoy can no longer perform as an aid to navigation in the prescribed operational conditions; or the hull is no longer watertight.

2.2.6.3 Operational Reserve Buoyancy

The operational reserve buoyancy corresponds to a stable design deployment configuration range. All operational criteria must be met within this range.

2.3 TECHNICAL REQUIREMENTS

The buoys shall meet the requirements of this specification and be capable of meeting all tests requirements specified herein.

2.3.1 Materials

2.3.1.1 General

All materials used in buoy construction are to meet the appropriate standards listed in Section 1.2. Novel materials, or materials not addressed herein may be acceptable if they meet performance and environmental requirements. The buoy shall be fitted with a buoy tower with a radar reflector. The buoy shall also make provisions for an adjustable ballast counterweight.

2.3.1.2 Material Certifications

A certificate is required to validate that the manufactured buoy does not contain any materials identified in the Canadian Environmental Protection Act (CEPA) Schedule I or materials identified for control or elimination on the CEPA Registry website.

In addition to the records required by the manufacturer QA program, the contractor shall maintain and provide material certifications from the material manufacturer or a certified independent testing laboratory, indicating that the materials described in the following sections meet the requirements of this specification over the life of the product:

a) UV stabilizers and colour pigments for 15 year life;

b) buoy shell material;

c) inserts and fittings;

d) internal/external ballast material;

e) buoyancy material; and

f) radar reflector.

2.3.2 Design, Dimensions and Surface Finish

2.3.2.1 General

To prevent the buoys from hanging, listing, or floating off its axis due to non-uniform distribution or interior material or construction, the location of the buoy centre of gravity and its tolerance shall be as shown on the supplier's drawings which will assist the CCG in their performance calculations.

2.3.2.2 Buoy Hull Construction

The buoy hull can be made from either of one section or sections fastened together. The buoy hull shall not be used to support any of the mooring loads associated with the buoy (i,e. counterweights, bridles or mooring chain) nor be structurally linked to the buoy's lifting eyes. In the case where the hull is attached to a structural frame, this frame shall meet all requirements described in Section 2.3.6 herein.

2.3.2.3 Buoy Tower Construction

Buoy towers above the hull shall be available in two options; a plastic or a metal tower.

2.3.2.3.1 Plastic Tower Mast

The fully enclosed plastic tower shall be water tight and enclose the radar reflector and serve as a platform to support the above mounting of a lantern as well as support internal equipment such as batteries as well as external mounted equipment such as solar panels. Supports shall be provided to facilitate the safe means of scaling the tower to conduct overhead servicing of the lantern and related equipment. The tower shall be strong enough not to sustain any cracks or breakage during normal handling or in the removal of ice with a hard rubber or wooden mallet.

2.3.2.3.2 Open Tower Mast

The open tower mast structure shall enclose the radar reflector and serve as a platform to support the above mounting of a lantern as well as support equipment such as batteries and solar panels. Supports shall be provided to facilitate the safe means of scaling the tower to conduct overhead servicing of the lantern and related equipment. The tower structure shall be strong enough not to sustain any cracks or breakage during normal handling or in the removal of ice with a hard rubber or wooden mallet.

2.3.2.4 Approved Shape

Buoys shall have the appropriate above water shape, as specified by the contract, meeting the requirements of Table 1-5, reference [21] herein.

2.3.2.5 Overall Dimensions

The overall dimensional limits, including Minimum / Maximum Height and Maximum Draft are defined in Annex A.

2.3.2.6 Weight in Air

The maximum weight in air of the buoy and associated standard outfit should not exceed the weight as referenced in Annex A. This excludes the weight of additional payload items e.g. LED lantern.

2.3.2.7 Surface Finish (Plastic)

The plastic buoy shall be free from blemishes, bumps, indentations, ragged edges, cracks, scales, pits and blisters. All corners and edges are to be rounded with minimum radii of not less than 3 mm.

2.3.2.8 Surface Finish (Metallic)

Metallic surface finishes shall be free of any burrs or sharp edges. All corners and edges are to be rounded with minimum radii of not less than 1 mm.

2.3.3 Structural Capabilities

The buoy shall be designed to meet the requirements of this section and maintain these throughout the specified life expectancy.

2.3.3.1 Safe Working Load (SWL)

All lifting and mooring attachments and assemblies shall have a **minimum** safety factor of 5 for the life of the buoy. The *Safe Working Load* is 20_% ($^1/_5$) of the failure strength.

2.3.3.1.1 Transference of Loads

Lifting eyes attached to an external rigid frame or an internal mechanism joining the lifting eye to the mooring eye inside the hull should contain a minimum number of components to transfer loading from the lifting to the mooring eye. This shall be known as the *Lifting Assembly.*

2.3.3.2 Lifting and Mooring Attachments

All lifting and handling eyes shall be from corrosion resistant materials. All lifting eyes shall be rated considering the deployment and retrieval conditions described in Section 2.2.3.1.

The values to consider for the SWL for each lug type are:

a) For a Lifting Assembly the sum of the equivalent air weight of:

- the buoy, as purchased
- all payload items, e.g. Lantern;
- the manufacturer's recommended maximum mooring mass as defined in Section 2.3.9.
- the environmental factors accumulated over the service life i.e. marine growth and ice accumulation.

b) For a *Mooring Lug* the value is equivalent to the *Lifting Assembly* in (a);

It is desired to be able to access and inspect all lifting assemblies over the life of the buoy. The capacity of each lug attachment must be clearly identified as per Section 2.3.7.5.

2.3.3.3 Impact Resistance

In general the buoy should be capable of withstanding impact loads from hydrodynamic factors (*e.g.* breaking waves) and dynamic loads; i.e. the survival level loads caused by typical handling operations in all operational temperatures. Actual testing using an Industry standard test method or mathematical analysis shall be used to show that the buoy will be able to withstand the fore mentioned loading conditions.

2.3.3.4 Abrasion Resistance

In general the buoy shell shall be capable of withstanding abrasion loads generated from slow moving ice or river debris in all operational temperatures. The buoy's shell shall be abrasion tested in accordance with the standard test specification ISO 9532 '*Abrasion Resistance of Rigid Plastics*' (Taber Test) with Wheel CS 17, Load of 1 kg and be capable of resisting any wear when subjected to the conditions as detailed in Annex A.

2.3.4 Exterior Outfit

2.3.4.1 Buoy Shell

The buoy shell, or protective outer skin, shall be constructed of a polymer plastic. For buoys that do not have a distinct outer skin, the outer surface shall be compacted in such a manner that it will act as a shell.

Unless otherwise specified, the entire shell shall be uniform in colour and appearance, and shall meet all requirements described in Section 2.3.6.

2.3.4.2 External Ballast

The buoys shall make provisions for external ballast that is adjustable in weight.

2.3.4.3 Fasteners, Bushings and Inserts

All metallic fittings and fasteners shall be of stainless steel types 18-8, 316, and/or 316L. All other alternative material will require prior CCG approval. The functionality of fittings and fasteners shall not be affected by prolonged exposure to the marine environment and be easy to dismantle using standard tools and equipment.

All parts shall be free of cracks and other material defects and all sharp corners and edges shall be rounded. Metal inserts and wear bushing shall be designed to remain functional over the buoy's specified life expectancy. Alternatives, such as replaceable fittings, may be considered if the maintenance-free service life is achieved.

2.3.4.4 Mooring Attachment Points

The buoys shall be fitted with a minimum of **two mooring attachment points** symmetrical opposite to each other. Each mooring eye shall be fitted with a stainless steel bushing inserts not less than the dimension specified in Annex A.

2.3.4.5 Lifting and Handling Attachment Points

The buoys shall be fitted with the specified number of lifting and/or handling attachment points as identified in Annex A. Each lifting and/or handling point shall be located as shown in Figure A.1.2 and in such a manner to allow safe access when in service, and abide by the minimum dimensional tolerances defined for each buoy type. Lifting eyes will be made from stainless steel or marine grade aluminum capable of meeting the requirements of 2.3.3.2.

2.3.5 Exterior / Interior Outfit

2.3.5.1 Internal / External Ballast

Ballast is used to ensure compliance with functional and stability criteria. Ballast material must be non-toxic and non-polluting and capable of resisting rust. Any material regulated or controlled for use by Environment Canada is prohibited. The ballast material must be linked to the buoy hull and not move from its design location over the life of the buoy.

2.3.5.2 Buoyancy Material

The buoyancy material used shall be closed cell foam; its type is at the discretion of the manufacturer. Preference will be given to recyclable materials as per section 2.3.8. Buoyancy material shall be non-permeable. The buoyancy material shall be free of cracks, gouges, and embedded foreign material. There shall be no internal voids of such quantity or size that could cause the buoy to be susceptible to flooding.

When buoyancy material is the principal method of containing interior outfit items, namely ballast and radar reflectors, it shall be strong enough to hold these components in place. When assessing this requirement, attention should be given to the rigors of the marine environment and the specified life expectancy of the buoy.

2.3.6 Colour

Buoy shells and other components comprising the buoy markings shall conform to the requirements of this section. The main colour of the buoy shall be homogenous through the buoy shell with a ***'high gloss'*** finish.

2.3.6.1 Colour Pigments

Figure 2-1 below defines the desired IALA chromaticity values for x and y for each of the pigments used in the buoy's plastic in accordance with IALA-108 E chart. As colour pigments are also known to fade over time towards the center of the graph, the CCG has defined preferred colour zones for its buoys.
Figure 2-2 defines the preferred CCG colour zones, where zone 1 is more desirable than zone 2.

Note: White and Black zones are not divided.

Manufacturers who comply with the colour and luminance of Zone 1 (Figure 2-2) will be awarded more points than Zone 2. The CCG will require that colour measurements shall be taken at (6) six random locations along the buoy's surface. The average of these values for each of the x and y will be compared to the Table 2-1. Colour pigmentation can be measured with the use of a handheld Color Photo Spectrometer or equivalent instrumentation for a 2 degree observation angle and an Illuminant of D65.

Recommendation E-108 – Surface colours used as visual signals on aids to navigation
May 1998 - Revised May 2004

Figure 1 – Chromaticity Regions for Ordinary Colours

Recommended regions for the ordinary colours specified in Table 1, the coordinates of the corner points are provided in Table 2.

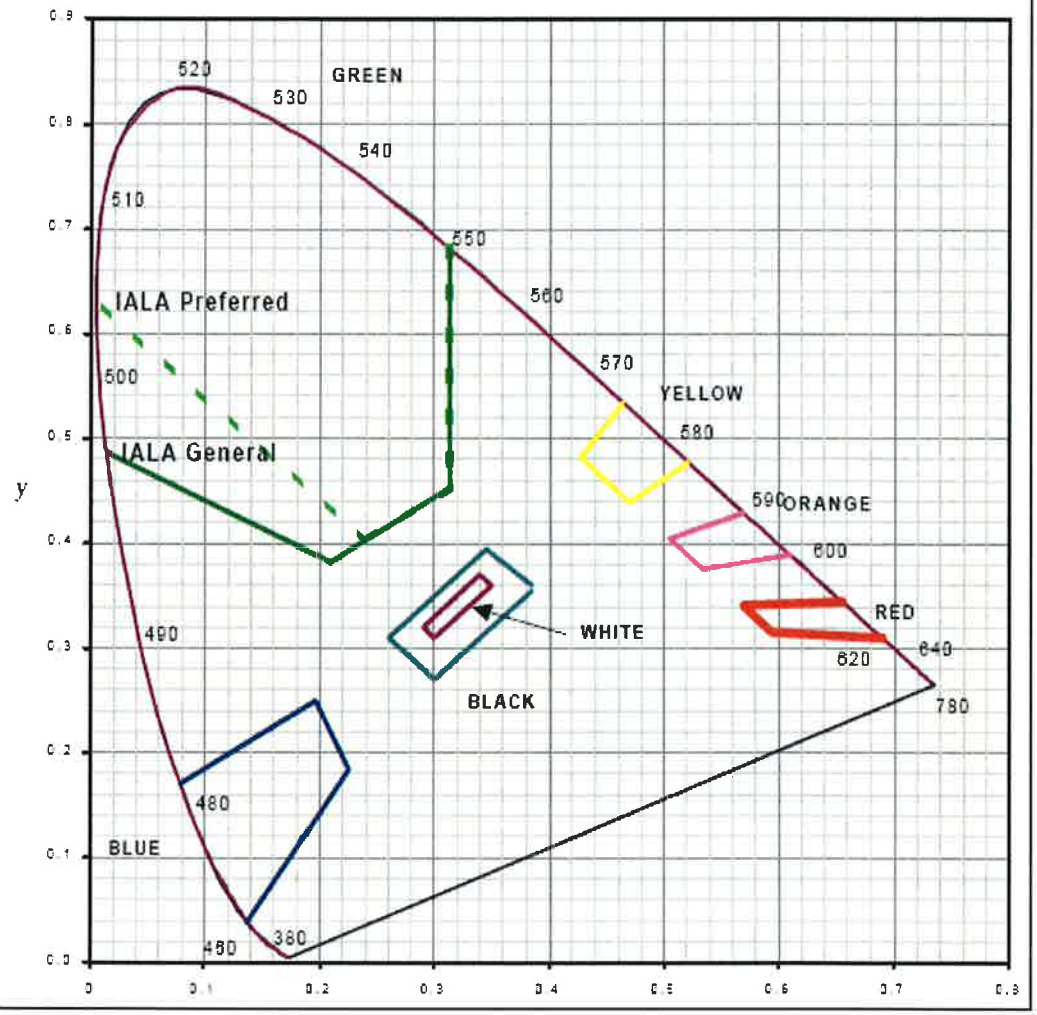

Figure 2-1: IALA-108 Chromaticity Chart

2.3.6.2 Preferred CCG Colour Zones

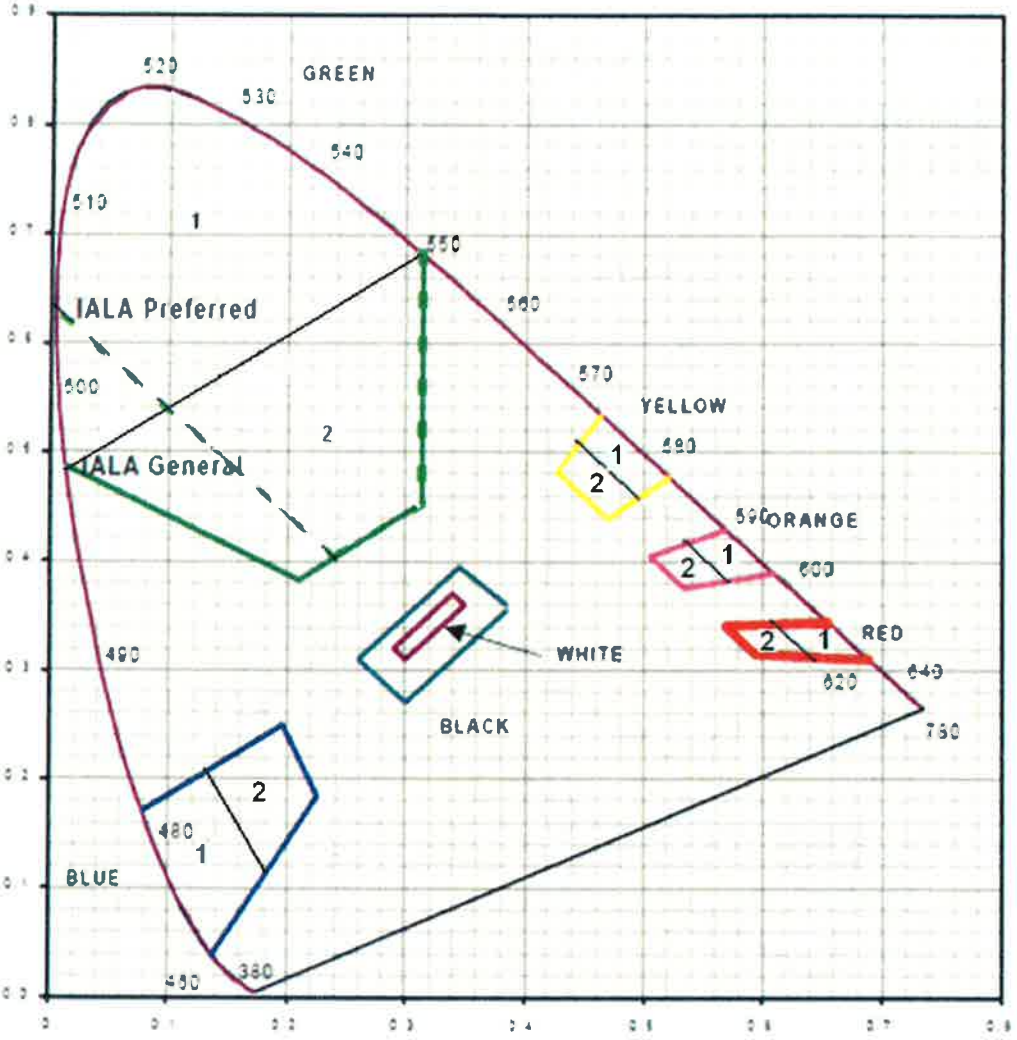

Figure 2-2: CCG preferred colours zones within IALA-108 Chromaticity Chart

Table 2-1: Definition of Boundary line within preferred colour zones

Colour	CIE 1931 values			
	x+	x-	y+	y-
Red	0. 6400	0. 6080	0. 3450	0. 3100
Orange	0.4200	0.3800	0.5750	0.5325
Green	0.3150	0.0015	0.6800	0.4800
Yellow	0.4550	0.4990	0.4600	0.5125
Blue	0.1320	0.1800	0.2060	0.1080

2.3.6.3 Ultraviolet Stabilizers

Ultraviolet stabilizers shall be added to the plastic to enhance colour retention and to protect the material from degradation due to continuous exposure to the sun. Stabilizers shall provide ultraviolet protection such that the colours specified will be maintained within IALA limits for a minimum of 6 years.

Colour stability shall be measured in accordance with Table 1-4 reference[18], and the allowable colour change shall not exceed ΔE^*_{ab} 4.0, after 1000 hours of exposure in a Xenon Weatherometer, according to reference [18] herein.

Alternate methods of colour retention may be proposed for consideration by CCG.

2.3.7 Markings

All markings, unless otherwise specified, will be clearly and legibly printed in a permanent fashion. The method and placement of all markings shall not affect the structural integrity of the buoy. They will be in French and English and shall be identified on delivered drawings (Section 2.3.8).

2.3.7.1 Coast Guard Markings

The words:

CANADIAN COAST GUARD

GARDE CÔTIÈRE CANADIENNE

20xx

where "20xx" is the year of manufacture, shall be inscribed in block digits on each buoy above the waterline. The letters shall not be less than twenty-five (25) mm tall. For buoy dimensions too small to accommodate the entire inscription~~;~~, only the year of manufacture will have 25 mm tall letters. The remaining title will be sized as appropriate, according to the buoy dimensions.

2.3.7.2 Identification

Every plastic buoy shall be fitted with a unique Serial Number. The numbering shall follow the following convention: *AB-12-3456,* where the "AB" is an alphabetic supplier designation; the first two numeric digits represent the year of manufacture; and the four digits is a unique buoy identifier. The size of lettering shall be in clearly legible.

2.3.7.3 Operational Reserve Buoyancy Markings

Two markings identifying the Operational Reserve Buoyancy limits of the buoy shall be clearly and permanently marked around the entire circumference of the hull. These markings shall not in any way affect the buoy's structural integrity. See Figure 1-1.

2.3.7.4 Radar Reflector Marking

When radar reflectors are contained within a plastic tower enclosure the letter "R" shall be inscribed after the year defined in Section 2.3.7.1. It is equivalent in size to the year of manufacture digits.

2.3.7.5 SWL Markings

The safe working load (SWL) associated with all lifting and mooring points will be marked using **SI units** adjacent to each lifting point.

2.3.8 Environmental Impact

Buoy designs and materials will be selected to minimize their environmental impact upon disposal at the end of their useful life. Considerations shall be given to the three "R's" of environmental protection, namely **R**euse, Waste **R**eduction and Material **R**ecycling. Also, it is desirable that manufacturing processes be environmentally friendly.

2.3.9 Deliverables (Supporting Documentation)

Manufactures are required to supply the following information in the language or languages required by the contract. All deliverables shall be in electronic PDF format. These requirements may be reduced at the discretion of CCG.

a) User Manual for each buoy type describing, as a minimum, the following:

- Recommended/required deployment, storage and retrieval procedures if applicable;
- Recommended/required maintenance procedures;
- Fastener torques, if applicable;
- Repair procedures, if applicable;
- Disposal plan options with associated procedures;
- Immersion charts in units of mass per vertical displacement [kg/cm];
- Recommended/required anchors sizes;
- Minimum and Maximum recommended mooring mass;
- Provide a mooring table as follows for water currents possibilities between 0-6 knots:

Water Depth (m)	Total Weight of Mooring Accessories including Chain and Counterweight (kg)	Sinker Air Weight (kg)
< 10		
10 - 20		
20 - 30		
30 - 40		
> 40		

b) Technical Data Package for each buoy type describing, as a minimum, the following:

- Engineering drawings including the design waterline, centre of gravity, meta-centric height, centre of buoyancy, weight-in-air and height from water line to top of buoy including appendages for both fresh and salt water; location and detail for all markings (e.g. height);
- Engineering calculations including determination of free board, buoy stability under maximum operational conditions (values listed in Annex A);
- Parts lists if applicable;
- Radar reflector details, if applicable;

Note: All engineering calculations shall be performed by a **professionally accredited** Naval Architect.

c) Design analysis of lifting and mooring points, and other elements crucial to operator safety.

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Annex A BUOY SPECIFIC PERFORMANCE REQUIREMENTS

A.1 SCOPE

This annex states the supplementary requirements for each of the buoy types. These buoys are divided primarily into two weight categories. Each buoy is to meet the requirements of this annex and the requirements of the main body of the specification.

A.1.1 Priority of Documents

In the event of any conflict between this annex and the main body of this specification, the requirements of Annex A and Annex B shall prevail.

A.1.2 Definition

The buoy shall meet the performance requirements listed below.

A.2 PERFORMANCE REQUIREMENTS

This section defines the environmental conditions under which the buoy must function as an aid to navigation. It also defines functional criteria and supplementary requirements, which the buoy must meet in order to meet the requirements of this section.

A.2.1 Medium Channel / Harbour Pillar- Category 1

Item	Dimensional Requirements	Units	Value
A.2.1.1	Minimum / Maximum Hull Diameter (W)	m	1.35 / 1.55
A.2.1.2	Minimum / Maximum Buoy Height (H)	m	3.2 / 5.5
A.2.1.3	Buoy Weight Range (excluding external ballast)	kg	**200 - 399**
A.2.1.4	Maximum Buoy Draft (Height submerged: Hs)	m	2.6
A.2.1.5	Impact Resistance	-	See Section 2.3.3.3
A.2.1.6	Buoy Hull Shell Abrasion Resistance	mg	**< 120 mg weight loss after 4000 cycles**
A.2.1.7	Threaded lantern mounting area	-	Figure A-2
A.2.1.8	Expected Maximum Lantern Weight	kg	20
A.2.1.9	Overall Buoy Silhouette	-	Figure A-1
	Functional Criteria		
A.2.1.10	Minimum Visual Range [at max mooring mass]	nm	1.2
A.2.1.11	Minimum Radar Range[6]	nm	1.5

A.2.1.12	Minimum Radar Cross Sectional Area	m^2	10.0
A.2.1.13	Minimum Visible Height [Hf at min Rb]	m	1.80
A.2.1.14	Tower Construction Type: 1= Plastic Tower Mast 2= Open Tower Mast	Optional (1 or 2)	1
	Equipment Requirements		
A.2.1.15	Radar Reflector	-	Yes
A.2.1.16	Lantern Mount	-	Yes
A.2.1.17	External Adjustable Ballast	-	Yes
	Lifting and Mooring Eyes		
A.2.1.18	Minimum Number of Lifting Lugs	-	2
A.2.1.19			
A.2.1.20	Minimum Number of Mooring lugs	-	2
A.2.1.21	Lifting Eye Safe Working Load (SWL)(range)	kg	See Section 2.3.3.1
A.2.1.22	Lifting Assembly Break Load	kg	See Section 2.3.3.2
A.2.1.23	Mooring Eye Break Load	kg	See Section 2.3.3.2
A.2.1.24	Minimum Mooring Lug Internal Diameter	mm	50
A.2.1.25			
A.2.1.26	Minimum Lifting Lug Internal Diameter	mm	150
	Environmental Conditions		
A.2.1.27	Maximum Marine Growth – Operational	kg	150
A.2.1.28	Operational Current Range	knots	0 - 4
A.2.1.29	Maximum Current – Survival	knots	10.0
A.2.1.30	Maximum Wind Speed – Operational	knots	30.0
A.2.1.31	Maximum Wind Speed – Survival	knots	80.0
A.2.1.32	Maximum Buoy Tilt Angle at max current – Operational	deg	6
A.2.1.33	Maximum Operational Wave Height	m	3
A.2.1.34	Exposure to Ice	-	Occasional
	Buoy Markings		
A.2.1.35	Operation Reserve Buoyancy Area	-	Rb

Table A-2.1

A.2.2 Medium Channel / Harbour Pillar- Category 2

Item	Dimensional Requirements	Units	Value
A.2.2.1	Minimum / Maximum Hull Diameter (W)	m	1.35 / 1.55
A.2.2.2	Minimum / Maximum Buoy Height (H)	m	3.2 / 5.5
A.2.2.3	Buoy Weight Range (excluding external ballast)	kg	**400 - 700**
A.2.2.4	Maximum Buoy Draft (Height submerged: Hs)	m	2.6
A.2.2.5	Impact Resistance	-	See Section 2.3.3.3
A.2.2.6	Buoy Hull Shell Abrasion Resistance	mg	**< 120 mg weight loss after 10,000 cycles**
A.2.2.7	Threaded lantern mounting area	-	Figure A-2
A.2.2.8	Expected Maximum Lantern Weight	kg	20
A.2.2.9	Overall Buoy Silhouette	-	Figure A-1
	Functional Criteria		
A.2.2.10	Minimum Visual Range [at min Rb]	nm	1.2
A.2.2.11	Minimum Radar Range[6]	nm	1.5
A.2.2.12	Minimum Radar Cross Sectional Area	m^2	10.0
A.2.2.13	Minimum Visible Height [Hf at min Rb]	m	1.80
A.2.2.14	Tower Construction Type: 1= Plastic Tower Mast 2= Open Tower Mast	Optional (1 or 2)	1
	Equipment Requirements		
A.2.2.15	Radar Reflector	-	Yes
A.2.2.16	Lantern Mount	-	Yes
A.2.2.17	External Adjustable Ballast	-	Yes
	Lifting and Mooring Eyes		
A.2.2.18	Minimum Number of Lifting Lugs	-	2
A.2.2.19			
A.2.2.20	Minimum Number of Mooring lugs	-	2
A.2.2.21	Lifting Eye Safe Working Load (SWL)(range)	-	See Section 2.3.3.1
A.2.2.22	Lifting Assembly Break Load	-	See Section 2.3.3.2
A.2.2.23	Mooring Eye Break Load	-	See Section 2.3.3.2
A.2.2.24	Minimum Mooring Lug Internal Diameter	mm	50
A.2.2.25			
A.2.2.26	Minimum Lifting Lug Internal Diameter	mm	150

Environmental Conditions			
A.2.2.27	Maximum Marine Growth – Operational	kg	150
A.2.2.28	Operational Current Range	knots	0 - 4
A.2.2.29	Maximum Current – Survival	knots	10.0
A.2.2.30	Maximum Wind Speed – Operational	knots	30.0
A.2.2.31	Maximum Wind Speed – Survival	knots	80.0
A.2.2.32	Maximum Buoy Tilt Angle at max current – Operational	deg	6
A.2.2.33	Maximum Operational Wave Height	m	3
A.2.2.34	Exposure to Ice	-	None
Buoy Markings			
A.2.2.35	Operation Reserve Buoyancy Area	-	Rb

Table A-2.2

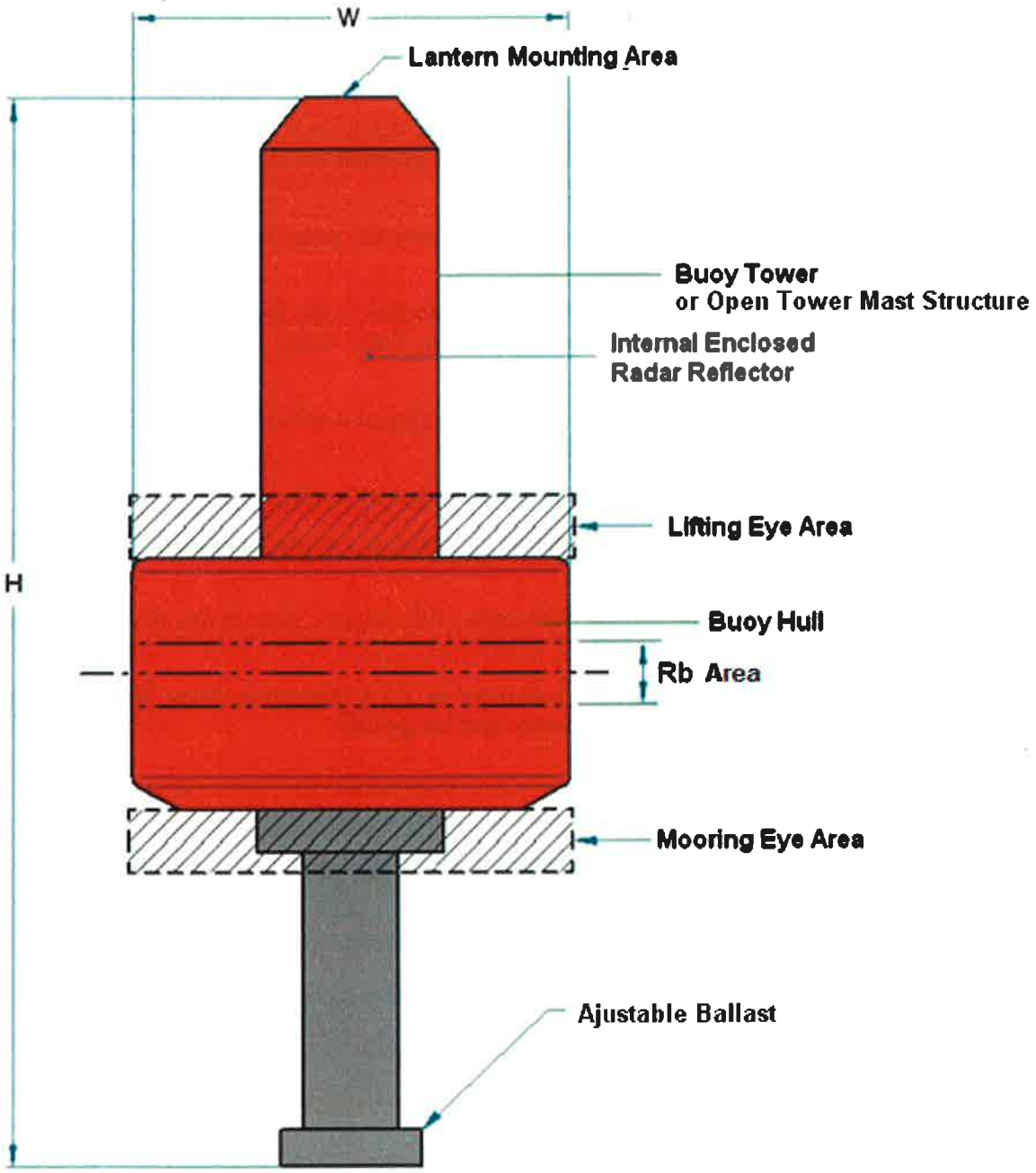

Figure A-1: Medium Channel / Harbour Pillar Buoy Silhouette

Notes

- Occasional exposure to ice indicates that these buoys may come in contact with ice fragments at the end of the navigation season.
- Visual Range assumes that the observer is 3m above the water level in clear weather with calm seas and an optimal visibility of 10 nautical miles. It is also assumed that there are no background features to obscure the buoy.
- Radar Range assumes an X-Band radar antenna 3m above the water level in clear weather and calm seas.
- Visible height is defined as the distance from the waterline to the top of the buoy. The waterline calculated in the delivered condition when floated in fresh water, including radar reflector and excluding the mooring.
- Lantern Mount, where required shall allow for the mounting of a self-contained LED lantern at the top of the buoy without interference with the lifting lugs.
- Marine growth includes any accumulated annual marine growth on the buoy or chain.
- The weight of mooring is the sum of all mooring components including the chain and external ballast etc (i.e. counterweights, sea growth).
- Expected lantern weight does not include the weight of the adaptor plate or any interface to the top of the buoy.
- Lifting Eye Safe Working Load (SWL) is calculated as 1/5 x (Maximum Buoy Weight + Maximum Mooring Mass – including counterweight, marine and ice growth).

A.2.3 Lantern Mounting

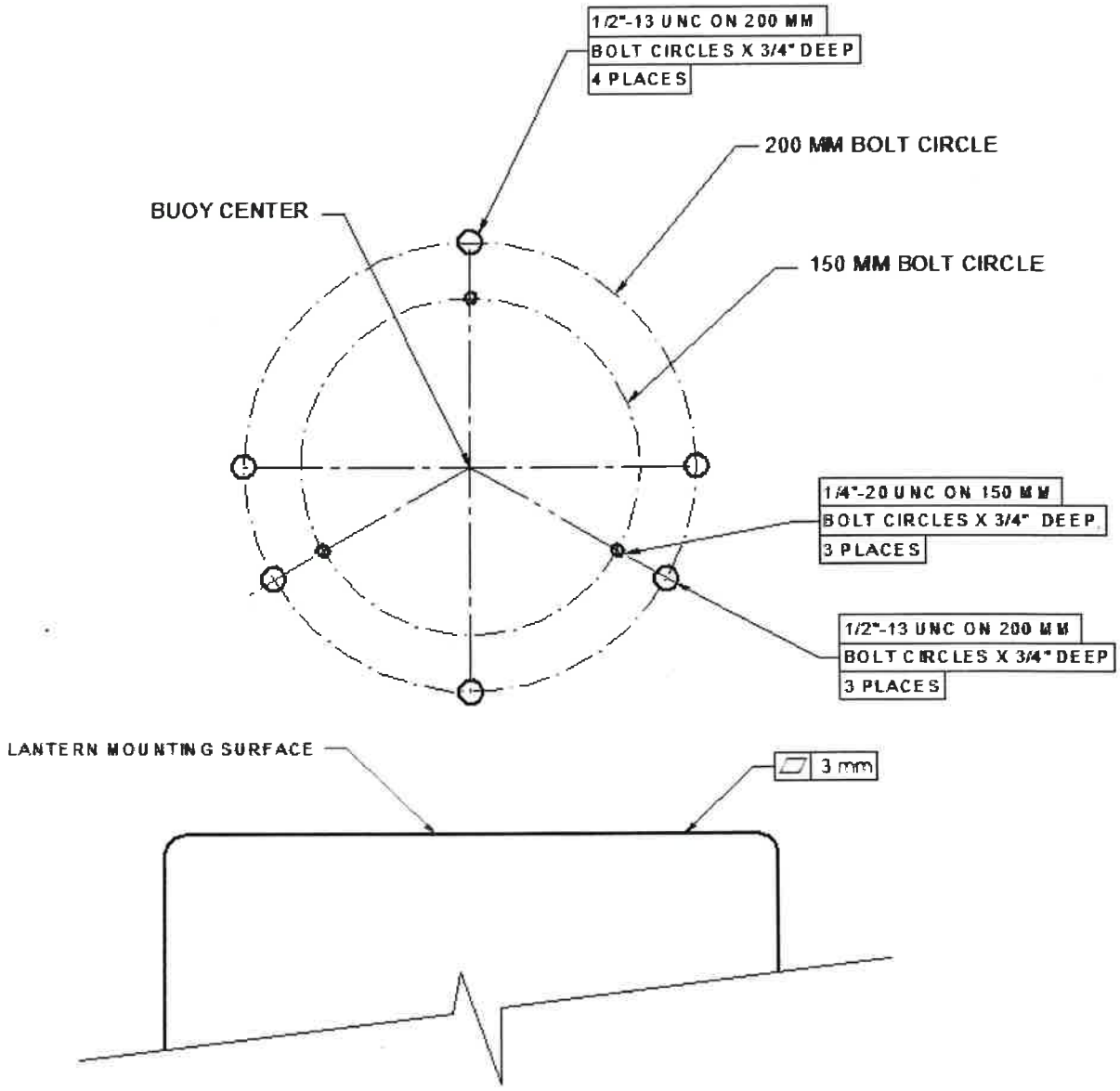

Figure A-2: Threaded Lantern Area