

# CMI INTERNATIONAL WORKING GROUP POSITION PAPER ON UNMANNED SHIPS AND THE INTERNATIONAL REGULATORY FRAMEWORK

## 1. Introduction

Unmanned ships are those which are capable of controlled movement on the water in the absence of any onboard crew. Instead, control is performed in essentially two ways.<sup>1</sup> It can be performed by remote-control, whereby a shore-based remote controller uses a laptop computer and joystick to control the unmanned ship's movement and signalling using radio and satellite communications. In doing so the controller is aided by the streaming of the ship's vicinity effected by cameras and aural sensors fitted to the ship's hull / chassis. On the other hand, the ship may be "controlled" autonomously. This involves the ship being pre-programmed before deployment (or before setting sail), and, thereafter, performs a predetermined nautical course without any human interaction whatsoever. This control, as well as a degree of collision avoidance capability, is affected with the use of highly sophisticated software technology, control algorithms and sonar radar. There are other control methods between these two modes of operation although, as will be seen, it is this binary distinction which is relevant from the point of view of regulatory compliance. It is also important to note that both of these modes of operation may be used consecutively on the same voyage, depending on the ship's operational itinerary. For the purposes of this paper "unmanned" refers to both "remote controlled operation" as well as "autonomous operation". These will be referred to individually where a distinction is drawn. Autonomous ships may be either supervised or unsupervised by a shore-based remote controller. This distinction will be drawn where relevant.

At present the operational usage of unmanned ships is modest when compared to their manned counterparts. They are presently used predominantly by the marine scientific research communities and also the defence sector for a broad range of marine operations. Today's unmanned ships are also comparatively modest in size, with even the largest of unmanned ships seldom extending beyond 15-20m in length. However, this is about to change. Prototypes are currently being developed by a range of protagonists to develop unmanned containers carriers and passenger liners of comparable size and operational capability with manned ships performing these functions.

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<sup>1</sup> This is a simplification to assist analytical expression. There are many different formulations of the levels of autonomy, see e.g. See A Serdy, M Tsimplis, R Veal et al, *Liability for Operation in Unmanned Maritime Vehicles with Differing Levels of Autonomy*, (European Defence Agency, Brussels, 2016). To obtain a copy, please contact Mr. Paul O'Brien of the EDA at [paul.obrien@eda.europa.eu](mailto:paul.obrien@eda.europa.eu). This study refers to the levels of autonomy established by the SARUMS Group. These are (0) Human on board; (1) Operated; (2) Directed; (3) Delegated; (4) Monitored and (5) Autonomous.

The exponentially developing nature of this unmanned technology makes regulatory preparedness an ever more pressing concern, not least because, at least in some types of operation, although there are obvious risks, there are also clear safety advantages to the exploitation of unmanned technology in carriage operations which come in the form of not having to expose seafarers to the still formidable perils of the seas.

## **2. The Regulatory Framework**

Maritime law is a functional term used for describing a whole range of laws and other sources that govern the legal framework related to ships and their operation. It includes a variety of different legal systems, ranging from international law to regional and national rules and down to local rules. It covers issues of public concerns, such as safety, security and environmental protection as well as civil law matters, such as contracts of carriage, liability and compensation for damage, salvage and rules related to marine risks and insurance, to name but a few.

The prospect of unmanned ships addresses a very fundamental feature in shipping – the role of the master and crew on board a ship – and will hence affect a multitude of laws and regulation across the whole range of maritime law.

The focus of this paper is on the international (global) rules. Three main kinds of such rules need to be distinguished. First, there are jurisdictional rules, which lay down states' rights and obligations to take measures with respect to ships. These are mainly laid down in the 1982 UN Convention on the Law of the Sea (UNCLOS), which is discussed in section 3. Second, the technical rules covering safety, environment and training and watchkeeping standards etc. are discussed in section 4. They are usually adopted by specialized UN agencies, such as, notably, the International Maritime Organization (IMO). Third, a series of international rules have been established in the field of private law to harmonise issues such as shipowners' civil liability for pollution, collisions or cargo-related losses and how such claims may be enforced. These rules are not as complete or widely ratified as the public law conventions discussed in sections 3 and 4 and may therefore be subject to greater national variation. The main relationships of these liability rules to unmanned shipping are discussed in section 5.

## **3. Law of the Sea**

### **3.1 General**

The law of the sea deals with the rights and obligations of states over the seas. As far as shipping is concerned, the key issues addressed by this body of law include: to what extent ships can navigate in different sea areas; what obligations do states have over ships flying their flag; and what rights do other states have to interfere in the navigation of ships in different sea areas?

Today's law of the sea governing navigation is more stable than ever before in history. The 'Constitution for the Oceans', UNCLOS, enjoys a widespread formal acceptance worldwide (169 contracting parties) and its provisions concerning navigational rights and duties are widely accepted as representing customary law (and hence apply to non-parties as well). The convention lays down the rules on establishment and delimitation of maritime zones and includes detailed rules for each zone with respect to states' rights and obligations.

A first – and fundamental – question to be resolved is whether ships without a crew on board are 'ships' or 'vessels' within the meaning of the convention at all. The two terms are used interchangeably in UNCLOS, but neither is defined. Article 91 provides that each state shall fix the conditions for the grant of its nationality to ships, which implies that the national law of the flag state will be critical for the definitions used. It does, however, follow from the nature of the activities carried out by large, self-propelled, cargo-carrying, commercially-operated unmanned ships that they probably will have to be regarded as vessels/ships by virtue of their size, features and functions. Existing international conventions that define the term ship do not include references to crewing<sup>2</sup> and at national level, too, the definition of a ship is usually disconnected from the question of whether or not the ship is manned.<sup>3</sup> It would also seem unjustified that two ships, one manned and the other unmanned, doing similar tasks involving similar dangers would not be subject to the same rules that have been designed to address those dangers.

From the assumption that unmanned ships are 'ships' and 'vessels' within the meaning of UNCLOS, it follows that they are subject to the same rules of the law of the sea as any ordinarily manned ship. The same obligations apply to unmanned ships and their flag states with respect to compliance with international rules. On the other hand, they also enjoy the same passage rights as other ships and cannot be refused access to other states' waters merely because they are not crewed.

### 3.2 Flag State Jurisdiction

Flag state jurisdiction represents the traditional cornerstone of the regulatory authority over ships. UNCLOS establishes that all states have a right to sail ships flying their flag and to fix the conditions for granting nationality to ships (Articles 90 and 91(1)). However, the convention also includes a number of detailed duties for flag states.

Every state has the obligation to "effectively exercise its jurisdiction and control

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<sup>2</sup> E.g. study by Professor Sozer, attached to CMI Working Group on Ship Nomenclature, (available at

[www.comitemaritime.org/Uploads/Work%20In%20Progress/Ship%20Nomenclature/Ltr%20to%20Presidents%20re%20IWG%20on%20Vessel%20Nomenclature%20-%20080316.pdf](http://www.comitemaritime.org/Uploads/Work%20In%20Progress/Ship%20Nomenclature/Ltr%20to%20Presidents%20re%20IWG%20on%20Vessel%20Nomenclature%20-%20080316.pdf)).

analyses the definition of the terms in almost 20 key maritime conventions. Not a single one of these instruments links the definition of ship to the presence of crew on board.

<sup>3</sup> See A Serdy, M Tsimplis, R Veal et al, *Liability for Operation in Unmanned Maritime Vehicles with Differing Levels of Autonomy*, (European Defence Agency, Brussels, 2016). To obtain a copy, please contact Mr. Paul O'Brien of the EDA at [paul.obrien@eda.europa.eu](mailto:paul.obrien@eda.europa.eu).

in administrative, technical and social matters over ships flying its flag” (Article 94(1)), including to “assume jurisdiction under its internal law over each ship flying its flag and its master, officers and crew in respect of administrative, technical and social matters concerning the ship” (Article 94(2)(b)). The flag state shall also “take such measures ... as are necessary to ensure safety at sea with regard, inter alia, to ... the manning of ships, labour conditions and the training of crews, taking into account the applicable international instruments” (Article 94(3)(b)), including measures necessary to ensure “that each ship is in the charge of a master and officers who possess appropriate qualifications, in particular in seamanship, navigation, communications and marine engineering, and that the crew is appropriate in qualification and numbers for the type, size, machinery and equipment of the ship” (Article 94(4)(b)). When adopting these measures each flag state is required “to conform to generally accepted international regulations, procedures and practices and to take any steps which may be necessary to secure their observance” (Article 94(5)).

UNCLOS, in other words, generally avoids the need to formulate more precise obligations of flag states by referring to an abstract, and continuously changing, set of international rules to be developed elsewhere. In this way it avoids ‘freezing’ the requirements at a given point in time or at a given technical level, while still preserving the international character of the rules in question. The more precise extent of flag states’ obligations is hence left to be developed by the IMO in particular.

### 3.3 Port and Coastal State Jurisdiction

While the flag state’s jurisdiction applies irrespective of the ship’s location, other states’ parallel jurisdiction over the same ship depends on the maritime zone concerned. The coastal state’s authority over a foreign ship increases with the proximity of the ship to its shores.

If the ship is voluntarily present in one of its **ports or internal waters**, the coastal/port state has broad jurisdiction over foreign ships. Internal waters form part of the sovereignty of the state (Article 2) and in the absence of specific limitations, the jurisdiction over foreign ships in this area is therefore complete. Moreover, ships have no general right to access foreign ports and the port state’s wide discretion to place entry conditions for foreign ships is widely acknowledged, including in UNCLOS Articles 25(2), 211(3) and 255. In other words, a port state may (unless it has accepted specific obligations to the contrary) refuse unmanned ships access to its ports or internal waters, provided that the refusal complies with certain more general criteria of reasonableness that exist in general international law, such as non-discrimination, proportionality between the measure and its objective and that the prohibition does not constitute an abuse of right (Article 300). This may turn out to be a significant limitation of the freedom of movement of unmanned ships, but the potential limitation is by no means unique to unmanned ships.

With respect to ships passing through its **territorial sea** (which may extend up to 12 nautical miles from the coastline/baseline), the rights of coastal states are

more limited. Under a longstanding principle of the law of the sea, all ships enjoy a right of 'innocent passage' through other states' territorial seas. Passage is deemed to be innocent as long as it is not "prejudicial to the peace, good order or security of the coastal state" (Article 19(1)). A list of activities that meet those criteria is given in Article 19(2), but as the list focuses on ships' *activities* (such as use or threat of force, military activities, fishing activities or wilful and serious pollution) questions related to a ship's manning will not as such render passage non-innocent under the wording of UNCLOS.

Regarding the coastal state's legislative jurisdiction, Article 21(2) provides that a state may not impose its national requirements on the construction, design, equipment or manning of foreign ships in its territorial sea, unless those requirements are giving effect to "generally accepted international rules and standards" (Article 21(2)). Independently of what laws the coastal state has adopted, it may not "impose requirements on foreign ships which have the practical effect of denying or impairing the right of innocent passage" (Article 24(1)(a)). The right of innocent passage extends to ships that may be deemed to pose a particular risk for the coastal state, such as tankers and nuclear-powered ships and ships carrying nuclear or other inherently dangerous or noxious substances (Articles 22(2) and 23).

The areas of a coastal state's territorial sea which form part of a '**strait used for international navigation**' are subject to even more limitations for coastal states (and correspondingly stronger passage rights for ships). There are different kinds of such straits, but many of the most important straits that are completely covered by the bordering straits' territorial seas, such as the Straits of Dover and Malacca, are subject to the regime of 'transit passage', where ships' right of passage are granted and may not even be temporarily suspended by the bordering states (Articles 37-44). Many other important straits, including the Danish and the Turkish Straits, are governed by long-standing international conventions which guarantee the navigational rights of foreign ships (Article 35(c)).

The jurisdiction to prescribe national requirements is even more limited with respect to ships sailing in the **exclusive economic zone (EEZ)**, which may extend beyond the territorial sea, up to a maximum of 200nm from the coastline/baseline. In this zone freedom of navigation for all states applies, subject to having due regard to the interest of other states (Article 58). The most express prescriptive jurisdiction of coastal states over foreign ships in the EEZ concerns laws aiming at the protection of the marine environment and even here, coastal states' jurisdiction is limited to prescribing rules that give effect to international rules (Article 211(5)). Similarly, enforcement measures are limited to requiring information (Art. 220(3)), save for the most serious cases of pollution and damage where the coastal state may exceptionally interfere in the passage (220(5)).

In sea areas which lie beyond the jurisdiction of any coastal state, **the high seas**, the starting point is that the flag state alone has jurisdiction over the ship. A

number of exemptions to this main rule exist, but none of them is relevant for the question of navigational rights of unmanned ships.

### **3.4 Other relevant provisions in UNCLOS**

Apart from the jurisdictional provisions, certain other UNCLOS provisions may turn out to be problematic for unmanned ships. The obligation set out in Article 94(4)(b) that each ship needs to have a (properly qualified) master and a crew has been mentioned above. While this requirement may arguably be met in case of remotely operated ships, it is less obvious how a fully automated ship would qualify. Since unmanned shipping operations will often involve differing degrees of automation, depending on sea areas, traffic density etc., further clarifications of this obligation may be needed, at least at the level of the 'generally accepted international regulations, procedures and practices' (Article 94(5)).

Another UNCLOS provision which presumes a crew on board is the obligation of the *master* to render assistance to persons in danger or distress according to Article 98(1) (as specified in SOLAS Regulation V/33). The rule would find no application to the extent that an unmanned ship has no *master*, although this is little comfort since this an express requirement of Article 94(4)(b) UNCLOS, as stated above. The communication part of the duty can presumably be met by remotely operated ships with relayed radio communications, but it is less clear how physical assistance can be rendered by a ship without a crew on board. The duties include qualifications by reference to "in so far as he can do so without serious danger to the ship" or "in so far as such action can be reasonably expected of him" which will probably reduce the extent of obligations for unmanned ships, as the available options will be fewer. However, the absence of a crew does not in itself obviate the duty to provide assistance to the extent necessary and reasonable.

## **4. Technical Requirements**

### **4.1 General**

There are over 50 IMO international shipping regulations and conventions in force today. The majority of the obligations imposed by IMO regulations are imposed on flag states, and these states must discharge these obligations by prescribing enforceable domestic shipping legislation reflecting the internationally agreed standards. State legislatures often delegate the tasks of enforcement of the domestic regulations to expert governmental maritime administrations or authorities. These administrations may not always have all the necessary technical expertise to cover every aspect of marine activity and hence essential expertise is also provided by classification societies. It will be seen that considerable discretion is afforded to the relevant maritime administrations and classification societies, particularly in terms of the adequacy of alternative compliance. Thus, each will play an integral role in the applicability of prescribed technical requirements to unmanned ships.

The following is not a comprehensive review of the application of IMO regulations to unmanned ships but instead an exploration of some of those regulations most pertinent in the context of the conduct of navigation of unmanned ships, both remote controlled and autonomous. These will be the essential initial regulatory hurdles to be negotiated if unmanned shipping is to become widespread. The analysis will consider the International Convention for the Safety of Life at Sea, 1974 (SOLAS), the International Regulations for the Preventing of Collisions at Sea, 1972 (COLREGS) and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention). It will consider both applicability of these regulations to unmanned ships and the ability of such ships to comply with them, as well as how the relevant level of unmanned ship autonomy impacts upon the position.

#### **4.2 The International Convention for the Safety of Life at Sea, 1974 (SOLAS)**

The International Convention for the Safety of Life at Sea obliges contracting states to ensure minimum standards, in particular, in construction, equipment and operation with the view to ensuring the safety of life at sea. The SOLAS Convention is supplemented by a highly detailed annex which spans twelve chapters. These include: Chapter I *General Provisions* (including definitions); Chapter II-1 *Construction* (including structure, subdivision and stability, machinery and electrical installation); Chapter II-2 *Fire Protection, Fire Detection and Fire Extinction*; Chapter III *Life Saving Appliances and Arrangements*; Chapter IV *Radiocommunications*; Chapter V *Safety of Navigation*; Chapter VI *Carriage of Cargoes*; Chapter VII *Carriage of Dangerous Goods*; Chapter VIII *Nuclear Ships*; Chapter IX *Management the Safe Operation of Ships*; Chapter X *Safety Measures for High Speed Craft*; Chapter XI *Special Measures to Enhance Maritime Safety* and Chapter XII *Additional Safety Measures for Bulk Carriers*.

##### *Chapter I – General Provisions*

It can be assumed that, in general, the provisions of SOLAS would find application to unmanned ships to the extent that they are flagged and engaged on international voyages.<sup>4</sup> SOLAS prescribes no general definition of “ship” and so unmanned operability presents no impediment to applicability. Instead, SOLAS refers to “cargo ships” defined broadly as any ship which is not a passenger ship i.e. a ship not carrying at least 12 passengers.<sup>5</sup> Importantly, the Convention and its Annex generally find no application to ships of less than 500 gross registered tons (grt) although this is subject to the specific applicability provisions in each chapter.<sup>6</sup>

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<sup>4</sup> Defined in 2(d) as “voyage from a country to which [SOLAS] applies to a port outside such a country, or conversely”.

<sup>5</sup> Regulation 2(g).

<sup>6</sup> Regulation 3(a)(2).

SOLAS is not without flexibility. A Contracting Government may exempt from compliance with the provisions in Chapters II-1, II-2, III and IV those ships which “embod[y] features of a novel kind” to the extent that the application of such provisions “might seriously impede research into the development of such features and their incorporation in ships engaged on international voyages”.<sup>7</sup> It can be argued that unmanned operability (both remote control and autonomous) constitutes a feature of a novel kind and therefore such ships may stand to benefit from this dispensation. Much depends on the attitude to the technology of domestic regulators. Further possibilities for the Contracting Government to grant exceptions to individual ships from the requirements of certain regulations are set out in the respective Chapters.

There is also considerable available “equivalence”. When a SOLAS provision calls for a “particular fitting, material, appliance or apparatus, or type thereof, [to] be fitted or carried in a ship, or that any particular provision [to] be made”, the relevant maritime administration may permit the use of alternatives to be carried if satisfied that these are at least as effective as the express provisions SOLAS prescribes.<sup>8</sup> It is doubtful that this would permit unmanned operability (to the extent that it is otherwise proscribed) since the ship’s crew which, of course, is traditionally carried on board, cannot be understood to be a “fitting, material, appliance or apparatus”.

#### *Chapter II-1 Construction*

Chapter II-1 deals with ships’ structure, subdivision and stability, machinery and electrical installations. Ship structural requirements do not, in general, present particular difficulty for unmanned operability. The chapter does, however, include requirements which necessitate considerations of equivalence in an unmanned context. For example, there is the Regulation 5-1 requirement that the ship’s “master ... be supplied with information ... as is necessary to enable him by rapid ... processes to obtain accurate guidance as to the stability of the ship under varying operating conditions”. This information must be vested in shore-based remote controllers at all times in the decision making loop.<sup>9</sup> The chapter also makes reference to the need for, by way of example, engineers’ alarms.<sup>10</sup> Whenever alarms designed to alert those in command of the relevant ship are required, the spirit of such rules requires alarms to similarly alert those remote controlling the ship from the shore. The spirit of such a regulation also requires autonomous ships to be capable of being brought under the immediate control of a remote-controller so that someone may act on the alarm signal. It should be noted that Regulation 55 of Chapter II-1 permits alternative design and arrangements in respect of machinery and electrical installations, subject to the prescribed evaluation and approval.

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<sup>7</sup> Regulation 4(b). Such ships however shall comply with other safety arrangements suitable for the ship’s intended service in the opinion of the Contracting Government.

<sup>8</sup> Regulation 5.

<sup>9</sup> See also Regulation 19, which requires the officer in charge of the ship to have access at all times, to damage control information.

<sup>10</sup> Regulation 38. See also Regulations 51 and 53(4).



### *Chapter II-2 Fire protection, Fire detection and Fire extinction*

Chapter II-2 also prescribes structural requirements but with the specific aim of safety from fire. The chapter also prescribes detailed requirements for fire detection through appropriate alarm systems.<sup>11</sup> Regulations 15 and 16 concern onboard training and drills and operations, respectively. These are aimed at ensuring personnel charged with command of the ship are prepared in the event of fire to combat and contain it. This presents challenges of equivalence in the context of an entirely shore-based crew. Nevertheless, even to the extent that a strict application of the chapter presents difficulty for unmanned operations, Regulation 4.1 gives the relevant maritime administration the ability to exempt individual ships from the requirements of the chapter if minded that its full application is “unnecessary or unreasonable” if the relevant ship is not to exceed a distance of 20 miles from the nearest land. This dispensation will be important since arguably much of the spirit of the chapter is aimed at the preservation from fire of onboard personnel and/or passengers, which may lack application in unmanned operations. This is an issue which must be addressed by those developing the technology for unmanned shipping as well as regulators. The chapter also permits the use of alternative design and arrangements to those expressly prescribed after the necessary evaluation and approval.<sup>12</sup>

### *Chapter III - Life Saving Appliances and Arrangements*

Chapter III prescribes the life-saving appliances to be carried on board the relevant ship and corresponding arrangements. It contains the same general exemption as Chapter II-2.<sup>13</sup> The chapter prescribes standards for onboard operations, such as maintenance;<sup>14</sup> again, consideration will be required as to its necessity and feasibility in an unmanned context. In the context of the carriage of passengers, however, passenger safety must be ensured to the same extent whether the ship is manned or unmanned. Some important requirements are, for instance, in the context of survival craft. Regulation 10 requires that “there shall be sufficient crew members, who may be deck officers or certified persons on board for operating the survival craft and launching arrangements.” Whilst the chapter permits the use of alternative design and arrangements to those set out in this chapter,<sup>15</sup> it will be very difficult for an unmanned ship carrying passengers to comply with this regulation without posting onboard personnel trained in evacuation procedures.

### *Chapter IV – Radiocommunications*

Chapter IV deals with radiocommunications and prescribes functional requirements for ships in the form of transmission capability. The chapter is exceptional in that it expressly applies to cargo ships of 300 grt upwards.<sup>16</sup> The

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<sup>11</sup> Regulation 7 Detection and Alarm.

<sup>12</sup> Regulation 17.

<sup>13</sup> Regulation 2.

<sup>14</sup> Regulation 36.

<sup>15</sup> Regulation 38.

<sup>16</sup> Regulation 1. It thereby deviates from the main Rule in Chapter I Regulation (3)(a)(ii) referred to above stating that SOLAS does not, as a starting point, apply to cargo ships of less than 500 grt.

chapter requires continuous watches to be kept on prescribed channels.<sup>17</sup> Regulation 16 expressly requires that every ship “carr[ies] personnel qualified for distress and safety radiocommunications”. This regulation presents difficulty for unmanned ships. From an equivalence standpoint, it is essential that the prescribed radiocommunications capabilities may be discharged by shore-based personnel. Again, the adequacy of any such arrangement will be subject to the satisfaction of the relevant maritime administration. Be it onboard or shore-based, the essence of the chapter speaks of human oversight. This presents acute difficulty for autonomous, unsupervised unmanned ships.

#### *Chapter V – Navigation*

For these purposes it is at least arguable that the most important regulation in Chapter V is **Regulation 14** on ships’ manning. The regulation requires that from the point of view of safety, all ships are “sufficiently and efficiently manned”. Contracting States are required to do this through the establishment of a transparent documentary procedure, i.e. ships’ manning documentation. The regulation does *not require* that at least one crew member be on board at any one time. Nevertheless, it can be questioned whether a requirement of manning adequacy necessarily prohibits unmanned operability, since an unmanned ship is not at all manned, by definition. On the other hand, it is clear that the adequacy of manning arrangements is a concept relative to the particular ship in question, and its particular capabilities. It can be argued that if a ship utilises highly innovative communications technology enabling it to manoeuvre as responsively as when under the command of a conventional onboard crew, an onboard crew numbering zero may be technically adequate.<sup>18</sup> Both interpretations are equally feasible. However, it seems unlikely that the wording of Regulation 14 *necessarily* proscribes unmanned operations outright and in all circumstances. The regulation’s aim is to establish a means by which the relevant administration may satisfy itself as to the safety credentials of a ship’s complement rather than calling for any particular mode of operability. However, gaining the approval of maritime administrations may prove very difficult, particularly in the early phases of unmanned operability and in the absence of bespoke and codified regulations for the particular operations.

Regulation 15 prescribes principles in relation to bridge design. The first principle is “facilitating the tasks to be performed by the bridge team and the pilot in making full appraisal of the situation...” In an unmanned shipping context, navigation will be performed from the shore but any substitute “electronic bridge” will need to comply with these principles if there is any prospect of addressing inevitable safety concerns and satisfying at least the spirit of this regulation. The same holds true for ships in autonomous mode, supervised with individuals qualified to assume remote-control of the ship immediately. A ship operating autonomously without any human oversight cannot comply with the Regulation. For such ships, there *is no* human appraisal (at least not contemporaneously). Regulation 22 prescribes minimum levels of visibility attainable on a ship’s bridge. It is true that a ship may be dually-

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<sup>17</sup> Regulation 12.

<sup>18</sup> IMO Resolution A.1047(27) provides that both level of ship automation and shore-based support may serve to reduce the relevant ship’s onboard crewing requirements.

operable, i.e. capable of both unmanned and conventional manned operation. In such case, both the on-board bridge and the electronic bridge would have to comply with the bridge design requirements. Dual operability may also aid in complying with the required pilot transfer arrangements in Regulation 23 by enabling qualified persons to board and undertake the pilotage operations. Otherwise, the pilot transfer would have to be done electronically and the port facility would have to have the facilities to assume remote control.

Another particularly significant regulation is Regulation 24 (Use of heading and / or track control systems). It requires that in “hazardous navigational situations” it shall be possible to establish “manual control of the ship’s steering immediately”. Even on the assumption that manual control may be performed remotely, unsupervised autonomous unmanned ships will not be able to comply with this regulation which requires officers to be able to control the ship’s movement immediately. In consequence, all unmanned ships must be supervised by qualified personnel capable of assuming manual control immediately.

Regulation 33 reiterates the obligation for the master of a ship, if in a position to do so, to proceed with all speed to the assistance of persons in distress at sea. For the duty to be of any relevance in an unmanned context, a member of the shore-side personnel controlling or supervising both remote controlled and autonomous ships must be deemed to be the unmanned ship’s master. To the extent that this is the case, it is clear that the obligation is not confined to taking persons on board. In an unmanned context the duty may be discharged by ensuring that any distress signals received are relayed to the relevant search and rescue authorities or retaining a proximate position to form a hub for communications. The requirement that persons taken on board be treated with humanity is qualified by the reasonable capabilities and limitations of the ship and it can be argued that this qualification applies to the duty more generally.<sup>19</sup> On balance, if a remote controller of an unmanned ship were to discover persons in distress and does nothing at all to satisfy himself that the appropriate authorities are informed, he is in breach at least of the spirit of the duty and such conduct would not augur well for unmanned ship integration into the more conventional maritime community.

Importantly, Regulation 3 (Exemptions and Equivalence) provides that maritime administrations may grant exemptions and equivalence when an absence of general navigational hazards and “other conditions affecting safety” are such to render a full application of Chapter V “unreasonable or unnecessary”. Specifically cited conditions are the duration of the voyage and the maximum distance of the ship from the shore. The extent to which an unmanned ship may rely on this flexibility will depend on its operational itinerary. Again, much will depend on the ability of a potential unmanned ship operator to convince the

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<sup>19</sup> Under Article 98 UNCLOS, the master’s duty to render assistance is qualified by the requirement that he can do so “without serious danger to the ship, the crew or the passengers”. The specific requirement to “to proceed with all possible speed to the rescue of persons in distress” is qualified by the more relaxed condition that he does so “in so far as such action may reasonably be expected of him”.

relevant authorities as to the safety of the alternative means by which the vessel will be commanded, be it remotely or autonomously.

#### *Chapter VI – Carriage of Cargoes and Oil Fuels*

Chapter VI deals mainly with operational requirements for the safe carriage of solid bulk cargoes. It contains special provisions for the carriage of such cargoes but also cargoes of grain. Regulation 2 requires the shipper to provide “the master or his representatives” information about the cargo. This function would need to be discharged by an alternative shore-based remote controller. Again, it is unclear the extent to which the performance of this function by a shore-based remote controller technically satisfies the requirement.

#### *Chapter VII – Carriage of Dangerous Goods*

The chapter seeks to ensure the safety of carriage of dangerous goods and requires their carriage to be in accordance with the International Maritime Dangerous Goods (IMDG) Code.<sup>20</sup> The chapter prescribes reporting requirements in respect of incidents involving such dangerous goods. The extent to which this may be discharged by shore-based personnel will depend on the surveillance technology enabling shore-based personnel to supervise stowed cargo.

#### *Chapter VIII – Nuclear Ships*

The chapter prescribes, inter alia, certification requirements in respect of nuclear ships. It has no unique relevance in the context of unmanned operations. Although, Regulation 3 states that a nuclear ship shall not, in any circumstances be exempted from compliance with “any regulations of [the] Convention”. Thus, any exemptions discussed in the context of SOLAS which unmanned ships may stand generally to benefit from will not be available in the context of unmanned nuclear ships

#### *Chapter IX – Management for the Safe Operation of Ships*

The chapter principally requires that the relevant “Company”<sup>21</sup> and ship comply with the requirements of the International Safety Management (ISM) Code. The ISM Code requires the shipowner or such person who has assumed responsibility for the ship to establish a safety management system. The ISM Code seeks to ensure greater integration of the shore-based company in the safety management of ships. The ISM Code includes a requirement that the master’s responsibilities be clearly defined as well as arrangements for shipboard operations, procedures and documentation.

From a regulatory perspective there is little or no codified practice guidance in the area of full shore-based control of a ship. Such guidance and practices must be developed. Arguably, the ISM Code is an appropriate instrument for this development.

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<sup>20</sup> Regulation 7-4.

<sup>21</sup> Company, according to Regulations XI-2/1.7 and IX/1.2, means the owner of the ship or any other organization or person such as the manager, or the bareboat charterer, who has assumed the responsibility for operation of the ship from the owner of the ship and who on assuming such responsibility has agreed to take over all the duties and responsibilities imposed by the International Safety Management Code.

### *Chapter X – Safety Measures for High Speed Craft*

Safety measures for high speed craft have no unique relevance in the context of unmanned operability.

### *Chapters XI (-1 & -2) Special Measures to Enhance Maritime Safety / Security*

The chapters prescribe additional measures aimed at enhancing safety and security of ships. Regulation 4 of Chapter XI-1 provides that a ship in a port of another Contracting Government will be subject to control by authorized officers of the port state when there are clear grounds for believing that the master or crew are not familiar with essential shipborne procedures relating to safety. Under Chapter XI-2, Regulation 3 requires the relevant maritime administration to “set security levels and ensure the provision of security-level information” to their flagged ships. Unique security challenges are posed in the context of unmanned operability, be it remote controlled or autonomous, particularly with regard to cyber infiltration. Regulation 6 requires ships to have a ship security alert system which has the ability to transmit ship-to-shore security alerts to designated authorities, indicating the ship’s location and that its security is under threat. This system must be able to be engaged from the ship’s bridge and at least one other place. In an unmanned shipping context, there must be a similar ship-to-shore alert mechanism in place to alert those at the shore-based facility as to when the ship’s physical or cyber-security has been compromised. Regulation 8 requires that the master’s discretion is not to be constrained by the Company or any other person in respect of ship safety. In principle, a chief shore-based remote controller may be given this role and undertake such authority in respect of the safety of an unmanned ship in spite of his shore-based location. The chapter calls for compliance with the International Ship and Port Facility Security (ISPS) Code, which concerns, inter alia, the specific obligations on ship companies in respect to security, including security procedures, the employment of security-focused personnel and certification and verification requirements. Regulation 11 gives contracting governments the permission to conclude bilateral agreements for alternative security measures in respect of shorter voyages between ports of those contracting states. Regulation 12 permits the Maritime Administration to allow a particular ship or group of ships to make use of alternative equivalent security arrangements, provided such measures are at least as effective as those prescribed by Chapter XI-2 and the ISPS Code.

### **4.3 The International Regulations for the Preventing of Collisions at Sea, 1972 (COLREGS)**

The International Regulations for the Preventing Collisions at Sea set out the navigational rules to be followed by vessels with the aim of avoiding collisions. The COLREGS are divided into five parts, Part A sets out general provisions for applicability, Part B prescribes the detailed steering and sailing rules, Part C sets out requirements for lights and shapes and Part D prescribes sound and light signalling requirements. Part E prescribes select exemptions from the Rules.

### *Part A – General*

By **Rule 1** The Rules apply to “all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels”.<sup>22</sup> Vessels, for these purposes, include “every description of water craft .... used or capable of being used as a means of transportation on water.”<sup>23</sup>

**Rule 2** is arguably the most important provision in the COLREGs. It provides that “nothing in [the] Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any ... neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case”. The Rule reaffirms the importance of good seamanship over and above a strict compliance with the Rules’ steering rules and expressly states that in select circumstances, deviation from the Rules is mandatory. The Rule requires contemporaneous human judgement in the decision making loop, not least in deciding on when a COLREG prescribed manoeuvre is required or alternatively, something potentially completely different. In principle, this judgement may be provided remotely, subject to the sophistication of the relevant communications technology. Even autonomous ships under permanent supervision paired with an ability to assume remote control arguably satisfy this requirement. Autonomous and unsupervised ships, however, would fall foul of Rule 2 in its current form.

### *Part B – Steering and Sailing Rules*

**Rule 5** requires that “every vessel ... at all times [maintains] a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances ... to make a full appraisal of the situation and risk of collision”. Reference to “sight and hearing” clearly requires a human input in surveying and assessing the situation and collision risk, consistently with Rule 2. As such, autonomous ships relying, for instance, on algorithmic collision avoidance technology would not satisfy the requirement of appraisal by sight and hearing. Of course, one might envisage a future of exclusively autonomous ships all communicating with each other so as to prevent close quarters situations. In such a case, the breach of Rule 5 would only be technical, but a breach no less. Even in such a case it can be argued that the currently prescribed human element would provide an essential back-up to an autonomous network.

The present generation of unmanned craft use sophisticated aural and camera sensors to project the vessel’s vicinity to shore-based remote controller. This arguably satisfies the Rule 5 requirement with the requisite human input still firmly in the appraisal process in the sense that the use of an electronic aids does not take the arrangement outside of the spirit or wording of Rule 5. Neither does its shore-based orientation. This is a point which must, however, be clarified.

Under **Rule 6** vessels must at all times “proceed at a safe speed so that [they] can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions”. This is a

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<sup>22</sup> Rule 1(a).

<sup>23</sup> Rule 3(a).

corollary of Rules 2 and 5 and any foreseeable delay in communications should be factored into the safe speed calculation. The transfer of data to the shore-based remote controller and transfer back of orders to the vessel inevitably will involve a delay of some duration, as will any satellite communications. The same can be said of **Rule 8** which requires that any action taken to avoid collision “shall be taken in accordance with the Rules of this Part and shall, if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship”. The remainder of Part B prescribes the detailed steering and sailing directions to be observed. The key point is that compliance with these provisions presents no difficulty if the relevant unmanned ship has the situational awareness required, in particular, as set out in Rules 2 and 5. As stated above, the required human appraisal arguably is satisfied in the context of remote controlled operation and even supervised autonomous operation so long as there is an ability to assume remote control immediately. Autonomous ships, which are unsupervised, however cannot meet the requirement.

Finally, under this Part, attention should be drawn also to **Rule 18** on “Responsibilities between vessels”. In particular, it gives navigational priority to vessels “not under command” defined in Rule 3(f) as a “vessel which through some exceptional circumstance is unable to manoeuvre as required by the Rules and is therefore unable to keep out of the way of another vessel”. This Rule usually covers vessels which have come into difficulty on account of engine failure, for instance. “Not under command” status might feasibly include an unmanned ship which has lost communications. In such a case, raising the appropriate signals to inform proximate sea users about this status is critical. However, the reference to “exceptional circumstances” clearly refers to circumstances other than a vessel’s ordinary operational arrangements and so would not generally cover unmanned operability.

#### *Part C & D: Lights and Shapes / Sound and Light Signals*

Parts C and D set out detailed requirements for the signalling vessels must use to communicate with other sea users. The special technical requirements are specified in the COLREGS **Annexes I-IV**. Importantly, these requirements also serve an alternative use in demonstrating the required sophistication of an unmanned ship’s electronic look out arrangements, since the ship must at a minimum be able to detect signals of other vessels. In general, making signalling capability resilient to ordinary communications failure, i.e. to ensure continued signalling capability when routine communication is lost, will be an important step for the unmanned ships in demonstrating their safety credentials. It should be noted, however, Governments may accept “closest possible compliance” with the requirements of Parts C and D in respect of “number, position, range or arc of visibility of lights and shapes as well as the ... characteristics of sound signalling appliances” in respect of vessels of “special construction or purpose”.<sup>24</sup> The extent to which unmanned ships may benefit from this dispensation will be subject to the dialogue between operators and the relevant maritime authorities.

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<sup>24</sup> Part A, Rule 1(e).

#### 4.4 The Convention on Standards of Certification, Training and Watchkeeping (STCW)

The STCW Convention, amongst other things, prescribes qualification standards for masters, officers and watchkeeping personnel on board seagoing ships. It also deals with watchkeeping procedures. Through Article III, the Convention expressly applies to “seafarers *serving on board* seagoing ships entitled to fly the flag of a Party”.<sup>25</sup> The Convention would thus ordinarily find no application to exclusively unmanned operations.

Unmanned operability introduces into the maritime domain an entirely new range of personnel charged with navigating the relevant ship. Such personnel currently lack a counterpart qualification regime. This must be addressed if unmanned shipping is to become widespread. In the absence of a uniform qualification standard for shore-based controllers and pre-programmers and also a codified standards regime for the relevant communications technology, satisfying a maritime administration as to the safety of an unmanned ship becomes more challenging. In particular, obtaining its satisfaction as to the safety of its proposed unmanned operability under SOLAS would be very difficult.

To a limited extent, the STCW Code – containing technical details associated with provisions of the STCW Convention – might be used as a blueprint for the development of a new qualifications regime. The Code’s detailed watchkeeping provisions serve as guidance as to the extensiveness of the obligations to be discharged by shore-based personnel in at least equivalent terms. It was suggested in the context of Rule 2 of the COLREGS that unmanned ships must be able to conform to the requirements of good seamanship, thus remote-controllers of unmanned ships must be suitably qualified in maritime navigation to be able to practically discharge this duty. This will, of course, need to be accompanied by the technological training made necessary by the inevitably increased use of IT in the navigation process.

In terms of the STCW’s watchkeeping requirements, Chapter VIII is titled “Standards regarding watchkeeping”. Part 4, paragraph 10 (Watchkeeping at Sea) states “when deciding the composition of the watch on the bridge ... the following factors, inter alia, shall be taken into account”. One of such listed factors includes “at no time shall the bridge be left unattended”. In addition, paragraph 24 provides that “the officer in charge of navigational watch shall “keep the watch on the bridge” and “in no circumstances leave the bridge until properly relieved”. Furthermore, paragraph 24.2 provides that the officer in charge of the navigational watch shall “in no circumstances leave the bridge until properly relieved”. To the extent that the STCW Convention finds application, these provisions presents difficulty for unmanned ships.

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<sup>25</sup> Emphasis added.



#### **4.5 International Convention for the Prevention of Pollution from Ships (MARPOL)**

MARPOL is the primary IMO regulation, which addresses select forms of pollution from ships. It includes provisions from construction and equipment requirements of, for example for oil tankers, to operational and procedural requirements, including discharge limits, procedures for ship-to-ship transfers and numerous reporting requirements in case of spills. Unmanned ships will have to comply with the provisions of MARPOL to the same extent as their manned counterparts, although relative to the other IMO regulations considered the obligations under MARPOL are unlikely to present the most onerous challenges to unmanned operations.

### **5. General Liability Rules**

#### **5.1 The Current State of Play**

Unmanned ships and especially autonomous navigation has the potential to alter the way in which liability is distributed in respect of accidents or incidents at sea. The careful navigation of a ship has traditionally been entrusted to trained seafarers whose competence the relevant shipowner can ensure based on codified standards. Navigation in an unmanned context will be the task either of a shore-based remote controller or alternatively, the developers and pre-programmers of software technology seeking to perform this task, or both. In other words, new liability players are introduced and even those retained arguably assume very different responsibilities.

Unlike matters subject to IMO regulations, the general liability position, which may be enforced at national level differs, potentially quite drastically, from jurisdiction to jurisdiction. Which law will apply to a dispute involving a ship “incident” at sea will depend on a number of factors and in particular, which waters the incident occurred in, the nature of the incident and sometimes the flag of the relevant ships and the nationality of persons involved. In which court such a dispute may be brought is subject to similar considerations. This section, therefore, is only meant to give a brief introduction into the potential issues that may arise in relation to the potential liabilities which may arise in relation to the operation of unmanned ships.

One of the main ways in which general civil liability differs between jurisdictions is the grounds on which it attaches. In most jurisdictions, civil liability is dependent on fault, be it through being negligence or breaching codified duties or rights. Fault-based liability is prescribed internationally in the context of collisions at sea. Under the Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels, 1910, liability is apportioned in accordance with the fault of the respective vessels.<sup>26</sup> In other jurisdictions,

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<sup>26</sup> Article 3.

however, merely causing the relevant harm will suffice to attract liability. Such “strict liability” is also prescribed internationally for select types of incident.<sup>27</sup>

Another issue is exactly which particular person or persons attract liability. In a maritime context it is the shipowner who effectively assumes an overarching responsibility for most maritime liabilities. This will either be because of a specific provision for such a position, again in the context of collision, the 1910 Collision Convention places liability on the relevant “ship” rather than individual seafarers. In any event, most jurisdictions recognise vicarious liability pursuant to which, in this case, the shipowner will be responsible for the negligence of his servants / employers, which traditionally has included, inter alia, the ship’s master and crew.

The fact that the shipowner often bears this overarching responsibility – *and* that in some cases, this liability will be strict – has given rise to an off-set in form of a general right, somewhat unique to the maritime domain, which is the right of limitation of liability for select maritime claims.

Potentially complex issues arise in the context of accidents at sea attributable to defects in the ship itself. The range of different types of technical issues is broad. The division of liability between the shipowner and, for instance, the shipbuilder or the manufacturer of an individual component is not always easy to draw. Many factors could play a role in this, not least the latency of the defect, in other words the extent to which any relevant defect might have been detected by due diligence on the part of the shipowner. In principle, however, the shipbuilder and component manufacturers are potential targets for liability if the relevant claimant can demonstrate fault, which is causative of their loss. The above pose difficult questions. What is the nature of the unmanned shipbuilder or component manufacturer’s duty? In other words, for what ought the manufacturer be liable? Further, when can even a proven negligent defect on the part of the manufacturer be deemed to have caused an accident, bearing in mind the shipowner’s obvious duty of maintenance and inspection? Case law assists to a limited extent but ultimately, each case is likely to turn on its own facts. Product liability and manufacturer liability exists in its own legal regime of case law, statute and European regulation.<sup>28</sup> Under this regime, manufacturers may face strict liability for harm caused by their products if they fall below a level of safety which might reasonably have been expected of them.

Criminal liability is even more varied at the national level. In particular, different offences are prescribed for different parties and perhaps equally significantly, the mental element required for liability to attach, may differ. Some criminal offences require no guilty mindset. The majority, however, require either intent

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<sup>27</sup> For instance, under Article 10 of the Nairobi International Convention on the Removal of Wrecks, unless an exception applies, “the registered owner shall be liable for the costs of locating, marking and removing [a] wreck”. Under article III of International Convention on Civil Liability for Oil Pollution Damage, 1992 “the owner of a ship at the time of an incident, ... shall be liable for any pollution damage caused by the ship as a result of the incident”.

<sup>28</sup> Directive 85/374 in the approximation of laws, regulations and administrative provisions of the Member States concerning liability for defective products.

or recklessness. In some jurisdictions there is a large body of offences for negligent acts. In a maritime context it is the shipowner and the ship master who are usually criminally liable.

## 5.2 Implications of Unmanned Ships

It is not possible to simply transplant the existing liability rules applicable in the context of traditional manned maritime activity to its unmanned counterpart. Although parallels may be drawn between shore-based remote controllers and conventional seafarers and although autonomous navigation software is essentially another form of fitting or installation, the proposed technological shift impacts on the nature of the responsibilities assumed. Not least the relevant level of unmanned ship autonomy will impact profoundly on this question.

Unmanned ships will have to place far greater reliance on IT, software and communications systems and it will be foreseeable that there will be no personnel on board or in the vicinity to diagnose and “troubleshoot” even minor defects or glitches. This may have an important bearing on the respective duties assumed. Between manufacturer and shipowner these responsibilities may be apportioned contractually but in respect of harm occasioned on third parties the position is less clear. It is also not clear how and in what circumstances liability to third parties might attach to software designers and manufacturers and whether the liability would be fault-based or strict. Liability of producers under the European Product Liability Directive,<sup>29</sup> for instance, is strict in respect of matters within its scope. However, the extent to which ordinary manufacturers’ liability will apply to unmanned shipping is yet to be determined. Shipowners will be expected to monitor, inspect and supervise their products and installations to a higher standard than consumers.

There is no reason in principle why the owner of an unmanned ship ought not to be given the benefit of the general right of limitation of liability currently enjoyed by manned shipowners. One of the most powerful arguments in favour of unmanned ships being regarded as “ships” and for their integration into the existing legal framework is that their operation would involve many of the same risks of collision and pollution as their manned counterparts.

The role of a remote-controller of an unmanned ship is in a sense similar to that of a master in that both assume real-time command of the movement and signalling etc. of the relevant ship. A pre-programmer of an autonomous unmanned ship, by contrast, enjoys a role unparalleled in the traditional maritime domain. He is potentially the last human input into the ship’s navigational course but unlike a master, he does not exercise real time decision-making influence. The pre-programmer is in that sense more akin to an engineer or even a component manufacturer but unlike each of these, in the context of an autonomous collision avoidance system with no onboard oversight, his before-the-event conduct potentially has a far more profound bearing on the ship’s

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<sup>29</sup> Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products.

navigational safety than the ordinary component manufacturer of a manned ship. Applying ordinary principles, liability stemming from an accident involving a pre-programmed autonomous unmanned ship stand to be apportioned in some proportion between the shipowner, the software manufacturer and the pre-programmer. Each of these could be separate or conjoined corporate entities, which adds to the complexity. To what extent liability between these parties should be joint and several must be considered, as must the entitlement or otherwise of the pre-programmer to invoke the liability limitations of the shipowner.

What is clear is that new regulations and practices will need to develop to cover the activities introduced by unmanned operability. This will most likely involve further standards of due diligence on the part of the shipowner, additional certification requirements for component / software developers and a new training and qualification standards for pre-programming and shore-based navigation. It will also involve maritime administrations and classification societies gaining expertise in such operations in order to discharge their own important regulatory functions. In either case, these developments will probably adopt some aspects from existing maritime law, technical standards and manufacturers' liability law but also introduce new provisions for the innovative practices presented by unmanned shipping.

## 6. The way forward

The absolute priority in the regulation of unmanned shipping is safety. With the proposed innovative technology, the level of safety currently ensured by manned ships is the obvious benchmark. It is not realistic to expect regulators or the broader shipping community to tolerate a lower standard.

From the point of view of the exploitation of the technology, the most expedient mode of regulation would be for unmanned ships to come within the ambit of the existing framework, with some important modifications, based on the findings in the preceding pages.

There is no reason why unmanned ships ought not to be regarded as "ships" so as to fall within the ambit of UNCLOS and why, therefore, the rights and obligations of flag and coastal states ought not to apply to them, *mutatis mutandis*. This is the case even though UNCLOS was not drafted with unmanned ships in mind.

As far as compliance with the existing IMO regulatory framework is concerned, it is clear that the level of unmanned ship autonomy is of profound importance. In particular, there is an important distinction to be drawn between, on the one hand, remote controlled unmanned ships (or those at least supervised by persons capable of assuming immediate remote control) and, on the other hand, autonomous ships operating without any human supervision. This is because the IMO Regulations, in particular SOLAS, the STCW and the COLREGS, make it clear that contemporaneous human involvement in the decision-making process is

essential, even if on-board attendance is not always. For remote-controlled ships, only modest amendments or perhaps only clarifications of the existing regulations may be needed. For this purpose, potentially only supplementary or interpretative guidelines may be needed. However, considerable amendment to the existing framework is needed for the operation of the latter kind of unsupervised autonomous unmanned ships. Amendment to the established IMO Regulations is likely to take considerable time as agreement between only a small number of states is not sufficient to affect change at the international level.

With the international position yet to crystallise, domestic and regional interest groups, largely comprising stakeholders in the unmanned maritime industry itself, have taken the prudent steps of beginning to draft codes of practice for unmanned operations. In some instances this is being undertaken in collaboration with national maritime authorities and classification societies. In the absence of international agreement, this could be an interim solution, as regulatory change is more easily achieved in the domestic sphere for obvious reasons.

The international regulatory framework is of more limited importance in the context of unmanned operations taking place within the confines of one coastal state's internal or territorial waters. Thus, domestic operations in unmanned shipping presents the most convenient opportunity for the new technology to demonstrate its safety credentials to national administrations, whose discretion has a major role to play, in due course, in the compliance of the technology with the currently enacted international requirements. With the technology still developing, persuading national administrations to exercise their discretion favourably will be a long-term process, but it is essential if the technology will ever flourish, both domestically and internationally.

As far as the international regulators are concerned, a number of measures are currently needed. There must be a more comprehensive review of the current regulatory framework to assess its applicability to unmanned ships as well as whether unmanned ships can comply with it and also the extent to which amendment to or clarification of, is necessary. It will also be import to identify and separate those provisions which are prescriptive and compulsory in nature from those which are permissive. A start has already been made in the academic community.<sup>30</sup>

Once this is undertaken, the position will be much clearer as to the extent of the measures needed to integrate unmanned ships. In other words, it will be clearer where soft law guidance and clarity is needed and, on the other hand, where convention amendment is essential and thirdly, where new provision is needed. In the latter case, a decision will have to be made as to whether such new regulation is itself prescriptive or more goal-based. Certainly as regards remote

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<sup>30</sup> R Veal and M Tsimplis, "The integration of unmanned ships into the *lex maritima*", [2017] LMCLQ 303. See also E Van Hooydonk, "The law of unmanned merchant shipping – an exploration", [2014] JIML 403.

controlled operations, for the reasons set out previously, it is suggested that soft law guidance would in most cases be the most appropriate and expedient option.

What is currently missing, however, is sufficient dialogue on this issue internationally. This is where the CMI Questionnaire on unmanned ships can assist. It will give maritime law associations the opportunity to consider the most salient questions which go the very heart of the issue of unmanned shipping regulation, focusing on the domestic law of each as well as the international conventions to which their respective States are party. It will also serve to encourage discussion in consequence, both between maritime law associations and their respective national authorities as well as between states at international level. This will serve to uncover any barriers to consensus and the greater use of the technology.