

CMI QUESTIONNAIRE ON UNMANNED CARGO SHIPS

1.1 Would a “cargo ship” in excess of 500 grt, without a master or crew on board, which is either

1.1.1 controlled remotely by radio communication; [or]

1.1.2 controlled autonomously by, inter alia, a computerised collision avoidance system, without any human supervision

constitute a “ship” under your national merchant shipping law?

Yes.

The applicable Canadian statutes are the *Canada Shipping Act, 2001* (the “CSA”), the *Marine Liability Act* (the “MLA”) and the *Federal Courts Act* (the “FCA”).

Section 2 of the *CSA* defines a “vessel” as follows:

a boat, ship or craft designed, used or capable of being used solely or partly for navigation in, on, through or immediately above water, without regard to method or lack of propulsion, and includes such a vessel that is under construction. It does not include a floating object of a prescribed class¹

According to this definition, the presence or absence of a crew is irrelevant for determining whether something is a “vessel” under the *CSA*. There are several examples of case law where unmanned scows and barges have been found to be “vessels” without controversy, and it appears that this would easily extend to unmanned cargo ships.

Section 2 of the *FCA* defines a “ship” as follows:

any vessel or craft designed, used or capable of being used solely or partly for navigation, without regard to method or lack of propulsion, and includes

(a) a ship in the process of construction from the time that it is capable of floating, and

(b) a ship that has been stranded, wrecked or sunk and any part of a ship that has broken up.

This definition was considered in *Cyber Sea Technologies, Inc. v. Underwater Harvester Remotely Operated Vehicle*, 2002 FCT 794. This case considered whether a remotely-controlled (by attached umbilical cable) submersible was a “ship”. The Court said in part:

[11] By defining a ship in terms of both vessel or craft, very general and broad words in themselves, the definition would seem to encompass anything used on or in the water. ... The net is thus exceedingly broadly cast, with the only limitation being that the vessel or craft be used at least in part in navigation. I do not see, if one were to make it an

¹ The definition of a “ship” in the *MLA* is essentially the same.

inclusive definition, adding the word "including", that the scope of vessels and craft, included in the definition of ship, would be broadened appreciably or at all.

...

[13] In reaching the conclusion that the submersible is, in all probability, a ship, I rejected the idea that there is any overall particular principle which I might apply in order to determine the issue, but rather have taken as a guide various elements which go into defining a ship, including those set out in page 362 of St. John Shipbuilding. I say including, because I do not believe that the list set out there is exhaustive, either for or against determining the submersible to be a ship. In St. John Shipbuilding the Court of Appeal considered various relevant facts in order to determine that a crane barge was a ship:

- (a) the barge was built for use on water;*
- (b) the barge was capable of being moved from place to place and was in fact so moved from time to time;*
- (c) the barge was capable of carrying cargo and had done so;*
- (d) the barge was capable of carrying people and clearly had to do so in order to provide a crew to operate the crane;*
- (e) that the barge was neither self-propelled nor capable of navigation herself, did not detract from the possibility that she was a ship.*

The present instance I would add additional factors being:

- (i) the submersible was designed and built for use in the water;*
- (ii) the submersible is equipped with its own power in order to navigate from place to place;*
- (iii) the submersible is to carry equipment to allow it to navigate, including sonar, cameras, lights, ballast and floatation systems;*
- (iv) the submersible will carry a number of inflatable balloons and other equipment, analogous to cargo, to allow it to float cut trees to the surface;*
- (v) that the submersible is unmanned is not a real factor in that towed cargo carrying barges are just one example of unmanned objects which may be ships;*
- (vi) that the submersible is controlled and navigated from the surface, so that its movement in navigating through the water is not dependent upon someone abroad, is a neutral factor, just as in the case of a towed dumb barge which is, in effect, navigated by the tug;*
- (vii) that the submersible which is designed to operate largely under water, except when brought to the surface to take on a cargo of more air balloons, tethering lines for the balloons and bolts to drive into trees, navigates under water, is not a factor in determining whether or not the object is a ship and here I have in mind full-scale submarines which are ships.*

Based on the foregoing factors, an unmanned cargo ship would constitute a “ship” under the *FCA*. When one considers that the *FCA* definition is very similar to the *CSA* definition, one can also assume that the same type of analysis could be used as further indication that an unmanned cargo ship would constitute a “vessel” under the *CSA*.

1.2 Would an unmanned “ship” face difficulty under your national law in registering as such on account of its unmanned orientation?

No.

Registration is governed by section 46 of the *CSA*. It reads as follows:

(1) Unless it is exempted under the regulations, a vessel must be registered under this Part if it

(a) is not a pleasure craft;

(b) is wholly owned by qualified persons; and

(c) is not registered, listed or otherwise recorded in a foreign state.

Contrary to having difficulty registering, the *CSA* mandates that an unmanned cargo ship would have to register. There is nothing to suggest that its unmanned nature would pose as a barrier to registration.

1.3 Under your national law, is there a mechanism through which, eg a government secretary may declare a “structure” to be a “ship” when otherwise it would not constitute such under the ordinary rules?

No.

Under Part 2 of the *CSA*, discretion in the registration of vessels in Canada is granted to the office of the Chief Registrar, but that discretion does not permit expansions or exemptions of what constitutes a vessel.

There are other Canadian regulatory bodies that have broader discretion when determining whether something is a ship. There are only two that might be applicable to the registration process.

The first is the discretion offered to the Minister of Transport under section 10(2) of the *CSA*, which permits the Minister to grant exemptions for any purpose if it is in the public interest to do so:

The Minister of Transport or the Minister of Fisheries and Oceans may, with respect to that Minister’s responsibilities under this Act, exempt for a specified period any authorized representative, master, vessel, class of vessels, operator of an oil handling facility, oil handling facility or class of oil handling facility from the application of any provision of this Act or the regulations, subject to any conditions that that Minister considers appropriate, if that Minister is of the opinion that the exemption is in the interest of preventing damage to property or the environment or is in the interest of public health or safety.

As it applies to the Chief Registrar’s authority over ship registration, the Minister of Transport could theoretically exempt one from complying with the requirement to register. However, it does not appear as though the Minister of Transport has the authority to deem something to be a ship when it is not.

Therefore, the exemption could only apply to allow non-registration of something that already constitutes a ship. It is difficult to imagine a scenario in which non-registration of a ship that otherwise would be a ship would be in the public interest, yet this possibility does exist.

The second is the ability to apply to the Marine Technical Review Board (the “MTRB”) for an exemption in respect of CSA-required approvals, including registration. The MTRB is established pursuant to sections 26 to 28 of the CSA, which read as follows:

26(1) For the purpose of ensuring the safety of the marine industry, the Marine Technical Review Board is hereby established to make decisions on applications for an exemption from, or the replacement of, any requirement under the regulations in respect of a Canadian vessel or in respect of the issuance of a Canadian maritime document to a person, other than one with respect to fees.

...

28(1) Any person may, in respect of a requirement set out in a provision of the regulations made under this Act that applies in respect of a Canadian vessel or in respect of the issuance of a Canadian maritime document to a person, apply to the Marine Technical Review Board for a decision to exempt the applicant from the requirement or to replace it with another requirement.

...

(4) If the panel struck to decide the application is satisfied that the exemption or replacement is in the public interest and would not jeopardize marine safety or the marine environment and, in the case of an application to replace a requirement with respect to safety, the replacement would result in an equivalent or greater level of safety, the panel is to issue a decision granting the application, subject to any conditions and for the period that the panel considers appropriate.

It is important to note that the MTRB’s exemptions are limited to the scope of technical requirements that apply to vessels. Put another way, the only type of exemption the MTRB can offer is an exemption from needing to comply with a certain technical requirement.

This has no bearing on the ability to register something as a ship, yet it does suggest that the MTRB could play an active role in determining the requirements with which unmanned cargo ships must comply once registered in Canada.

1.4 Under your national merchant shipping law, could either of the following constitute the unmanned ship’s “master”

1.4.1 The chief on-shore remote-controller

1.4.2 The chief pre-programmer of an autonomous ship

1.4.3 Another “designated” person who is responsible on paper, but is not immediately involved with the operation of the ship

No, a remote person cannot constitute a "master" for compliance purposes under the CSA. However, it is an open question whether a remote person could be imbued with the liabilities of a "master" in tort or in violation of other statutory obligations.

On its face, the definition of a master in section 2 of the CSA appears to allow for a master that is not physically on board the vessel. It simply defines a master as "the person in command and charge of a vessel".

However, both the *CSA* and its accompanying *Marine Personnel Regulations* (the "MPRs") appear to preclude a master from either a) operating an unmanned ship or b) operating it without being on board.

Under the *CSA*, section 82(2) prohibits a master from operating a vessel unless it "is staffed with a crew that is sufficient and competent for the safe operation of the vessel". While one could argue that an unmanned cargo ship can safely operate with a crew of 0, there is a clear intent that every vessel have some complement of an on board crew. This precludes a master from operating an unmanned ship.

Under the *MPRs*, section 207 (or section 241 for a foreign vessel) requires that every vessel have a minimum complement of crew on board. For an unmanned cargo ship as defined for these questions, this minimum includes the master, a chief mate, a person in charge of machinery, person(s) required to keep watch, and various others depending on the make-up of the vessel. This precludes a master from operating a vessel without being on board, and without other crew being on board.

Additionally, the *CSA* contains various duties and authorities of a master, many of which could only be performed by someone physically on board. These include:

- ensuring that a Canadian vessel flies the Canadian flag (s. 64(2));
- in the case of a Canadian vessel, ensuring the presence on board of all required certificates (s. 107);
- on all vessels, ensuring the safety of persons on board, including stevedores using on-board equipment (s. 109(1));
- on all vessels, ensuring compliance with load lines (s. 110(2));
- on all vessels, ensuring compliance with directions of marine safety inspectors (s. 111);
- on all vessels, giving notice of dangerous conditions, including ice, derelicts or weather, to other vessels and to authorities ashore (s. 112);
- for all vessels, rendering assistance to the other vessel if there has been a collision (s. 148); and
- for all vessels, complying and ensuring compliance by others with directions of persons, e.g. inspectors, classification societies, conducting inspections (s. 211(4)).

Without regulatory reforms, a master cannot meet his or her obligations under the *CSA* or the *MPPRs* without being on board.

We are unaware of any case law addressing the identification of a remote person as a "master" under Canadian maritime law more generally. Thus, it is an open question whether such a person could have tort liability as a "master" for duties to navigation, whether he could claim a maritime lien, or whether he might be exposed to regulatory or pseudo-criminal penalties under other statutes.

For example, a master has responsibilities to guard against the improper disposal of substances pursuant to section 124 of the *Environmental Protection Act, 1999* and a "master" is required to ensure that no person deposits a substance harmful to migratory birds, pursuant to section 5.1 of the *Migratory Birds Convention Act, 1994*. In the case of the latter legislation, the "master" and other prescribed people (on shore) are vicariously liable where a vessel commits an offence, if they "directed, authorized, assented to, acquiesced in or participated in the commission of the offence" (s. 13.12(1)). As in the case of the *CSA*, the "master" is not defined to be a person on board, although it might be presumed from context.

1.5 Could other remote-controllers constitute the "crew" for purposes of your national merchant shipping laws?

No.

Under the aforementioned sections of the *MPPRs*, many officers and crew in addition to the "master" are required to make up the minimum complement on board a vessel.

2.1 Do you foresee any problems in treating unmanned ships as "vessels" or "ships" under the Law of the Sea in your jurisdiction (ie, that such ships would be subject to the same rights and duties such as freedom of navigation, rights of passage, rights of coastal and port states to intervene and duties of flag states) in the same way as corresponding manned ships are treated?

Not insofar as Canadian domestic law applies.

This is considered a matter of public international law, specifically the interpretation and application of UNCLOS. That said, Canadian marine safety officials have statutory powers under the *CSA* to deny entry into Canadian waters of any vessels which they believe "might discharge a pollutant" (s. 175.1), and to detain vessels which they believe are "unsafe" or "not seaworthy" (s. 222).

Therefore, if unmanned cargo ships were felt to represent a pollution risk or a safety risk, Canadian domestic law does in theory deny rights of passage to those vessels.

2.2 Paragraphs (3) and (4) of UNCLOS Article 94 include a number of obligations of flag states with respect to the manning of ships. Do you think that it is possible to resolve potential inconsistencies between these provisions and the operation of unmanned ships without a crew on board through measures at IMO (under paragraph (5) of the same Article) or do you think other measures are necessary to ensure consistency with UNCLOS. If so, what measures?

There have been various scholarly articles written regarding the interplay between UNCLOS and IMO. As a result, the answer to this question is largely a subjective one, and would likely vary based on one's view of the role of the IMO (i.e. to implement standards of the kind

mentioned by UNCLOS, or to use UNCLOS as a standard for determining and implementing its own standards).

As noted in the question, there is an inconsistency between the requirement in UNCLOS that ships ought to be manned with a master and crew, and the suggestion that IMO can be used to regulate unmanned ships. The only way this could be accomplished solely through IMO would be to accept that IMO can operate outside of the language of UNCLOS. Again, acceptance of this premise would vary depending on one's views of IMO's role.

It is beyond the scope of the writer to provide a definitive opinion on this point. Suffice it to say, operating an unmanned cargo ship without amending UNCLOS (or having some sort of interpretative declaration regarding its applicability to unmanned ships) would appear to be in violation of UNCLOS. Addressing this through IMO would only be as good as the maritime community's acceptance of its legitimacy.

3.1 Does your national law implementing the safe manning requirement in Regulations 14 of Chapter V of SOLAS require at least a small number of on board personnel or does the relevant authority have the discretion to allow unmanned operation if satisfied as to its safety?

Please see the answers to questions 1.3 – 1.5.

3.2 Regulation 15 of SOLAS Chapter V concerns principles relating to bridge design. It requires decisions on bridge design to be taken with the aim of, inter alia, "facilitating the tasks to be performed by the bridge team and the pilot in making full appraisal of the situation ...". In the context of a remote controlled unmanned ship, could this requirement be satisfied by an equivalent shore-based facility with a visual and aural stream of the ship's vicinity?

Presumably, if unmanned cargo ships are to be permitted under Canadian domestic law, the technical systems required to support such permission would include (yet not be limited to) bridge design issues under Regulation 15 of SOLAS Chapter V. Regardless of whether a ship is manned, it is also presumed that it would have a bridge. There is no apparent reason why an unmanned cargo ship could not have its bridge designed in such a way that facilitates any tasks to be performed.

That said, Regulation 15 of SOLAS Chapter V is drafted in such a way that assumes a minimum complement on board a ship. As noted in MCA Guidance Note 3 on the SOLAS web site, the intent of Regulation 15 is to facilitate completion of the same sort of tasks described in answer 1.4, which require a physical presence on board the ship.

MCA Guidance Notes 1, 6 and 7 also state that Regulation 15 is particularly important for masters while operating a ship. As we know from answer 1.4, Canadian domestic law appears to require that a master be on board any ship.

3.3 As interpreted under national law, could an unmanned ship, failing to proceed with all speed to the assistance of persons in distress at sea as required by Regulation 33 of SOLAS Chapter V, successfully invoke the lack of an on-board crew as the reasons for omitting to do so (provided that the ship undertook other measures such as relaying distress signals etc.)?

Not without an exemption.

In Canadian domestic law, the statutory requirements to assist vessels or persons in distress are interpreted to be mandatory. The relevant portions of the CSA are worded similarly to Regulation 33 of SOLAS Chapter V, and read as follows:

130(2) On being informed that a person, a vessel or an aircraft is in distress or is missing in Canadian waters or on the high seas off any of the coasts of Canada under circumstances that indicate that they may be in distress, a rescue coordinator may

(a) direct all vessels within an area that the rescue coordinator specifies to report their positions;

(b) direct any vessel to take part in a search for that person, vessel or aircraft or to otherwise render assistance;

(c) give any other directions that the rescue coordinator considers necessary to carry out search and rescue operations for that person, vessel or aircraft;

...

(3) Every vessel or person on board a vessel in Canadian waters and every vessel or person on board a vessel in any waters that has a master who is a qualified person shall comply with a direction given to it or them under subsection (2).

131(1) Subject to this section, the master of a vessel in Canadian waters and every qualified person who is the master of a vessel in any waters, on receiving a signal from any source that a person, a vessel or an aircraft is in distress, shall proceed with all speed to render assistance and shall, if possible, inform the persons in distress or the sender of the signal.

(2) If the master is unable or, in the special circumstances of the case, considers it unreasonable or unnecessary to proceed to the assistance of a person, a vessel or an aircraft in distress, the master is not required to proceed to their assistance and is to enter the reason in the official log book of the vessel.

(3) The master of any vessel in distress may requisition one or more of any vessels that answer the distress call to render assistance. The master of a requisitioned vessel in Canadian waters and every qualified person who is the master of a requisitioned vessel in any waters shall continue to proceed with all speed to render assistance to the vessel in distress.

Failure by any vessel to comply with these requirements is punishable by fine and potential imprisonment.

Although there is scant case law on this issue, there is nothing to suggest that the absence of a crew would serve as a defence under Canadian domestic law. An unmanned cargo ship certainly could not consider its unmanned nature to be a special circumstance, as the lack of crew would be an ordinary circumstance.

It is also unlikely that such a ship could use its lack of crew as proof that it is unable to respond. Even if a ship had no crew that could offer rescue services, such a ship could presumably carry supplies to be used during or in the aftermath of a rescue. The fact that an unmanned cargo ship might have a pre-loaded voyage plan or that it might face difficulty in altering its course

would not be a strong defence, as this arguably applies to manned ships as well and they are required to respond to persons in distress.

In fact (although this is mere speculation), one could anticipate that the requirement to respond to distress would be *heightened* for an unmanned cargo ship. If we are beginning to enter into an era of increasingly unmanned ships that lack the traditional ability to assist, one can assume that the relevant regulatory bodies will want to ensure that such ships can meaningfully respond to distress signals, rather than finding a way to exempt them from responding.

4.1 Would the operation of an unmanned “ship” without any on board personnel, per se, be contrary to the duty/principle of “good seamanship” under the COLREGS, as interpreted nationally, regardless of the safety credentials of the remote control system?

No.

There is no Canadian case law to suggest that “good seamanship” requires that a ship be manned. Based on the description of an unmanned cargo ship used for the purpose of these questions, such a ship would either be controlled remotely or programmed with a collision avoidance system. Provided the individual or system in charge of collision avoidance causes the ship to act in the same manner as manned ships are expected to act (which varies based on the circumstances), the standard of good seamanship can presumably be met.

That said, there is a set of regulations in Canadian domestic law known as the *Collision Regulations*, enacted under the *CSA*. These regulations, among other things, adopt the COLREGS into Canadian domestic law. This includes not just the principle of “good seamanship”, but the technical requirements for all lights, shapes, sound-signaling appliances and radar reflectors. They also require that the authorized representative and the master of any ship ensure that the ship carry proof of compliance for all lights, shapes, sound-signalling appliances and radar reflectors. See answer 1.4 for a discussion of the difficulties could arrive if an unmanned cargo ship experiences difficulties with these requirements without having anyone on board to correct them.

4.2 Would the autonomous operation of a “ship”, without any on-board personnel or any human supervision, be contrary to the duty/principle of “good seamanship” under the COLREGS, as interpreted nationally, regardless of the safety credentials of the autonomous control system?

See answer 4.1.

4.3 As interpreted under national law, could the COLREG Rule 5 requirement to maintain a “proper lookout” be satisfied by camera and aural sensory equipment fixed to the ship transmitting the ship’s vicinity to those “navigating” the ship from the shore?

Unknown, but likely.

There does not appear to be any Canadian case law considering whether a “proper lookout” can be carried out remotely. The case law that does interpret the meaning of a “proper lookout”² describes the following requirements:

- visual lookout;
- aural lookout;
- intelligent interpretation of data received from electronic navigational aids; and
- an unobstructed view.

All of these requirements could be met remotely.

Furthermore, based on the plain wording of COLREG Rule 5, it is possible for camera and aural sensory equipment to meet the requirement that lookouts be maintained “by sight and hearing”. There is nothing in COLREG Rule 5 that specifically calls for these tasks to be carried out by an on board crew member.

4.4 Would a ship navigating without an on-board crew constitute a “vessel not under command” for purposes of COLREG Rule 3(f), read together with COLREG Rule 18, as interpreted under your national law?

Unknown, but unlikely.

Again, there does not appear to be any useful Canadian case law considering whether an unmanned ship is a “vessel not under command”³.

Based on its plain wording, an unmanned cargo ship does not meet the requirements under COLREG Rule 3(f). Rule 3(f) requires that such a ship be “unable to manoeuvre” due to “exceptional circumstances”. In the ordinary course, an unmanned cargo ship would presumably be able to manoeuvre, and even if it is not due to a pre-loaded voyage plan or some other part of the ship’s design, this would not meet the threshold of being exceptional (which is reserved for events such as machinery failure, fire, flooding, etc).

5.1 The STCW Convention purports to apply to “seafarers serving on board seagoing ships”. Would it therefore find no application to a remotely controlled unmanned ship?

Correct.

There is nothing to suggest that the STCW Convention would apply in the context of an unmanned cargo ship. However, one might suspect that the STCW Convention will be amended or re-thought as we enter an era of increasingly unmanned ships.

² See *Atkinson (Guardian of) v. Gypsea Rose (Ship)*, 2014 BCSC 1017 for a recent and thorough analysis.

³ The aforementioned *Atkinson* decision does state that a ship with its engine turned off and no one at the helm may be considered “not under command”, yet this is not applicable to our circumstances. The only other Canadian decision – *Clackamas v. Cape D’Or*, [1926] 1 D.L.R. 384 (S.C.C.) – is not useful in light of the wording of Rule 3(f).

5.2 As interpreted under national law, can the STCW requirement that the watchkeeping officers are physically present on the bridge and engine room control room according to Part 4 of Section A-VIII/2 be satisfied where the ship is remotely controlled? Is the situation different with respect to ships with a significantly reduced manning (bearing in mind that the scope of the convention only applies to seafarers on board seagoing ships)?

As described in answer 5.1, the STCW Convention would not apply to unmanned cargo ships.

6.1 Suppose a “ship” was navigating autonomously ie through an entirely computerised navigation/collision avoidance system and the system malfunctions and this malfunction is the sole cause of collision damage – broadly, how might liability be apportioned between the shipowner and the manufacturers of the autonomous system under your national law?

While it is not possible to give a definitive opinion on liability without a complete set of facts, the governing statutory authority in Canada is the *MLA*, and in particular Part 2.

Section 17(1) of the *MLA* tritely states that liability is proportionate to the degree of fault borne by each negligent party. If it is not possible to determine the degree to which two or more negligent parties are at fault, liability is split equally.

Broadly speaking, and without breaking down the various types of damage for which the shipowner could be held liable and the various types of contractual arrangements that could shift liability, it is possible that the shipowner could avoid liability. Unless the shipowner acted negligently in choosing the navigation system, installing it, maintaining it, inspecting it, or selecting its operator, it is conceivable that the system could have failed solely due to a manufacturing flaw unrelated to the acts or failure to act of the shipowner.

Absent additional facts, the best that can be said at this juncture is that the shipowner would bear liability proportionate to its degree of fault, or equally if the proportion cannot be determined, in the event that it contributed to the cause of the system malfunction.

6.2 Arts. 3 and 4 of the 1910 Collision Convention provide for liability in cases of fault. As interpreted under your national law, does the fact that the non-liability situations listed in Art. 2 are not conversely linked to no-fault, leave room for the introduction of no-fault (ie strict) liability (eg for unmanned ships) at a national level?

The 1910 Collision Convention is no longer part of Canadian domestic law, as it is not among the Conventions listed in Schedule 1 of the *CSA* as those which are applicable in Canada.

Therefore, the imposition of strict liability on unmanned cargo ships in Canada would be a matter for future legislative action, if thought appropriate.

ADDITIONAL CANADIAN COMMENTS

1. Navigation in Ice

It is presumed that unmanned cargo ships would not be deployed to waters where (internationally) the *Polar Code* applies or (domestically, i.e. the Canadian Arctic north of 60°N latitude) the *Arctic Waters Pollution Prevention Act* applies. Therefore, issues of equipping and manning which arise under those regimes have not been considered.

However, in some waters of eastern Canada south of 60°N, ice may still be encountered. In such cases, Canadian requirements may mitigate against use of unmanned cargo ships in those waters during seasons when ice may be present. Again, this has not been considered.

Transport Canada has issued guidance publications TP15163 (2015), "Joint Industry-Government Guidelines for the Control of Oil Tankers and Bulk Chemical Carriers in Ice Control Zones of Eastern Canada" and TP8941 (1987), "Interim Standards for the Construction, Equipment & Operation of Passenger Ships in the Sea", applying to all laden tankers and to passenger ships registered in Canada or licenced to participate in Canada's coasting trade. Both require, among other things, the on board presence in certain circumstances of ice advisors (TP15163, section 5.0; TP8941, sections 4-7). This requirement appears to inferentially require the on board presence of crew to receive the advice.

Parenthetically, this also raises the issue of compulsory pilotage anywhere in the world, and how those requirements may be met by unmanned cargo ships.

Coming back to navigation in ice in Canada, it may also be the case that tankers and passenger ships are unlikely to be unmanned ships, and so the requirements of these guidance documents may not be especially relevant. However, quite apart from the aforementioned guidelines and legislation, there are Canadian regulations which apply to all ships in all waters that recognize the need to plan for the potential of ice travel.

In particular, Canada's *Marine Machinery Regulations*, Schedule VII, Part 4, Division IV reads as follows:

(1) For ships required to operate in ice-covered waters where ice may choke sea-water inlets, maintenance of essential sea-water supply shall be maintained by

(a) diversion arrangements for warmed cooling water from overboard discharges into sea- water inlet boxes;

(b) means to clear sea-water inlet boxes, preferably by steam that has a pressure not in excess of the design working pressure of the sea-water inlet boxes and that is vented to the upper deck by means of a valved pipe; and

(c) ensuring sea-water inlet strainers have

(i) perforations approximately 20 mm in diameter to prevent ingestion of large ice particles, and

(ii) a strainer perforated area approximately 5 times the total cross-sectional area of the inlet pipes being served to ensure full fluid flow in slush ice conditions.

Although it may be technically possible that remotely or autonomously controlled engine rooms could comply with these requirements, it seems that the required attention is more likely to be provided through human interventions, thus requiring a manned engine room. In effect, this means that any ship that might travel through ice-covered waters (regardless of whether the ship is traveling north of 60°N latitude) likely requires some form of manned complement on board.

For further information on these points, see the Transportation Safety Board of Canada Marine Investigation Report M14A0051 at pages 16-18, and more generally Canadian Coast Guard

publication *Ice Navigation in Canadian Waters* (Rev August 2012) at <http://www.ccg-gcc.gc.ca/folios/00913/docs/ice-navigation-dans-les-galces-eng.pdf>.

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