TOWARDS GREATER CERTAINTY FOR UNMANNED NAVIGATION, A RECOMMENDED UNITED STATES MILITARY PERSPECTIVE ON APPLICATION OF THE "RULES OF THE ROAD" TO UNMANNED MARITIME SYSTEMS

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I. INTRODUCTION

On December 15, 2016, China seized a United States Navy unmanned maritime system (UMS) in the South China Sea.[1] The UMS, known as an "ocean glider," was used by the Navy to gather oceanographic data in the region.[2] Chinese naval personnel seized the

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[1] *See* U.S. DEP'T OF DEF., UNMANNED SYSTEMS INTEGRATED ROADMAP, FY 2013-2038, at 8 http://www.dtic.mil/dtic/tr/fulltext/u2/a592015.pdf [https://perma.cc/3JA4-HM3C] [hereinafter DoD Integrated Roadmap] (using the term unmanned maritime system (UMS) to refer to all unmanned maritime vehicles (UMVs), to include unmanned underwater vehicles (UUVs) and unmanned surface vehicles (USVs)). See also Maritime U.K., *Being a Responsible Industry, an Industry Code of Practice*, *a Voluntary Code 1.0* at 15 (Nov. 2017), https://www.maritimeuk.org/documents/197/CODE_OF_PRACTICE_V1.0_-_Up_to_24m_-_Final.pdf [https://perma.cc/F6GJ-PU9H] (hereinafter Maritime U.K. Code of Practice) for an example of another acronym "MASS"- "Maritime Autonomous Surface Ship" used by the IMO, United Kingdom, and other states and organizations to refer to unmanned maritime technology.

[2] Dan Lamothe & Missy Ryan, *Pentagon: Chinese Naval Ship Seized an Unmanned U.S. Underwater Vehicle in South China Sea*, WASH. POST (Dec. 17, 2016), https://www.washingtonpost.com/news/checkpoint/wp/2016/12/16/defense-official-

UMS within sight of Navy research vessel, USNS Bowditch, and despite protests by the United States, the Chinese did not return the UMS for several days.[3] A little over a year later, Houthi rebels reportedly seized another United States Navy UMS off the coast of Yemen, although circumstances behind this second incident remain unclear.[4] These high profile incidents highlight important questions about the rights and obligations of unmanned systems vis-à-vis the international maritime agreements, notably the 1982 United Nations Convention on the Law of the Sea (UNCLOS),[5] and the various International Maritime Organization (IMO) conventions, including the International Convention for the Safety of Life at Sea (SOLAS), the International Convention on Standards of Training, Certification and Watchkeeping (STCW convention), the International Convention for the Prevention of Pollution from Ships (MARPOL), and the International Regulations for Preventing Collisions at Sea (COLREGS).[6] Because these agreements pre-date UMSs, at least in the modern sense of the term,[7] the extent that these and other maritime

chinese-naval-ship-seized-an-unmanned-u-s-ocean-glider/ [https://perma.cc/3M6B-Z9TX].

[3] Jane Perlez & Matthew Rosenberg, *China Agrees to Return Seized Drone, Ending Standoff, Pentagon Says*, N.Y. TIMES, Dec. 18, 2016, at A-10.

[4] Ben Werner, *VIDEO: Houthi Forces Capture U.S. Navy Unmanned Underwater Vehicle Off Yemen*, USNI NEWS (Jan. 3, 2018, 2:24 PM), https://news.usni.org/2018/01/03/houthi-rebels-find-likely-u-s-navy-unmanned-underwater-vehicle [https://perma.cc/RMY5-Y6B4].

[5] United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397; *see also* U.S. DEP'T OF DEF., OFFICE OF THE GENERAL COUNSEL, LAW OF WAR MANUAL at § 13.1.2 (updated Dec. 2016), https://dod.defense.gov/Portals/1/Documents/pubs/DoD%20Law%20of%20War%20Manual%20-%20June%202015%20Updated%20Dec%202016.pdf [https://perma.cc/F2X2-UK3M] (Stating that the United States is not a party to UNCLOS, but it acts "in accordance with the balance of interests reflected in the LOS Convention relating to traditional uses of the oceans, such as navigation and overflight" and that the United States would "exercise and assert navigation and overflight rights and freedoms on a worldwide basis in a manner that is consistent with the balance of interests reflected in the . . . Convention.").

[6] *See generally* Convention on the International Regulations for Preventing Collisions at Sea, Oct. 20, 1972, T.I.A.S. 8587, 28 U.S.T. 3459, [hereinafter COLREGS]; International Convention for the Safety of Life at Sea, Nov. 1, 1974, 1184 U.N.T.S. 3 [hereinafter SOLAS]; International Convention on Standards of Training, Certification and Watchkeeping, Jul. 7, 1978, 1361 U.N.T.S. 2 [hereinafter STCW Convention]; International Convention for the Prevention of Pollution from Ships, 1973, as Modified by the Protocol of 1978, Feb. 17, 1978, 24 U.S.T. 3407, 1340 U.N.T.S. 61 [hereinafter MARPOL].

[7] Michael Schmitt & David Goddard, *International Law and the Military Use of Unmanned Maritime Systems*, 98 INT'L REV RED CROSS. 568, 570 (Sep. 25, 2017) (providing a brief history of UMS and stating that "it is only in the twenty-first century

agreements govern UMSs is unclear. This paper focuses primarily on challenges that UMSs present under the COLREGS, the technical rules on maritime navigation, from a perspective recommended for the United States military.

In order to enhance safety of navigation, to limit the ability of adversaries to exploit uncertainty against United States UMS operations, and to a lesser extent, to incentivize the development of UMS technology, this paper asserts that the United States should work towards definitive recognition that most UMSs are subject to the COLREGS, in conjunction with the regulatory scoping effort underway at the IMO.[8] To this end, this paper seeks to frame the major issues anticipated for United States Navy and Department of Defense (DoD), other United States government entities, and international decision-makers working to address this problem. Following the introduction in Part I, Part II provides an overview of the characteristics and missions for DoD UMSs, their status as vessels or non-vessels under current law and regulations, and a description of the efforts by the IMO and other maritime organizations to address these issues. Part III addresses the challenges of COLREGS compliance for UMSs, including rule-based and technological challenges; COLREGS special categories that may provide leeway for UMSs to operate under the Rules, including restricted-in-ability-to-maneuver status; and best practices and amendments to the COLREGS for UMSs proposed by various maritime organizations. Part IV examines COLREGS uncertainty for UMSs in admiralty law, including the possibility that applying the Rules to unmanned systems will incentivize technological development. Part V evaluates alternatives to COLREGS application, including considering UMSs as a novel category subject to a separate set of navigation rules,[9] treating UMSs as components of a launching platform,[10]

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that UMSs became the subject of aggressive technological progress and operational concept development.").

[8] Press Release, International Maritime Organization (IMO), IMO Takes First Steps to Address Autonomous Ships, (May 25, 2018), http://www.imo.org/en/mediacentre/pressbriefings/pages/08-msc-99-mass-scoping.aspx [https://perma.cc/Y2S3-WDNK] [hereinafter IMO autonomous ships briefing] (providing an update on the IMO regulatory scoping exercise for UMSs (referred to as Maritime Autonomous Surface Ships (MASS) following the 99th session of the Maritime Safety Committee (MSC) meeting in May 2018); *see also* Part III, Sections C and D *infra* for a discussion of mitigation measures contained in the Rules.

[9] *See* Daniel A. G. Vallejo, *Electric Currents: Programming Legal Status into Autonomous Unmanned Maritime Vehicles*, 47 CASE W. RES. J. INT'L L. 407, 408, 414–16, 425–28 (2015) (arguing that UMSs should be classified as novel category, military devices, instead of vessels due to the challenges for UMSs to comply with COLREGS that cannot be overcome without amendment, and the time and delay necessary to amend the COLREGS which the author argues the military will not wait for before deploying its

classifying military UMSs that qualify as warships,[11] and retaining the status quo in which the UMS regulatory environment remains uncertain. Finally, Part VI discusses the likely phases towards definitive COLREGS governance and provides recommendations for the IMO's regulatory scoping exercise. The paper concludes that a strong United States position for COLREGS governance over most UMSs will persuade other states, maritime organizations, and the IMO to act on this increasingly relevant issue.[12]

In general, the COLREGS, also known as the "Rules of the Road," consist of two sets of rules: (1) the Inland Rules that govern in United States inland waters such as lakes and rivers and (2) the International Rules that govern in all water surfaces beyond the inland waters, including on the high seas and in connected navigable waters.[13] This paper focuses on the International Rules, although the International and Inland rules match each other in most important respects. Rule 1(a) of the COLREGS (International Rules) states, "These Rules shall apply to all *vessels* upon the high seas and in all waters connected therewith navigable by seagoing

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systems. The same author also argues for the creation of a new set of navigation rules to govern UMSs as military devices).

[10] *See* Andrew Norris, *Legal Issues Related to Unmanned Maritime Systems Monograph*, NAVAL WAR COLLEGE, 23–24 (2013), https://www.hsdl.org/ [https://perma.cc/UT9A-VHPN] (compiling results of workshop on UMSs at the Naval War College that includes extensive discussion of UMS vessel status and alternative options such as a UMS as an adjunct or component of a launch platform, object or device, and implications of warship and weapons system status for certain UMSs that meet the definition of a vessel).

[11] *See id*. at 27–30; Vallejo, *supra* note 9, at 413; Lieutenant Andrea M. Logan, JAGC, U.S. Navy, *Human Machine Teaming at Sea: A Model for Unmanned Maritime Systems and the Use of Force*, 24–28 (2016) (unpublished) (on file with author).

[12] *See* Schmitt & Goddard, *supra* note 7, at 578 (asserting that a United States position on UMS navigational rights and obligations in the law of the sea context may cause other states to follow suit) (emphasis added).

[13] COLREGS, *supra* note 6, Rule 1 ("These [International] Rules shall apply to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels."); Inland Navigation Rules, 33 C.F.R. § 83.03(q) (2017) ("Inland Waters means the navigable waters of the United States shoreward of the navigational demarcation lines dividing the high seas from harbors, rivers, and other inland waters of the United States and the waters of the Great Lakes on the United States side of the International Boundary."). Note that all citations in this paper to the "COLREGS" are to the International Rules, unless a reference is made to the Inland Rules, at which time the Inland Navigation Rules C.F.R. provision will be specifically cited. For a useful reference that combines the International and Inland Rules into a single publication, see U.S. DEP'T OF HOMELAND SECURITY, U.S. COAST GUARD, NAVIGATION RULES AND REGULATIONS HANDBOOK (Aug 2014), https://www.navcen.uscg.gov/pdf/navRules/CG_NRHB_20180126.pdf [https://perma.cc/JZ4G-HBJE] [hereinafter NAVIGATION RULES AND REGULATIONS HANDBOOK].

vessels."[14] While the COLREGS govern the conduct of vessels (a term that is interchangeable with ships),[15] the Rules do not directly regulate non-vessels, such as buoys or fixed objects like piers. Similarly, aside from minor provisions on the lighting of unmanned barges, the COLREGS do not address "unmanned" ships, systems, craft, or other objects, including autonomous or semi-autonomous craft, as vessels or non-vessels.[16] It is therefore an open question whether the COLREGS apply to UMSs, creating an uncertain regulatory environment for unmanned systems and manned vessels that encounter them.

The December 2016 Chinese seizure of the United States Navy UMS raises a host of legal issues, but as it relates to the COLREGS, the incident highlights uncertainty for UMSs in the following way: if the UMS seized by China was considered a vessel for COLREGS purposes, the COLREGS would govern the conduct of both the Chinese vessel and the UMS vessel in this incident, as the Rules impose definite obligations on how vessels interact with one another. For example, COLREGS Rules 13, 14, and 15 that prescribe actions for vessels to take when overtaking one another, in crossing situations, and in head-on situations, apply to the "[c]onduct of *vessels* in Sight of One Another,"[17] which presumably was the case in this incident. If the UMS was a vessel for COLREGS purposes, then the Chinese vessel certainly violated the COLREGS when it failed to take action to avoid the UMS.[18] If the UMS was not a vessel, it is unclear which navigational rules, if any, govern the interaction, although by intentionally seizing the UMS, the Chinese vessel violated several

[14] COLREGS, *supra* note 6, Rule 1(a).

[15] *Id*.; *see also* Norris *supra* note 10, at 24 (stating that the terms ship and vessel are mostly synonymous in international agreements; several agreements use the term vessel; other agreements use the term ship). This paper will use the term vessel unless a specific treaty is referred to that makes use of the term ship necessary, such as UNCLOS provisions on warship status.

[16] *See generally* COLREGS, *supra* note 6. Aside from limited sections about unmanned barge lighting requirements (Inland Rules, Annex I and 33 C.F.R. §84.16(c) and 33 C.F.R. §82.7 and §90.7)), no other provisions in the COLREGS (International or Inland Rules) discuss unmanned craft, so whether the Rules apply to UMSs remains unclear.

[17] COLREGS, *supra* note 6, Rules 13–15.

[18] *See* James Kraska & Raul (Pete) Pedrozo, *China's Capture of U.S. Underwater Drone Violates the Law of the Sea*, LAWFARE (Dec. 17, 2016, 7:03 PM), https://lawfareblog.com/chinas-capture-us-underwater-drone-violates-law-sea [https://perma.cc/KF3J-3NPU] (asserting that the Chinese vessel that seized the UMS violated the COLREGS, among other international laws and norms) (emphasis added). For the purpose of this paper, it is assumed that the UMS was operating on the surface when it was seized because the COLREGS do not govern subsurface navigation. *See* Schmitt & Goddard, *supra* note 7, at 577.

international norms in any case, including its obligation to exercise due regard.[19]

The UMS seizure by China in the South China Sea was a high profile intentional incident that has not been repeated, with the possible exception of the incident off the coast of Yemen, mentioned in Part I above.[20] Nonetheless, uncertainty about COLREGS application to UMSs is much more likely to result in lower profile maritime accidents, as UMSs become more numerous and manned vessels encounter them more frequently. For example, the uncertain application of the COLREGS to UMSs could result in the following mishaps: (1) a manned vessel closes on a UMS but hesitates to act in time to prevent a collision because its crew is uncertain whether to treat the UMS as a vessel for COLREGS purposes; (2) a manned vessel closes on a UMS that looks like another manned vessel, and absent any markings to indicate it is unmanned, the manned vessel unsuccessfully tries to get the attention of the UMS using bridge-to-bridge radio before colliding, and (3) a remote UMS operator assumes that a UMS is not obligated to follow the COLREGS, therefore fails to give way to a manned vessel when it would be required to under the Rules, resulting in a collision in which a crew member is killed, potentially exposing the UMS operator to significant liability.

Fortunately, the problem of UMS-COLREGS uncertainty demonstrated by these and similar situations has not gone unnoticed. Several governmental entities, non-governmental maritime organizations, and trade groups including the IMO, the United States Coast Guard, Maritime U.K., the Comité Maritime International (CMI), among others are studying these issues and developing recommendations to address the problem.[21] The recent work by CMI is particularly helpful. CMI's

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[19] *See* Kraska & Pedrozo, *supra* note 18 (discussing China's failure to observe due regard in an UNCLOS context in violation of Articles 58 and 87); *see also* COLREGs, *supra* note 6, Rule 2(b) (Providing the rule on due regard in the COLREGS, "[i]n construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate danger.").

[20] *See* Werner, *supra* note 4. Note that the statement that the UMS seizure has not been repeated is based solely on information reported in open source media.

[21] *See, e.g.*, COMITÉ MAR. INT'L, INT'L WORKING GRP., POSITION PAPER ON UNMANNED SHIPS AND THE INTERNATIONAL REGULATORY FRAMEWORK 2021, 22–23, http://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf [https://perma.cc/6R84-CJZ7] [hereinafter CMI IWG Position Paper]; U.S. NAVIGATION AND SAFETY ADVISORY COMMITTEE, RESOLUTION 16-01, UNMANNED MARITIME SYSTEMS BEST PRACTICES (May 5, 2016), https://maddenmaritime.files.wordpress.com/2016/06/navsac-resolution-16-01-unmanned-maritime-systems-ums-best-practices-final-05-may-2016.pdf

International Working Group (IWG) produced an informational paper on UMSs and solicited input from its national maritime law association (MLA) members via questionnaire on application of the maritime regulatory framework to UMSs, including ship and vessel status, ship registration rules, and considerations in UNCLOS, SOLAS, the STCW convention, and the COLREGS.[22] To date, twenty-two national MLAs, including MLAs from the United States, the United Kingdom, and France, have submitted responses to CMI's questionnaire, providing insight on these issues from diverse national legal perspectives that will aid the IMO.[23] However, with unmanned systems increasing in number and capability, as well as the likelihood of full-sized commercial UMSs within a few years,[24] dangers to navigation safety caused by regulatory uncertainty will become more pervasive until definitive guidance is provided.[25]

In addition to the perspectives of governmental and non-governmental maritime organizations and industry groups, a military perspective is also vital to any comprehensive effort to address the UMS-COLREGS issue. The military has distinct concerns related to the application of the COLREGS to UMSs that go beyond the interests of groups like private industry that are primarily concerned with navigation safety. First, according to available information, UMSs owned or operated by the military, particularly the United States military,[26] are more

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[https://perma.cc/L87H-YKJL] [hereinafter NAVSAC Resolution 16-01]; Maritime U.K. Code of Practice, *supra* note 1.

[22] *See id*.; *Questionnaire*, Comité Mar. Int'l, Int'l Working Grp. (Mar. 24, 2017), http://comitemaritime.org/work/unmanned-ships/ [https://perma.cc/TW5C-WUGF].

[23] *See* Comité Mar. Int'l, Int'l Working Grp., http://comitemaritime.org/work/unmanned-ships/ [https://perma.cc/V2PN-4VF7] [hereinafter CMI IWG Website] (Responses to the IWG questionnaire from twenty two national maritime law associations (MLAs) include Argentina, Australia, Belgium, Brazil, Canada, Croatia, Denmark, Finland, France, Germany, Ireland, India, Italy, Japan, Malta, Netherlands, Panama, Singapore, Spain, United Kingdom, United States, and Venezuela (a Chinese MLA paper was originally posted, but it was subsequently withdrawn from the site).).

[24] *See* MAREX, *The Autonomous Revolution*, THE MAR. EXECUTIVE (Aug. 25, 2017, 8:06 PM), https://maritime-executive.com/features/the-autonomous-revolution [https://perma.cc/7Y2J-WPMG] (discussing the various prototypes of UMSs planned for commercial use for international companies and their expected timelines).

[25] *See generally* NAVIGATION RULES AND REGULATIONS HANDBOOK *supra* note 13, at i (describing the role of the IMO, formerly the Inter-Governmental Maritime Consultative Organization (IMCO), in development of the COLREGS and its amendments).

[26] *See* Scott Savitz et al., *U.S. Navy Employment Options for UNMANNED SURFACE VEHICLES (USVs)*, RAND NAT'L. DEF. RESEARCH INST. at 10–11 (2013), https://www.rand.org/content/dam/rand/pubs/research_reports/RR300/RR384/RAND_RR384.pdf [https://perma.cc/FAK3-PAD5] (Showing that the United States has the greatest number of USVs at technology readiness level (TRL) 8 or above by a wide margin.).

developed and operate in greater numbers than other UMSs, so they are exposed to proportionally greater risks from regulatory uncertainty based on numbers and autonomous development alone.[27] Second, military UMSs have certain operational requirements that may be uniquely impacted by future regulatory action or amendments to the COLREGS, especially those that would unduly constrain freedom of operation.[28] Therefore the military should be involved in shaping regulatory policy in a way that increases navigational certainty, while preserving its operational flexibility to the maximum extent possible.[29] Third, military UMSs face additional considerations in the UNCLOS context, recognized in relevant part by the United States (a non-party) as customary international law, such as recent challenges to UMS activities like military marine data collection.[30] While

[27] *See id.* (demonstrating that as of 2013, "the more developed naval sector that accounts for nearly 70 percent of currently available systems," while also noting that the civilian market has more diverse applications); *see also* MAREX, *The Autonomous Revolution*, *supra* note 24 (indicating that wide-spread use of ocean-going commercial UMSs are not anticipated in the short-term); *Market for Unmanned Naval Vessels Projected to Grow*, MAREX (Jan. 6, 2016, 20:34), https://www.maritime-executive.com/article/market-for-unmanned-naval-vessels-projected-to-grow [https://perma.cc/B53Z-6HGV] (citing statistics that show the autonomous naval vessel market is expected to grow six percent over next five years).

[28] *See* discussion *infra* Part III, Section D (Discussing a potential unique military requirement for a UMS to disguise a UMS' location. This requirement may be inconsistent with regulatory guidance or COLREGS amendments that propose to require prominent identification for all UMSs.).

[29] *Id.*

[30] *See* Kraska & Pedrozo, *supra* note 18 (outlining legal issues involved with the December 2016 UUV seizure and arguing that China violated three norms in international maritime law and UNCLOS by seizing the UMS to include (1) that China stole a United States vessel that was legitimately operating in the sea; (2) that China violated United States sovereign immunity rights over its UMS, and (3) that China interfered with high seas freedoms which the UMS was engaged in by failing to exercise "due regard" for the UMS); Julian Ku, *The Non-Existent Legal Basis for China's Seizure of the U.S. Navy's Drone in the South China Sea*, LAWFARE (Dec 16. 2016, 5:50 PM), https://www.lawfareblog.com/nonexistent-legal-basis-chinas-seizure-us-navys-drone-south-china-sea [https://perma.cc/6YJP-WMGE]; *see also* Mark J. Valencia, *U.S.-China Underwater Drone Incident: Legal Grey Areas*, THE DIPLOMAT (Jan. 11, 2017), http://thediplomat.com/2017/01/us-china-underwater-drone-incident-legal-grey-areas [https://perma.cc/F2PU-AQ4U] (Questioning the lawfulness of the U.S. position on the UMS seizure for several reasons to include: (1) seizure was not a "theft" from China's perspective because the unmanned undersea vehicle (UUV) was unidentified and China was ensuring safety at sea; (2) because UUV was not a warship or governmental ship engaged in non-commercial practice, it was not entitled to sovereign immunity under UNCLOS art 32; and (3) because the UUV was conducting marine scientific research in the EEZ of Philippines, the U.S. was required to obtain consent of the Philippines as coastal state under UNCLOS article 258, which the U.S. failed to do, making this situation a legal "grey area."). *But see* Raul (Pete) Pedrozo, *Military Activities in the Exclusive Economic Zone: East Asia Focus*, 90 INT'L L. STUD. 514, 524–31 (2014)

not directly related to the issue of COLREGS uncertainty, UNCLOS considerations are informative to the UMS-COLREGS discussion, as the COLREGS and UNCLOS both govern maritime navigation, with UNCLOS applying on a jurisdictional level and the COLREGS on a vessel-specific level.[31] As an important caveat, although they are related, the COLREGS and UNCLOS are distinct agreements with different purposes and effects, so the recommendation to recognize most UMSs as COLREGS vessels does not necessarily mean that interested states should take a similar position on UMSs in the UNCLOS (and customary international law of the sea) context.[32]

(demonstrating in detail that military data and intelligence collection activities in EEZs are lawful irrespective of coastal state consent based on long-standing state practice, customary international law, and the language of UNCLOS).

[31] See UNCLOS and COLREGS, *supra* notes 5 and 6 (UNCLOS (and the customary international law of the sea) governs maritime navigation on a macro level, addressing issues of jurisdiction and passage rights, while the COLREGS apply on a micro level, regulating vessel-specific issues like safe speed, lighting, and rules on interaction among vessels). For information about UNCLOS incorporating IMO convention standards by reference, including COLREGS standards, see ANNA MIHNEVA-NATOVA, THE RELATIONSHIP BETWEEN UNITED NATIONS CONVENTION ON THE LAW OF THE SEA AND THE IMO CONVENTIONS 7–11 (2005), http://www.un.org/depts/los/nippon/unnff_programme_home/fellows_pages/fellows_papers/natova_0506_bulgaria.pdf [https://perma.cc/BS72-P3L3].

[32] *See* Schmitt & Goddard, *supra* note 7, at 576–77 (arguing that UMSs cannot be "unequivocally characterize[d]" as vessels or ships under every international agreement because the definitions of these terms were created for the purposes of each respective agreement and the terms do not necessarily apply the same in other agreements); Logan, *supra* note 11, at 8 (arguing that one legal definition for UMSs is unhelpful in part because"[i]nternational maritime legal regimes serve different purposes and effectuate different policy interests"). *But see* Maritime Law Association of the United States, *Response of MLA to CMI Questionnaire re Unmanned Ships* at 5, http://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-US.pdf [https://perma.cc/D6Z5-63UJ] [hereinafter MLAUS response to CMI Questionnaire] (Discussing the impact of "the effectively single statutory definition of "vessel" in United States law for various purposes "because a craft that is a vessel for one purpose also is a vessel for nearly every other purpose under the law, once a craft is determined to be a vessel, it is imbued with all of the rights and obligations concomitant with that status."). UNCLOS considerations are largely beyond the scope of this paper, but whether UMSs as ships or vessels are subject to the rights and responsibilities of UNCLOS may be more important to the DoD than whether the COLREGS apply. For example, whether a UMS is recognized as a ship or vessel within UNCLOS (and customary international law) could impact the extent a UMS is entitled to exercise navigation rights such as innocent passage, and may implicate sovereign immunity considerations. *See* Schmitt & Goddard, *supra* note 7, at 578–82. *See generally* Norris, *supra* note 10, at 30–46. In any case, this paper asserts that definitive recognition of UMSs as vessels under the COLREGS need not accompany a similar result on ship status within UNCLOS as the two issues are not necessarily related.

Finally, the recommendation in this paper for the United States to work towards definitive recognition of UMSs as COLREGS vessels is subject to two additional clarifications. First, the recommendation is limited to those UMSs that reasonably meet the definition of a COLREGS vessel. As discussed in Part II, Section B, *infra*, not every UMS meets or should meet the vessel definition, although this paper recommends an inclusive interpretation to strengthen regulatory certainty for as many UMSs as possible and to incentivize the development of COLREGS-compliant devices.[33] Second, while this paper primarily concerns UMSs operated by the military, the COLREGS should govern all UMSs that meet the definition of a vessel including those operated by the military, those in other governmental service, and privately-owned UMSs. UMSs that are privately-owned or that otherwise engage in commercial service face certain regulatory considerations that do not necessarily apply to UMSs in non-commercial service.[34] Nonetheless, there is no overriding policy rationale for treating military and non-military UMSs vessel status differently under the COLREGS, and navigation safety would be furthered by maximum recognition of UMSs as vessels, to the extent supported by law. Subject to caveats discussed in Part III, *infra*; this paper will demonstrate that most UMSs can and should operate as vessels under the COLREGS, while additional regulatory guidance and amendments to better account for UMSs should be pursued.[35]

II. UMS CHARACTERISTICS AND CURRENT STATUS

A. Characteristics of DoD UMSs in Operation and Development

According to DoD's Unmanned Integrated Roadmap FY2013-FY2038, UMSs in operation and in development range widely from small torpedo-shaped objects, to vehicles resembling speedboats, to larger

[33] *See* discussion *infra* Part II, Section B (describing vessel status under the COLREGS, United States and foreign law); discussion *infra* Part IV (discussing a technology forcing benefit of broad recognition of vessel status for UMSs).

[34] *See* Norris, *supra* note 10, at 56 (stating that certain UMSs may be subject to the requirements of international maritime agreements that do not necessarily regulate UMSs in government non-commercial service such as the STCW Convention, MARPOL, SOLAS (depending of the size and tonnage of the government ship), and the International Management Code for the Safe Operation of Ships and for Pollution Prevention).

[35] *See* NAVSAC Resolution 16-01, *supra* note 21 (recommending a series of best practices for UMSs to provide guidance, information and awareness for UMS operators); s*ee also infra* Part III, Section D and Part VI (discussing regulatory best practices and proposed amendments to the COLREGS in greater detail).

craft.[36] Per Navy doctrine, UMSs are divided between unmanned surface vehicles (USVs) and unmanned underwater vehicles (UUVs).[37] The United States Navy envisions a diverse set of missions for its USVs,[38] and the systems the United States Navy operates and plans to develop range widely in size and scale.[39] As an example, the Defense Advanced Research Projects Agency (DARPA) anti-submarine warfare continuous trail unmanned vehicle (ACTUV) "Sea Hunter" is a large, 130-foot trimaran-style USV in testing that will be capable of operating autonomously or semi-autonomously for up to seventy days without resupply.[40] According to its most recent publicly available plan for UUVs, the United States Navy is also developing a wide spectrum of UUVs.[41] The United States Navy also contemplates using its UUVs for a variety of mission sets.[42] As a general rule, the COLREGS present fewer challenges for UUVs than USVs because the COLREGS do not govern subsurface operations.[43]

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[36] DoD Integrated Roadmap, *supra* note 1, at 8 (depicting various types of UMSs under development by the DoD).

[37] *See* U.S. DEP'T OF NAVY, THE COMMANDER'S HANDBOOK ON THE LAW OF NAVAL OPERATIONS, NWP 1-14M, § 2.3.4–2.3.6 (August 2017) [hereinafter COMMANDER'S HANDBOOK].

[38] *See id*. § 2.3.4; *see also* U.S. DEP'T OF NAVY, THE NAVY UNMANNED SURFACE VEHICLE (USV) MASTER PLAN xi (2007) [hereinafter USV MASTER PLAN].

[39] *See* USV MASTER PLAN *supra* note 38, at xii (explaining that USVs are scaled from small "x-class" platforms that vary widely in size and purpose, to "harbor and snorkeler-class" sizes with 7-meter hulls, to "fleet class" with 11-meter (or larger) hulls).

[40] Paul Benecki, *DARPA Christens (Mostly) Autonomous Vessel*, MAR. EXEC.(Apr. 7, 2016, 6:28 PM), http://www.maritime-executive.com/features/darpa-christens-mostly-autonomous-vessel [https://perma.cc/K9K8-Z7EG].

[41] *See* U.S. DEP'T OF NAVY, THE NAVY UNMANNED UNDERWATER VEHICLE (UUV) MASTER PLAN, xxii (2004) [hereinafter UUV MASTER PLAN] (describing UUVs as ranging from a small "man-portable class" that displaces about 25-100 lbs., to a "light weight vehicle class" that displaces about 500 lbs., to a "heavy weight class that displaces about 3000 lbs., to a "large vessel class" that displaces approximately 10 long-tons); *see also* Sally DeBoer, *A Survey of Missions for Unmanned Undersea Vehicles: Publication Review,* DRONES TECH REV. (June 9, 2015), http://cimsec.org/survey-missions-unmanned-undersea-vehicles-publication-review/16670 [https://perma.cc/5KFQ-AR72] (stating that an updated UUV master plan was produced in 2011, but not released to the public).

[42] *See* COMMANDER'S HANDBOOK, *supra* note 37, § 2.3.5; UUV MASTER PLAN, *supra* note 41, at xix. (describing the range of missions for UUVs including "intelligence, surveillance, and reconnaissance; mine countermeasures, ASW, inspection/identification, oceanography, communication/navigation network nodes, payload delivery, information operations . . . time critical strike, barrier patrol (homeland defense, antiterrorism/force protection and barrier patrol (sea base support)").

[43] *See* COLREGS, *supra* note 6, Rule 1(a) ("These rules shall apply to all vessels *upon* the high seas and in all waters connected therewith navigable by seagoing vessels.") (emphasis added).

In addition to having a wide variety of characteristics and utility for diverse missions, the level of autonomy for UMSs also ranges significantly. Levels of autonomy are not described in the same way by every organization that works with UMSs, but organizations tend to describe autonomy on a scale that ranges from maximum human control (manual control) to full autonomy.[44] In its USV Master Plan, the United States Navy describes the range of autonomy: "manual" (humans remotely make all decisions), semi-autonomous (some behaviors are autonomous and others are initiated by humans) and fully autonomous (a UMS makes decisions without regular human interaction and control).[45] The IMO also created a framework for degrees of autonomy ranging from a ship with automated processes with seafarers onboard, to remote control with seafarers onboard, to remote control without seafarers onboard, to a fully-autonomous ship with a system that makes decisions and determines actions by itself.[46] Notably, even the most autonomous UMS envisioned by DoD retains human oversight for emergencies, such as the ability to override an action of a UMS, but human input will be reduced to "one of supervision,"[47] as autonomy is planned to increase in the long-term.[48]

B. UMSs as Vessels under the COLREGS

One of the first and most important considerations for decision-makers working on the UMS-COLREGS effort is whether UMSs, or perhaps only a subset, are (or should be) vessels subject to the COLREGS, or in the alternative, whether UMSs fall (or should fall) outside of the Rules as non-vessels. The following section reviews the requirements and definitions for vessel status in the COLREGS, in United States law, and in foreign law to help answer this question. This section concludes that broad and inclusive vessel status for all but a small subset of UMSs is supported by law and desirable for policy reasons.

The definition of a vessel in Rule 3(a) of the COLREGS includes "every description of watercraft, including non-displacement craft, WIG

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[44] *Compare* USV MASTER PLAN, *supra* note 38, at xi (listing levels of autonomy as manual, semi-autonomous, and autonomous or fully autonomous), *with* Maritime U.K. Code of Practice, *supra* note 1, at 14 (describing levels of control defined by the European Defen[s]e Agency's Safety and Regulations for European Unmanned Maritime Systems (SARUMS) group in six levels ranging from: manned, to operated, to directed, to delegated, to monitored, to autonomous—with an operator retaining the ability to monitor events in the most autonomous categories).

[45] USV MASTER PLAN, *supra* note 38, at xi; *see also* DoD Integrated Roadmap, supra note 1, at 15, 66–72.

[46] IMO Autonomous Ships Briefing, *supra* note 8.

[47] DoD Integrated Roadmap, *supra* note 1, at 16.

[48] *See id*. at 72.

[wing-in-ground] craft, and seaplanes, used or capable of being used as a means of transportation over water."[49] This definition is not unlike the definitions in the domestic law of maritime states. For example, the United States statutory definition includes "every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water," and the definitions in foreign laws of other maritime states are similarly broad.[50]

Lozman v. City of Riviera Beach, a 2013 United States Supreme Court decision on the definition of a vessel in American admiralty law, is particularly helpful for its analysis on vessel status, given the close similarity between the definition in the COLREGS and United States law.[51] In *Lozman*, the Supreme Court used an objective test to determine vessel status for an immobile house-boat, deciding that while "not *every* floating structure is a vessel"[52] the test for a vessel is whether "a reasonable observer, looking to the physical characteristics and activities [of the object], would consider it designed to a practical degree to be capable of carrying persons or things over water."[53] In holding that a house-boat was not a vessel, the Court took a step away from an "anything floats" approach—a very broad definition of a vessel—used in earlier cases, but the Court also noted that traditional vessel characteristics, such as possession of a steering mechanism, a raked hull, a capacity to generate or store power, and means of propulsion, remained important to the analysis.[54] As an example of a notable foreign case on UMS vessel status, the Canadian decision in *Cyber Sea Technologies, Inc. v. Underwater*

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[49] COLREGS, *supra* note 6, Rule 3(a). Note that absent more detailed language in the COLREGS to define the term vessel, UMS vessel status is an issue that ultimately will be determined by the courts. However, this section on vessel status is included as a framework for planners and decision-makers to determine the extent that UMSs, as a class, will need to comply with the COLREGS.

[50] 1 U.S.C. § 3 (2006); *see* Eric Van Hooydonk, *The Law of Unmanned Merchant Shipping – an Exploration*, 20 J.I.M.L. 403, 408 (2014) (describing vessel and ship definitions from United States, United Kingdom, Dutch, Spanish, Chinese, and Belgian law); *see also* CMI IWG Website, *supra* note 22 (including the responses to CMI Questionnaire from twenty two national maritime law associations (MLAs), many which include the definition of a vessel of their respective states).

[51] Lozman v. City of Riviera Beach, 568 U.S. 115 (2013).

[52] *Id*. at 121.

[53] *Id*. (using a practical requirement for the definition of a vessel, whether a reasonable observer looking to the house-boat's physical characteristics and activities, would consider it designed to a practical degree for carrying people or things over water).

[54] *Id*. at 121–22 (departing from an anything floats approach to determining vessel status seen in earlier cases, the Court stated "a . . . washtub, a plastic dishpan, a swimming platform on pontoons, a large fishing net, a door taken off its hinges, or Pinocchio (when inside the whale) are not 'vessels,' even if they are 'artificial contrivance[s]' capable of floating, moving under tow, and incidentally carrying even a fair-sized item or two").

Harvester Remotely Operated Vehicle found that an unmanned submersible used to remove submerged timber was a vessel for the purposes of Canada's maritime law jurisdiction.[55]

The definitions for a vessel in the COLREGS, United States, and many foreign laws are therefore quite broad but not so broad to include anything on the water, such as a floating tree or a fixed oil platform. Many of the types of DoD's UMSs described in Section A of this Part, *supra*, likely meet the definition of a vessel under these expansive definitions but not every UMS does, so lines will have to be drawn between UMSs that are vessels and those that are not. A few principles are useful in drawing these lines. First, the size of the UMS alone is not determinative. The COLREGS do not have a de minimis size limit for which vessels fall within the Rules. Some rules apply to very small vessels, notably paragraph (d)(ii) of Rule 23 on Lights and Shapes governs power-driven vessels less than seven meters in length (without specifying a minimum size), and paragraph (d)(ii) of Rule 25 on Sailing Vessels Underway and Vessels Under Oars governs rowing vessels.[56] Therefore, small and possibly even expendable UMSs, including those envisioned for "swarming" attacks,[57] should not necessarily be excluded from COLREGS vessel status based on their size alone. Likewise, the degree of autonomy possessed by a UMS has not been considered a defining characteristic of vessel status.[58] However, UMSs that are physically connected to a mothership, known as remotely-operated vehicles (ROVs), have been treated as appurtenances to vessels in some cases, rather than independent vessels.[59]

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[55] Cyber Sea Technologies, Inc. v. Underwater Harvester Remotely Operated Vehicle, [2002] F.C. 569 (Can.) (a Canadian case that decided an unmanned submersible used to remove timber from a flooded reservoir was a ship for the purposes of Canadian maritime law jurisdiction under the Federal Courts Act); *see also* CANADIAN MLA, RESPONSE TO CMI QUESTIONNAIRE ON UNMANNED CARGO SHIPS, http://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-CANADA.pdf [https://perma.cc/7YEQ-98V3] [hereinafter Canada MLA response to CMI questionnaire] (including discussion of the *Cyber Sea Technologies, Inc*. case definition of a UMS as a ship under the Canadian Federal Courts Act and the statutory definition of a vessel under the Canadian Shipping Act (2001)).

[56] COLREGS, *supra* note 6, Rules 23(c)(ii), 25(d)(ii).

[57] *See generally* Warrior Scout, *Navy Builds Future Attack Drone 'Ghost Fleet,"* WE ARE THE MIGHTY (Feb. 2, 2017, 2:50 PM), https://www.wearethemighty.com/articles/navy-advances-plans-for-futuristic-ghost-fleet [https://perma.cc/9P45-9BTR] (describing planned swarming capability for smaller UMSs).

[58] *See generally* Kraska & Pedrozo, *supra* note 18.

[59] The term "ROV" is defined differently by various sources, but for the purposes of this paper, ROV will be used to refer to those unmanned systems that are physically connected by a tether to a launch platform or mothership, regardless of size, degree of autonomy, or other factors. *See* Halle v. Galliano Marine Serv., LLC, No. 15-5648, 2016

Some authors, like Daniel A. G. Vallejo, argue that UMSs as a whole are not vessels because they are not "capable of being used as a means of transportation."[60] This is because UMSs are generally designed for activities other than transportation (e.g., mine clearance), and they usually only carry internal equipment, which these authors assert as meaning that a UMS cannot be considered "as a means of transportation" without stretching the definition of "transportation" beyond its intended meaning.[61] This argument correctly notes that there are important limits to the types of UMSs that can be considered vessels, but the assertion that UMSs as a whole are not vessels goes too far, given the broad definition in international agreements, United States law, and foreign law as described in this section, *supra*.[62]

In contrast, this paper asserts that a narrow reading of the vessel definition, excluding UMSs that are not specifically designed for transportation or unable to carry items beyond internal equipment, is not the only reasonable interpretation of vessel.[63] Instead, the United States

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U.S. Dist. LEXIS 51572, at *4 (E.D. La. Apr. 18, 2016) (quoting Coakley v. SeaRiver Mar., Inc., 319 F. Supp. 2d 712, 714 n.1 (E.D. La. 2004) ("Critical to the Court's finding was the fact that the ROV was an appurtenance of the vessel. An appurtenance is 'any identifiable item that is destined for use aboard a specifically identifiable vessel and is essential to the vessel's navigation, operation or mission.'"); *see, e.g.*, F.A. Azis et al., *Problem Identification for Underwater Remotely Operated Vehicle (ROV): A Case Study*, 41 PROCEDIA ENGINEERING 554, 554–560 (2012) ("A ROV is a tethered unmanned underwater robot."); *see also* discussion *infra* Part V, Section B (discussing an alternative option to COLREGS governance for UMSs by expanding the adjunct/appurtenance concept to UMSs as a class, in lieu of COLREGS vessel status). *But see* Cyber Sea Tech., Inc. v. Underwater Harvester Remotely Operated Vehicle [2002] F.C. 569 (Can.) (holding that for the purposes of Canadian maritime law jurisdiction, an unmanned submersible is a ship, even though it was connected to a barge by a 400-foot umbilical cord).

[60] *See* Vallejo, *supra* note 9, at 411–13.

[61] *See id*.; Brendan Gogarty & Meredith Hagger, *The Laws of Man over Vehicles Unmanned: The Legal Response to Robotic Revolution on Sea, Land and Air*, 19 J. L. INFO. & SCI. 73, 114 (2008) (Gogarty and Hagger doubt that UMSs are capable of being used for transportation, explaining that "[t]he obvious problem here is the use of the word 'transportation', which requires that vessels must transport something or someone. Whilst many USVs and UUVs will in fact be used for transportation, others may be sealed units, such as exploratory, surveillance or mapping craft.").

[62] Kraska & Pedrozo, *supra* note 18 (providing examples from international agreements to show that vessels are broadly defined in maritime law, listing agreements such as the London Dumping Convention, the 1996 Protocol to the London Dumping Convention, and the COLREGS); *see also* Van Hooydonk, *supra* note 50, at 408.

[63] Rob McLaughlin, *Unmanned Naval Vehicles at Sea: USVs, UUVs, and the Adequacy of the Law*, 6 J. L. INFO. & SCI. 100, 112 (2011) ("I absolutely agree that there is no requirement to read into the definition of 'vessel' any necessity for transporting someone or something characterizable as 'separate' from the vessel. The COLREGs definition is designed to cast the broadest possible net of application . . . ."); Andrew H. Henderson,

and IMO should take an inclusive position that broadly construes "capable of being used as a means of transportation" to include those UMSs that carry internal sensors, equipment, and weapons systems[64] unless courts dictate otherwise. An inclusive reading of vessel status would further navigation safety by ensuring that most UMSs would be governed by the COLREGS, instead of falling outside the requirements of navigational rules as non-vessels.[65]

The technology level of UMSs is another factor that may be relevant to vessel status.[66] UMSs today vary widely in terms of technological capabilities. While none are fully compliant with the COLREGS at this time, some, like DARPA's ACTUV, are functionally compliant or close to compliant with many of the Rules.[67] One could argue that treating lower technology UMSs that are unable or mostly unable to comply with the COLREGS as vessels the same as advanced UMSs like the ACTUV is not sensible, especially for devices that lack the basic capabilities to navigate and maneuver.[68] Taking this argument a step further, only the most advanced or high technology UMSs would be vessels subject to the COLREGS, while lower technology or less advanced ones would not be subject to the Rules.

Although level of technology is not expressly mentioned in the definition of vessels in Rule 3(a) of the COLREGS, United States statutes and case law, or foreign laws,[69] the technological ability of a UMS to

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Murky Waters: The Legal Status of Unmanned Undersea Vehicles, 53 NAVAL L. REV. 55, 66 (2006).

[64] Kraska & Pedrozo, *supra* note 18 ("[T]he variation between manned systems and unmanned systems, such as size of the means of propulsion, type of platform, capability, endurance, human versus autonomous control and mission set, has not been a defining character of what constitutes a 'vessel' or 'ship.'").

[65] Note that a broad and inclusive position on COLREGS application to UMSs also aligns with planning assumptions in DoD's Unmanned Integrated Roadmap. *See* DoD Integrated Roadmap, *supra* note 1, at 82 (stating that "USVs must operate in accordance with [COLREGS]" as physical, regulatory, and policy environment planning factors for future UMS development).

[66] *See infra* Part III, Section B (addressing some of the current technological challenges for UMSs to comply with the COLREGS).

[67] *See* Benecki, *supra* note 40.

[68] *See* Savitz et al., *supra* note 26, at 7–15 (discussing the range in technology among UMSs, to include lower technology devices in the emerging market).

[69] *See* 1 U.S.C. § 3 (2018); Lozman v. City of Riviera Beach, 568 U.S. 115 (2013); COLREGS, *supra* note 6, Rule 3(a); Van Hooydonk, *supra* note 50, at 408 (indicating that none of these sources explicitly discuss level of technology as a factor for vessel status under the COLREGS or in admiralty law, although this paper asserts that definitional language "capable of being used as a means of transportation" inherently implies some ability to move and maneuver in light of the traditional vessel characteristics described in Lozman).

operate on the seas is relevant to its status as a vessel. While the possession of traditional vessel characteristics, like steering or a means of propulsion, is not dispositive to vessel status, they are still relevant to the analysis.[70] A UMS without steering or propulsion, for example, is unable to navigate in any meaningful sense and is a hazard to navigation. Moreover, steering and propulsion, as attributes of vessel status, are more important for UMSs than traditional dredges or barges that courts have considered vessels, even though they lack independent propulsion.[71] Unlike a dredge or barge, a UMS is not normally moved by tow, so its ability to maneuver is normally entirely independent. Therefore, level of technology is relevant to vessel status as a baseline, insofar as a UMS possesses these key traditional characteristics of a vessel as described in *Lozman*.[72]

If decision makers want to go beyond possession of steering and propulsion, technology readiness levels (TRLs) may provide a more in-depth way to use level of technology as a benchmark to determine UMS vessel status. TRLs have been used by DoD to assess its UMSs across various categories like navigation, autonomy, communications, propulsion, launch and recovery, and others.[73] While a system of TRLs may be useful to DoD for internal purposes, like resource allocation and development, this paper asserts that TRLs or a similar system is inappropriate to use as a basis for determining COLREGS vessel status for the following reasons. First, there is no guidance in the COLREGS, United States law, or foreign law on what precise technology level or TRL should

[70] Canada MLA response to CMI questionnaire, *supra* note 55 (including portions of the *Cyber Sea Technologies, Inc.* case showing the submersible's possession of power and equipment to navigable were important for vessel status); *see Lozman*, 568 U.S. at 137 (citing The Robert W. Parsons, 191 U.S. 17, 31 (1903)); *see also* Van Hooydonk, *supra* note 50, at 408 (citing Belgian law that considers "every craft, with or without its own propulsive power . . ." to be a "vessel."). For simplicity, this paper distills traditional vessel requirements listed in *Lozman* to steering and propulsion, the key attributes necessary for basic maneuverability and mobility.

[71] *Cf.* Stewart v. Dutra Constr. Co., 543 U.S. 481, 489–95 (2005) (indicating that a dredge is a vessel for the purposes of the Longshore and Harbor Worker's Compensation Act (LHWCA), although dredges generally lack independent means of propulsion and are often moved under tow or by some method other than independent power).

[72] *Lozman*, 568 U.S. at 121–22.

[73] *See* Savitz, *supra* note 26, at 11–15; USV MASTER PLAN, *supra* note 38, at 67–69; UUV MASTER PLAN, *supra* note 41, at 55–60 (demonstrating DoD's use of TRLs to evaluate technological capabilities of USV classes, assessed for hull, ballast, energy, navigation, guidance and control, communications, propulsion, masts, auto-launch and recovery, and UUV classes, assessed for sensors, communication, navigation, energy, data signal processing, autonomy, structure, mission equipment, vehicle control, host interface, and logistics support).

qualify a UMS for COLREGS vessel status.[74] Any lines drawn using levels of technology, beyond the baseline discussed above,[75] would be arbitrary without further guidance. Additionally, the IMO could develop a system like DoD's TRLs for international application, but doing so is likely impractical because of the wide variety of UMSs[76] and because companies and adversaries would likely refuse to disclose the technical information necessary to develop and implement international standards. Even if a consensus could be reached on technology standards for vessel status, doing so would cause a significant number of UMSs to initially fall outside the COLREGS as non-vessels.[77] As non-vessels, these UMSs would not be subject to any navigation rules, cutting against the policy goal of enhancing navigation safety. A final argument against using TRLs is that by using detailed technology standards to determine a UMS's vessel status, UMS developers may be negatively incentivized to develop future UMSs at a level just below the requisite TRL for a vessel, whatever it may be, to avoid the need to make a UMS COLREGS-compliant. Based on the above, this paper posits that as long as a UMS is capable of basic steering and propulsion, it should not be excluded from COLREG vessel status based on technology factors alone.[78]

Taken together, an inclusive reading of the vessel definition in the COLREGS encompasses any UMS as a vessel that operates as a distinct, yet not necessarily autonomous, entity on the water, which also possesses some steering capability and a means of propulsion (excluding immobile or unpowered craft and craft that are physically connected to a launching platform).[79] Until the IMO acts to definitively recognize that unmanned systems can have COLREGS vessel status, COLREGS application will remain uncertain for even the most capable and vessel-like UMS. Nonetheless, broad and inclusive vessel status for UMSs serves United States and IMO interests and should be used by decision-makers as a planning factor for the IMO exercise and beyond.

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[74] *See* COLREGS, *supra* note 6, Rule 3(a).
[75] *See supra* note 51 and accompanying discussion.
[76] *See* Savitz et al, *supra* note 26, at 11–15 (discussing variety in UMS technology among TRL levels).
[77] *See* discussion *supra* Part I (including language in Rule 1 on application of the COLREGS to vessels).
[78] *See* discussion *infra* Part IV (discussing technology forcing benefits of broad and definitive COLREGS application for UMSs, including lower technology and UMSs that are incapable of full compliance with the COLREGS).
[79] *See supra* note 59 and accompanying discussion.

C. Current United States Government and International Efforts

As reflected in its 2013 Unmanned Integrated Roadmap FY2013-FY2038, DoD has assumed that its UMSs must follow the COLREGS, at least as a planning factor for future development.[80] However, since the issuance of the Roadmap, the United States government has considered options other than definitive COLREGS application for UMSs, such as the potential adoption of UMS best practices, and has worked with the IMO to thoroughly study the issue.[81] In 2017, the United States co-sponsored a proposal with other states at the IMO Maritime Safety Committee (MSC) to study application of the IMO regulations to UMSs.[82] This proposal recommended that MSC "engage in a regulatory scoping exercise" to review IMO regulations and propose amendments "to ensure that the construction and operation of Maritime Autonomous Surface Ships (MASS) were carried out safely, securely, and in an environmentally

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[80] DoD Integrated Roadmap, *supra* note 1, at 81–82; *see also* Maritime U.K. Code of Practice, *supra* note 1, at 6.3, 6.4, 7.13 (Stating that MASSs (its term for UMSs) should comply with light, shape, and sound signals in the COLREGS, and "Control System shall be capable of operating with the requirements of Chapter 5 [vessel design and manufacture standards] and Chapter 10 [System integrity certification and test procedures] to a level of compliance with the COLREGS as appropriate to the MASS class.").

[81] *See* Letter from J.G. Lantz, Director, Commercial Regulations and Standards, U.S. Coast Guard, COMDT (CG-5PS), to Ki-tack Lim, Secretary General, International Maritime Organization (Jan. 15, 2016), http://www.imo.org/en/About/strategy/Documents/Member%20States%20-%20tdc/United%20States%20-%20Input%20to%20TDCs.pdf [https://perma.cc/P5QD-UCRL] [hereinafter Coast Guard letter] (Responding to IMO request for information on trends, developments and challenges, the United States Coast Guard stated that "IMO Conventions, such as COLREGS and SOLAS, will likely need amendments to address ship-to-ship movements and communication requirements for [UMSs'] safe operation.").

[82] Internat'l Maritime Org. [IMO], *Maritime Safety Committee (MSC), 98th session*, *7-16 June 2017* (June 28, 2017), http://www.imo.org/en/mediacentre/meetingsummaries/msc/pages/msc-98th-session.aspx [https://perma.cc/XX8K-225C] (discussing the scoping exercise of IMO regulations proposed by the MSC for application to marine autonomous surface ships (MASS)) [hereinafter IMO Maritime Safety Committee Ninety- Eighth Session]; Int'l Maritime Org. [IMO], Maritime Safety Committee Ninety-Ninth Session, MSC 99/22, *Regulatory Scoping Exercise for the Use of Maritime Autonomous Surface Ships (MASS), Plan of Approach for the Scoping Exercise* (June 5, 2018), http://www.iadc.org/wp-content/uploads/2018/07/MSC-99-22-Report-Of-The-Maritime-Safety-Committee-On-Its-Ninety-Ninth-Session-Secretariat.pdf [https://perma.cc/L45N-LBW2] [hereinafter IMO Maritime Safety Committee Ninety- Ninth Session Plan of Approach] (providing a plan of approach to implement the regulatory scoping exercise, proposed at the ninety-eighth session of the MSC in MSC 98/20/2 by Denmark, Estonia, Finland, Japan, the Netherlands, Norway, Republic of Korea, the United Kingdom and the United States).

sound manner," with a projected completion date in 2020.[83] MSC later established definitions for MASS and degrees of autonomy and established a plan to implement the scoping exercise at its 99th session in May 2018.[84] Although this paper is focused on the COLREGS, the IMO scoping exercise is also examining the impact of UMSs within the other IMO conventions like the International Convention for the Safety of Life at Sea (SOLAS) and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention).[85] As such, the IMO is conducting a very comprehensive effort to determine the impact of UMSs on the maritime regulatory framework and how the framework may need to change to accommodate this new technology.[86]

At the present time, no other maritime state operates UMSs to the degree that the United States does,[87] and some have different perspectives on this issue.[88] Nonetheless, unlike recent controversies over autonomous weapon systems[89] or challenges to United States' assertions of UMS navigational rights in the UNCLOS context,[90] opposition to greater clarity

[83] IMO Maritime Safety Committee Ninety-Ninth Session Plan of Approach, *supra* note 82.

[84] *See* IMO autonomous ships briefing, *supra* note 8. *See generally id*.

[85] *See* Internat'l Convention on Standards of Training, *Certification and Watchkeeping for Seafarers,* July 7, 1978, [hereinafter STCW Convention]; MARPOL *supra* note 6.

[86] *See* IMO autonomous ships briefing, *supra* note 8.

[87] *See* Savitz, et. al *supra* note 26, at 11–15 (indicating that in 2013, the United States and friendly nations dominated the current and emerging market for UMS production, especially for higher, but also lower, technology UMSs).

[88] *See, e.g*., BRITISH MAR. LAW ASS'N, RESPONSE TO CMI QUESTIONNAIRE: UNMANNED SHIPS 1, http://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-UK.pdf [https://perma.cc/34LU-ML6G] [hereinafter British MLA response to CMI Questionnaire] (providing an example of the British MLA view on the potential for "vessel" status for UMSs that would seem to present fewer challenges compared to other perspectives as"[t]he unmanned operability of any such "ship" does not seem to present barriers to compliance with the specific UK requirements for ship registration).

[89] *See* STEVEN GROVES, HERITAGE FOUND., A MANUAL ADAPTING THE LAW OF ARMED CONFLICT TO LETHAL AUTONOMOUS WEAPONS SYSTEMS 69–71 (Apr. 7, 2016), http://www.heritage.org/defense/report/manual-adapting-the-law-armed-conflict-lethal-autonomous-weapons-systems [https://perma.cc/QLS3-43JM] (describing opposition from Human Rights Watch, Amnesty International, Article 36 and other non-governmental organizations (NGOs) and certain states to lethal autonomous weapons systems (LAWS) in the Convention on Certain Weapons process as well as the "Campaign to Stop Killer Robots" and the International Committee for Robot Arms Control).

[90] *See generally* William Yale, *Uncharted Waters, the Sobering Implication of the Chinese UUV Seizure,* THE NAVALIST (Dec. 21, 2016), https://thenavalist.com/home/2016/12/20/to4rzgdg6a3x4r7ogbwqcbnr9eq2kx

for UMSs under the COLREGS is less likely based on a review of survey responses from various national MLAs.[91] This is because a more certain regulatory environment for UMSs would benefit all states, regardless of whether they operate UMSs or not. Additionally, the focus of the COLREGS on technical and vessel-specific issues is less controversial than UNCLOS matters, which more directly impact state sovereignty. Accordingly, international consensus on the UMS-COLREGS issue is achievable, and the IMO exercise has a good chance of success.

III. COLREGS CHALLENGES FOR UMSS

In order to show that definitive COLREGS governance for UMSs is desirable, first it is necessary to demonstrate that COLREGS compliance is possible, i.e., that UMSs are capable of complying with the Rules as written. This assessment must focus on: (A) whether COLREGS Rules that were drafted for manned vessels, categorically require the physical presence of humans in order for a vessel to follow the rules and (B) given the present state of unmanned systems technology, whether UMSs are technologically able to comply with the Rules. This Part also considers application of COLREGS special categories to UMSs and addresses best practices and proposed amendments to clarify the Rules to better account for UMSs.

A. COLREGS Rule-Based Challenges for UMSs

This section explores the impact of specific COLREGS rules to UMSs and whether any rule categorically requires the physical presence of a human onboard a vessel. At first look, Rule 2 on Responsibility in Part A on General Rules and Rule 5 on Look-outs in Part B on Steering and Sailing present the most difficulty for UMSs because these rules appear to require the involvement of humans, at least implicitly.[92] Rule 2(a) contains a requirement that vessels must be handled in accordance with the "ordinary practice of seamen."[93] Additionally, Rule 2 includes an exigent

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[https://perma.cc/B9UA-SWZT] (outlining Chinese statements and arguments seeking to challenge the United States Navy's UMS (UUV) and legitimize its seizure of the United States UMS in December 2016).

[91] *See generally* CMI IWG website, *supra* note 23.

[92] See COLREGS, *supra* note 6, Rule 2 and 5; *see also* Vallejo, *supra* note 9, at 423 n.78 ("The usage of the words 'sight' and 'hearing' denote human characteristics of observation.").

[93] COLREGS, *supra* note 6, Rule 2(a) ("Nothing . . . shall exonerate any vessel, . . . from the consequences of any neglect to comply with these Rules or of the neglect of any

circumstances exception that allows a departure from the rules when necessary to avoid danger or collision.[94] This rule therefore implies a degree of human or human-like decision-making to have the ability to make judgments of an "ordinary seaman" and to determine when a departure from the Rules is necessary.

Rule 2 requirements should not present a rule-based challenge for remote-controlled UMSs because human controllers can exercise the judgment of an ordinary seaman as well as a seaman physically onboard a vessel.[95] The rule may, however, present significant challenges for the more autonomous UMSs that do not involve humans for most decisions, requiring a broad reading of the rule at a minimum.[96] In any case, Rule 2 does not explicitly require a physical human presence onboard a vessel in order to comply with the rule, and an autonomous UMS with a remote human decision-maker in the loop for emergency situations as a workaround should allow the UMS to meet these requirements.[97]

Perhaps more than Rule 2 and the other COLREGS rules, Rule 5, on look-outs, comes the closest to explicitly requiring human presence on a vessel. Rule 5 states that "[e]very vessel shall at all times maintain a proper look-out by *sight and hearing* as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and risk of collision."[98] At least one court noted that the use of Automatic Radar Plotting Aid (ARPA) does not obviate the need to use a dedicated look-out, and this reasoning could be extended by analogy to UMSs.[99] While the sensors of a UMS may perform better than a human's eyes and ears, it is possible a UMS sensor suite would not satisfy these requirements under a strict interpretation of

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precaution which may be required by the *ordinary practice of seamen* (emphasis added), or by the special circumstances of the case.").

[94] *Id*. Rule 2(b) (allowing further departure from the Rules when the "dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate danger").

[95] CMI IWG Position Paper, *supra* note 21, at 13–14 (discussing the ability of a UMS to comply with Rule 2, "[i]n 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").

[96] *See infra* Part III, Section D.

[97] COLREGS, *supra* note 6, Rule 2.

[98] *Id.* Rule 5 (emphasis added).

[99] *See* Tokio Marine & Fire Ins. Co. v. M/V Flora, No. 97-1154, 1999 LEXIS 267, at *42–43 (E.D. La. Jan. 11, 1999), *aff'd*, 235 F.3d 963 (5th Cir. 2001) (discussing that use of radar does not obviate the need for a dedicated look-out).

Rule 5, although a remote human observer probably would.[100] Rule 5 does not define whether the "look-out" requirement means an actual look-out as a watch-stander or merely the function of a watch-stander, so there is room to argue that an autonomous system with sensors can fulfill the functional requirement for a look-out.[101] In any case, Rule 5 presents a rule-based challenge for direct application to UMSs, which can be overcome by a broad reading of the rule or an amendment that exempts UMSs from Rule 5.[102] Echoing the views of some commentators, this paper asserts that a broad reading of Rule 5, considering sensors the functional equivalent of "sight and hearing," is reasonable, noting that UMSs are being developed with sensors advanced enough to meet judicial requirements for the Rule.[103] Notwithstanding, an amendment to expressly exempt UMSs from Rule 5's look-out requirement is recommended, such as one proposed by the United States Navigational and Safety Advisory Council (NAVSAC), a federal advisory committee on navigation safety that has studied UMS issues, discussed *infra* in this Part, Section D.[104]

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[100] *See* CMI IWG Position Paper, *supra* note 21, at 14.

[101] *See* GERMAN MLA (DVIS), CMI IWG QUESTIONNAIRE "UNMANNED SHIPS" RESPONSE 11 (June 20, 2017), http://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-GERMANY.pdf [https://perma.cc/C8Q2-DDT3] (providing a well-developed analysis about application of the look-out requirements of Rule 5 to UMSs and asserting that whether this rule can be met remotely depends on whether the requirement mandates a look-out as an actual human watch-stander or instead, as a function).

[102] *Id.* at 12 (Discussing remote compliance with Rule 5, "the fact that the information is perceived by way of technical means does not in itself constitute a breach of Rule 5" and "visual and aural information transferred would need to enable the lookout to see and hear at least as good as if he would had he been physically present on board," and other factors would need to be considered "such as the likelihood and consequences of a possible malfunctioning of the technical equipment."). *Contra* Vallejo *supra* note 9, at 422–23 (Asserting that unmanned vessels are incapable of meeting the look-out requirements of Rule 5—"Not only do the definitions listed in the regulations assign each vessel a human navigator, but the navigations itself is supposed to adhere to navigation and safety provisions based on human characteristics.").

[103] *See* Paul W. Pritchett, *Ghost Ships: Why the Law Should Embrace Unmanned Vessel Technology*, 40 TUL. MAR. L.J. 197, 205–06 (2015) ("[T]he [unmanned] system is extremely close to meeting the courts' formulations of the capabilities of a proper lookout. It can detect large and small objects, it can detect changes in the course of other vessels, and it can be simultaneously stationed on multiple parts of the vessel."); MLAUS response to CMI Questionnaire, *supra* note 32, at 12 ("It is nevertheless possible that a sufficiently sophisticated on-board system that would enable "sight and hearing" for a remote human controller equivalent to that which could be attained by a lookout stationed on the bridge and/or bow of the vessel would be satisfactory under Rule 5.").

[104] U.S. NAVIGATION & SAFETY ADVISORY COMM., RESOLUTION 11-02, UNMANNED VEHICLES/VESSELS (2011), https://homeport.uscg.mil/Lists/Content/Attachments/455/NAVSAC%20Resolution%2011-02%20-%20Unmanned%20vessels.pdf [https://perma.cc/VS86-7SWA] [hereinafter

While Rule 5 seems to present the biggest rule-based challenge for UMSs that contemplates human presence, other rules in the COLREGS also need to be reviewed.[105] Rule 6 on Safe Speed does not require a human to be onboard, but it does require several factors to be considered when determining safe speed, some which may be difficult for UMSs.[106] Some of these factors include: weather, visibility, sea state, maritime traffic, and proximity to hazards.[107] An autonomous UMS needs to have adequate sensors to take these and other maritime factors into account. Rule 7(a) on Risk of Collision states that "[e]very vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists . . . ."[108] Rule 7(c) further states that "assumptions shall not be made on the basis of scanty information, especially scanty radar information."[109] This rule does not require a human crew per se, but it is important that UMS sensors have sufficient precision to provide more than "scanty" information. Rule 8 on Actions Taken to Avoid Collision includes descriptions of the actions and manner of actions that a vessel needs to take to avoid collision.[110] This Rule is unlikely to present unique challenges for a UMS, aside from paragraph (a) that states "[a]ny action taken to avoid collision shall be taken . . . with due regard to the observance of good seamanship."[111] As with Rule 2, a UMS can meet the "good seamanship" requirement with a human remote-controller or perhaps eventually by advanced

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NAVSAC RESOLUTION 11-02]; U.S. NAVIGATION & SAFETY ADVISORY COMM., RESOLUTION 12-08, UNMANNED VEHICLES/VESSELS (2012), https://homeport.uscg.mil/Lists/Content/Attachments/461/NAVSAC%20Resolution%2012-08%20-%20Unmanned%20vessels.pdf [https://perma.cc/3JSJ-E3P3] [hereinafter NAVSAC RESOLUTION 12-08]. To date, the recommendations in Resolution 11-02 and Resolution 12-08 have not been adopted by the Coast Guard; *see also* Norris, *supra* note 10, at 49 (Stating NAVSAC is . . . "a group of experts selected and appointed to, among other things, advise and make recommendations to the U.S. Coast Guard on the Rules of the Road.").

[105] *See* CMI IWG Position Paper, *supra* note 21, at 13–15 (discussing challenges UMSs face under COLREGS rules 2, 5, 6, 8, 18, and parts C and D); *see also* SEBASTIAN OHLAND & AXEL STENMAN, YRKESHÖGSKOLAN NOVIA, INTERACTION BETWEEN UNMANNED VESSELS AND COLREGS 17–30 (2017), https://www.theseus.fi/bitstream/handle/10024/125252/Ohland_Sebastian-Stenman_Axel.pdf [https://perma.cc/5QEK-5KCD] (discussing challenges that certain COLREGS rules pose for UMSs).

[106] *See* COLREGS, *supra* note 6, Rule 6(a); CMI IWG Position Paper, *supra* note 21, at 15; OHLAND & STENMAN, *supra* note 105, at 28.

[107] COLREGS*, supra* note 6, Rule 6(a); OHLAND & STENMAN, *supra* note 105, at 28.

[108] COLREGS*, supra* note 6, Rule 7.

[109] *Id.* Rule 7(c).

[110] COLREGS*, supra* note 6, Rule 8(a); CMI IWG Position Paper, *supra* note 21, at 15; OHLAND & STENMAN, *supra* note 105, at 20.

[111] COLREGS, *supra* note 6, Rule 8(a).

programming. Rule 19 on Conduct of Vessels in Restricted Visibility applies to vessels not in sight of one another when navigating in or near an area of restricted visibility. Rule 19 also does not explicitly require human presence per se, but in order to comply with the rule, a UMS must have the ability to perceive conditions that qualify as restricted visibility and to act accordingly.[112]

UMS design characteristics often do not match those of traditional vessels, so a UMS also may have difficulty complying with some of the light and shape requirements in Part C and sound and light signal requirements in Part D of the COLREGS, especially without a human crew onboard.[113] However, Rule 1 authorizes the government to issue a certificate of closest-possible compliance for "vessel[s] of special construction or purpose," to allow variance from "the number, position, range or arc of visibility of lights or shapes, as well as to the disposition and characteristics of sound-signaling appliances."[114] These certificates may be useful for many types of DoD UMSs, and they should be considered in the design process. To comply with the COLREGS, a UMS must not only conform to the characteristics in Parts C and D but also must be able to perceive light and shape requirements and sound signals of other vessels.[115] While Parts C and D do not present rule-based limitations that necessarily require a UMS to be manned, programming a UMS to perceive sounds, lights, and shapes does present a significant technological challenge for UMSs that will be discussed more in Section B *infra*.

A final rule-based challenge to UMSs under COLREGS is the requirement of a human crew for radio communications as a method to arrange passage and as a means to communicate distress as demanded in Annex IV on Distress Signals.[116] Assuming radio equipment is operational and has a sufficient range, which can be a challenge,[117] a human-operated UMS that is controlled remotely (and within range) should be able to communicate with other vessels by radio as well as a manned vessel. For autonomous vessels, this challenge is greater, but it can likely be

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[112] OHLAND & STENMAN, *supra* note 105, at 21–22, 29.

[113] *See* COLREGS, *supra* note 6, parts C and D; CMI IWG Position Paper, *supra* note 21, at 15.

[114] COLREGS, *supra* note 6, parts C and D.

[115] COLREGS, *supra* note 6, parts C and D; CMI IWG Position Paper, *supra* note 21, at 15.

[116] COLREGS, *supra* note 6, annex IV (explaining radio communications as a method to indicate distress); *see also* Vessel Bridge-to-Bridge Radiotelephone Regulations, 33 C.F.R. § 26 (2017) (applying to navigable waters of the United States).

[117] *See What is VHF?*, BLUESEAS, http://www.offshoreblue.com/communications/vhf-capabilities.php [https://perma.cc/H4KQ-EVSR] (showing that traditional bridge-to-bridge radio range is generally limited to a transmission radius of 20 nautical miles).

overcome by a UMS forwarding radio communications to a remote human operator. Notwithstanding, use of voice recognition technology for an autonomous UMS to directly communicate by radio is not yet achievable, even for the ACTUV Sea Hunter.[118] If not for the workaround of forwarding communications to a human operator, radio communications would present the clearest rule-based hurdle for autonomous UMSs. As such, this paper recommends an amendment to Annex IV to clarify that UMSs are exempt from radio communications.[119] This would also help mariners clearly understand an important difference between a UMS and a manned vessel.

As demonstrated by this section, none of the COLREGS Rules categorically require the physical presence of a human crew onboard for a UMS to comply with the Rules as written. However, a broad reading of certain rules, like Rule 5, or a workaround that involves the use of a remote human operator, like Rule 2, and the rules on radio communications is necessary for even the most advanced UMS to fully comply with the COLREGS as written.

B. Technological Challenges to UMS COLREGS Compliance

Given that the COLREGS are not categorically restricted to manned vessels per se, it is also important to address whether UMSs are capable of complying with the Rules from an overall technological perspective. Unlike Part II, Section B, which discusses technology level as a possible factor to determine vessel status, this section assumes the COLREGS apply to qualifying UMSs as vessels and focuses, instead, on the challenges that technology poses for autonomous or mostly-autonomous UMSs to comply with the Rules.[120] Autonomous varieties of UMSs have made significant progress in recent years, but even the most advanced autonomous systems are not yet capable of full COLREGS compliance without workarounds or modifications to the Rules discussed in this section and Section D *infra*.[121]

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[118] Benecki, *supra* note 40 (stating that Sea Hunter is not yet capable of autonomously communicating via radio).

[119] *See* Coast Guard letter, *supra* note 81 (stating that possible amendments to the COLREGS may be necessary in the areas of ship movements and communications).

[120] *See* NAVSAC RESOLUTIONS 11-02, *supra* note 104 (distinguishing between autonomous and remote-controlled UMSs regarding the ability to comply with the COLREGS and asserting that remote-controlled UMSs should be treated like manned vessels); NAVSAC RESOLUTIONS 12-08, *supra* note 104 (same).

[121] *See* Benecki, *supra* note 40; *see also* Pritchett, *supra* note 103, at 207 (arguing that UMSs are not technologically capable of complying with the COLREGS).

The COLREGS technology limitations do not equally apply to all types of UMSs. The degree to which the COLREGS present a challenge to an unmanned system is directly related to its level of autonomy.[122] For example, assuming technology is in working order, a manual or remote-controlled UMS, for which a human makes all decisions, should be able to comply with the COLREGS as well as a manned vessel, except for rules (if any) that require a human to be physically present onboard the vessel. Although not adopted, NAVSAC previously recommended that remote-controlled UMSs operated by humans should be considered as "manned" for COLREGS purposes.[123] This rationale should also apply to semi-autonomous UMSs to a lesser extent because semi-autonomous UMSs have human operators to supervise and make certain key decisions. At the other end of the spectrum, UMSs with the greatest levels of autonomy will have the most difficulty complying with the COLREGS due to the absence of a human operator and programming limitations discussed *infra*.[124]

Above all else, technological challenges for autonomous UMSs primarily involve the difficulties of programming a UMS to adequately perceive "COLREGS-defined lights, shapes, sounds and vessel categories,"[125] which, among other reasons, is critical to determine when a vessel (or UMS) is the stand-on or give-way vessel. A related challenge involves programming an autonomous UMS to operate in complex environments that involve multiple objects.[126] In the Unmanned Integrated

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[122] DoD Integrated Roadmap, *supra* note 1, at 16 (discussing levels of autonomy planned for UMSs); *see also* CMI IWG Position Paper, *supra* note 21 (discussing the relative ease that remote-controlled vehicles have to comply with the COLREGS compared to autonomous craft).

[123] NAVSAC RESOLUTION 11-02, *supra* note 104 (Recommending the promulgation of "an interpretive rule under 33 C.F.R. Parts 82 and 90 to provide that a vessel being operated remotely is considered to be manned and must comply with the applicable Navigation Rules and annexes."); NAVSAC RESOLUTIONS 12-08, *supra* note 104.

[124] Benecki, *supra* note 40 (describing limitations of DARPA's ACTUV Sea Hunter in complying with the COLREGS); *see also* Pranay Agrawhal & John Dolan, *COLREGS-Compliant Target Following for an Unmanned Surface Vehicle in Dynamic Environments*, 2015 IEEE/RSJ INT'L CONFERENCE ON INTELLIGENT ROBOTS & SYS. (IROS), Oct/Sept., https://www.ri.cmu.edu/pub_files/2015/9/IROS-Pranay-Final-Copy.pdf [https://perma.cc/3HR6-L34J].

[125] Benecki, *supra* note 40 (Stating that the DARPA ACTUV Sea Hunter "does not presently have the ability to perceive and understand COLREGS-defined lights, shapes, sounds and vessel categories.").

[126] *Id.* (Quoting a Leidos representative who stated that DARPA's ACTUV's current level of capability is to operate in open-sea areas outside of congested waters, although operating in complicated environments is "quite technically feasible, he suggested—with enough funding."); Pritchett, *supra* note 103, at 202 (Citing studies showing that UMSs have challenges in dynamic environments. "Computational models show that "path planning around moving obstacles . . . is Non-Deterministic Polynomial-Time hard (NP-hard) or, in other words, very difficult," and "recent field tests of autonomous vessel

Roadmap FY2013–FY2038, DoD assumes that its UMSs will need to operate in complex scenarios in the vicinity of multiple vessels in major shipping lanes and harbors,[127] so this limitation on operating in complex environments is important. Advances in UMS technology have made progress, but not even the most advanced UMSs, like the ACTUV, are able to fully comply with the COLREGS or currently operate in these challenging scenarios.[128]

Notwithstanding these limitations, it is anticipated that autonomous UMSs will be able to fully comply with the COLREGS at a future date. As such, personnel qualification standards (PQSs), or benchmarks derived from these standards, could provide useful programming guidelines for engineers developing future UMSs as well as a standard to certify when an autonomous UMSs become COLREG-compliant.[129] The Navy uses PQSs to evaluate the ability of sailors and bridge crews to navigate vessels and assess characteristics of other vessels such as lighting, sound, and shape signals, to determine appropriate actions in relation to other vessels, and to evaluate numerous other requirements of professional seamanship.[130] An evaluation and certification process similar to a PQS for UMSs could have military and civilian applications and ultimately could provide a method to determine when a UMS crosses the threshold into full COLREGS compliance.[131] In the near-term, while rule-based challenges likely can be overcome by broad interpretations of the Rules or workarounds using a

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systems have demonstrated that in congested waters there is still no substitute for human control.").

[127] DoD Integrated Roadmap, *supra* note 1, at 82 (Describing the planned physical operating environment for a UMS. "The intended physical operating environments for UMS are in and around harbors . . . placed within major shipping routes such as the Strait of Hormuz, or possibly out in the open ocean. . . USVs must be capable of avoiding ships, docks, floating debris, and navigation aids.").

[128] Benecki, *supra* note 40 ("Sea Hunter is not yet the maritime equivalent of a Google Self-Driving Car, handling rush hour in downtown San Francisco, but it could be likened to a freeway-self-driving Tesla Model S."); *see also* ROBERT RYLANDER & YEMAO MAN, LIGHTHOUSE SWEDISH MAR. COMPETENCE CTR., AUTONOMOUS SAFETY ON VESSELS 47 (2016), http://www.lighthouse.nu/sites/www.lighthouse.nu/files/autonomous_safety_on_vessels_-_webb.pdf [https://perma.cc/S3SL-Y3YD] (discussing two European projects on unmanned systems and recommending an incremental approach as functionality matures and legislation catches up to technology).

[129] *See* Email from Captain Albert Janin, JAGC, USN, Deputy Assistant Judge Advocate General for Admiralty and Maritime Law (Nov. 3, 2017, 3:51 PM) (on file with author).

[130] *See generally* U.S. DEP'T OF NAVY, CHIEF OF NAVAL OPERATIONS INSTR. 3500.34G, PERSONNEL QUALIFICATION STANDARDS (15 May 2014).

[131] *See id*.; Maritime U.K. Code of Practice, *supra* note 1, §§ 3.3.1, 12.3, 12.4 (outlining proposed certification requirements for classes of UMSs (MASS), described in general terms).

remote human operator, technological challenges for more autonomous systems are much harder to overcome. However, this does not mean that definitively applying the COLREGS to UMSs is undesirable or impossible, given flexibility provided by special categories contained in the Rules and discussed in the next section *infra*.

C. Special Categories

Noting the challenges above, COLREGS special categories that account for vessels unable to fully maneuver and keep out of the way of other vessels may be useful for UMSs, especially in the interim period before definitive guidance on UMSs is available following completion of the IMO scoping exercise. In general, the COLREGS require other vessels to give way to vessels in a special category on a hierarchical basis, with certain classes of vessels given deference over other classes of vessels based on the degree that their ability to maneuver is limited.[132] Notably, a vessel in a special category is generally required to adhere to certain lighting and shape requirements to alert other vessels about its limitations.[133] As described in Rule 3 (f) and (g), some of these categories that may be applicable for a UMS include: (1) vessels not under command (NUC), "a vessel which through some exceptional circumstance is unable to maneuver as required by these Rules and is therefore unable to keep out of the way of another vessel," and (2) vessels restricted in [their] ability to maneuver (RAM), a "vessel which from the nature of her work is restricted in her ability to maneuver as required by these Rules and is therefore unable to keep out of the way of another vessel."[134] This category includes a non-exhaustive list of vessels including those that work with undersea cables, underwater operations, replenishment at sea, launching and recovering aircraft, and towing operations.[135]

The NUC categorization may be appropriate in emergency situations, such as when a UMS loses propulsion or when communications are lost, but this category is usually temporary and should not be used for

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[132] COLREGS, *supra* note 6, Rule 18.

[133] *Id*. Rule 27(b) (indicating the lighting and shape requirements for vessels with RAM status).

[134] *Id*. Rule 3(g).

[135] *Id*. (listing the non-exhaustive categories of RAM vessels to include: (i) a vessel engaged in laying, servicing or picking up a navigation mark, submarine cable or pipeline; (ii) a vessel engaged in dredging, surveying or underwater operations; (iii) a vessel engaged in replenishment or transferring persons, provisions or cargo while underway; (iv) a vessel engaged in the launching or recovery of aircraft; (v) a vessel engaged in mine-clearance operations; (vi) a vessel engaged in a towing operation such as severely restricts the towing vessel and her tow in their ability to deviate from their course").

UMSs that are operational and retain the ability to navigate.[136] Compared to NUC status, a vessel can assert RAM status as long as the vessel engages in work that restricts its ability to maneuver, so RAM status apparently provides an option that would be available for UMSs more often.[137] UMSs that are involved in certain types of work, like surveying activities, easily fit into an express RAM category while conducting this work, but since the list of RAM-qualifying activities above is not exclusive, the COLREGS would not necessarily prevent "autonomous operations" in general from being considered as a category of work that restricts the ability of UMSs to maneuver.

Some have suggested that RAM status may not be available to a UMS engaged in routine operations, such as transiting from point *A* to point *B*, in part because autonomous operation is arguably just a mode of operation instead of a "nature of work" that restricts a vessel's ability to maneuver.[138] This paper gives some weight to this position and does not suggest that RAM status is a panacea to allow UMSs that are not fully capable of maneuvering under the COLREGS to operate in a completely safe manner or in all circumstances. Nonetheless, RAM status may be a useful mitigation tool to increase safety for UMSs that operate under the current Rules in advance regulatory guidance by the IMO or other organizations. At a minimum, UMSs engaged in work which fits an express RAM category, like cable maintenance, would qualify for RAM

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[136] McLaughlin, *supra* note 63, at 112 (Arguing that not under command (NUC) status is inappropriate for unmanned vessels because it only covers vessels with "an inability to take collision avoidance action due to some special circumstance (such as loss of propulsion), not the lack of a human on board to command."); Michael R. Benjamin & Joseph A. Curcio, *COLREGS-Based Navigation of Autonomous Marine Vehicles*, AUTONOMOUS UNDERWATER VEHICLES, 2004 IEEE/OES, at 2 (July 2004), https://www.researchgate.net/publication/4143876_COLREGS-based_navigation_of_autonomous_marine_vehicles [https://perma.cc/3Z5D-6DGR]; British MLA Response to CMI Questionnaire, *supra* note 88, at 6 ("The rule [NUC] may, however, cover an unmanned ship that has lost its communications owing to loss of satellite coverage, for instance.").

[137] *See* McLaughlin*, supra* note 63, at 112; Gogarty & Hagger, *supra* note 61, at 115; Benjamin & Curcio, *supra* note 136, at 2 ("[i]t is somewhat more conceivable that the AMV [autonomous marine vehicle] could be considered a vessel restricted in her ability to maneuver").

[138] OHLAND & STENMAN, *supra* note 105, at 30 (arguing that RAM status is not applicable to UMSs when they engage in normal operations because UMSs are designed to work like manned vessels which, like manned cargo ships, do not receive RAM status in their daily work); *see also* Gogarty & Hagger, *supra* note 61, at 115 ("[i]n the alternative, individual vessels within such a swarm might be defined as 'restricted in their ability to manoeuvre', but that would most likely depend on their level of autonomy, how routine the operations they were involved in are, and their ability undertake non-trivial navigation in response to environmental stimuli").

status under the existing COLREGS while engaging in this work. In fact, several missions the Navy envisions for USVs and UUVs include laying undersea sensor grids, mine countermeasures, bottom mapping and surveying, and others, easily fall within existing RAM categories.[139]

In the alternative, by taking a more expansive view of RAM status, UMS operators could assert that "autonomous operations" is a nature of work that restricts a UMS's ability to maneuver. This would require operators to ensure that its UMSs comply with the lighting and shape requirements of Rule 27(b) for RAM status to the extent required by the COLREGS and leave the issue for courts to decide in the event a UMS that asserts RAM status is involved in a mishap.[140] An expansive interpretation of RAM status is defensible under the existing rules,[141] but an amendment to the COLREGS to explicitly make a UMS operating autonomously an express RAM category, similar to an amendment proposed by NAVSAC as discussed *infra* in this Part, Section D,[142] is preferred because it would more precisely account for UMSs under the existing rules.

D. Best Practice Guidance and Amendment Proposals

Several maritime organizations and industry trade groups have proposed regulatory best practices to help regulate UMS operations to supplement the requirements in the COLREGS.[143] For example, in 2016, NAVSAC proposed several non-binding best practices for UMS operations to operate alongside the COLREGS in the areas of safety, professionalism, respect, and procedures. Those recommendations that involve configuring a UMS for safety of navigation include:

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[139] COMMANDER'S HANDBOOK, *supra* note 35, §§ 2.3.4–2.3.5.

[140] *See* COLREGS, *supra* note 6, Rule 27(b).

[141] It is reasonable to argue that because autonomous UMSs are not yet fully capable of keeping out of the way of other vessels in complex environments based on the current technological limitations of autonomous operations, RAM status would be appropriate under the existing COLREGS for vessels engaged in autonomous operations. *See* Benecki, *supra* note 40.

[142] NAVSAC RESOLUTION 11-02, *supra* note 104; NAVSAC RESOLUTION 12-08, *supra* note 104; *see also infra* Part III, Section D.

[143] For an example of steps taken by this United Kingdom maritime organization to review feasibility for unmanned systems operating within international maritime organization framework, see U.K. Marine Indus. All., *Information Paper Submitted to the IMO MSC 95th Session* 10 (Marine Autonomous Systems Regulatory Working Grp, MSC 95/INF., 2015), http://www.maritimeindustries.org/write/Uploads/UKMIA%20Uploads%20-%20DO%20NOT%20DELETE/The_IMO_regulatory_framework_and_its_application_to_Marine_Autonomous_Systems.pdf [https://perma.cc/4M8X-2LZD].

- Placement of a flashing white light . . . on UMS that is visible for at least two nautical miles at all times while operating on or near the surface of the water;
- Unique retro-reflective markings;
- Markings that identify the UMS as a UMS, e.g.: UNMANNED;
- Yellow paint;
- An Automatic Identification System (AIS) that broadcasts a unique identifier; e.g., UNMANNED;
- A radar transponder that displays Morse code Romeo (".-.");
- A sound producing device that, if practicable, can produce the sound signal Morse code Romeo (".-."); and
- Use of a position recorder.[144]

While they have not been adopted by the Coast Guard to date, these proposals could be published in a Navigation Vessels Inspection Circular (NVIC) that would promulgate guidance for United States UMSs.[145] Similarly, the United Kingdom's MASRWG recently published a comprehensive and voluntary Code of Practice for British UMSs.[146] While guidance that may be provided by the Coast Guard will not necessarily apply to DoD's UMSs, it may be in DoD's interests to follow those recommendations that advance navigation safety. At the same time, DoD has certain military requirements for its UMSs that may not be consistent with every best practice proposed by the Coast Guard. For example, a Navy UMS may need to conceal its location on occasion, making a requirement for every UMS to identify itself with a flashing white light impractical for military UMSs.

In addition to best practices, some organizations have proposed amending the COLREGS themselves to better account for UMSs. For example, in 2011 and 2012, NAVSAC proposed amending the COLREGS by: (1) requiring UMSs to be equipped with AIS, if practicable; (2) adding self-propelled, unmanned autonomously operating vessels to the

[144] NAVSAC RESOLUTION 16-01, *supra* note 21.

[145] *See Naval Vessel Inspection Circulars*, U. S. COAST GUARD, http://www.dco.uscg.mil/Our-Organization/NVIC/Year/2010/ [https://perma.cc/L4FL-QNQS] (showing that as of November 25, 2018, the Coast Guard has not yet published an NVIC on UMS operations).

[146] Maritime U.K. Code of Practice, *supra* note 1 (comprising a manual of best practices for UMS (MASS) in the United Kingdom ranging from operations, to design and manufacturing standards to navigational characteristics involving lights, shapes, and sound signals, to system and operator certification, to pollution and other matters).

categories of vessels restricted in their ability to maneuver; (3) limiting the application of Rule 5 on look-outs to manned vessels, and (4) creating new light and flag requirements for UMSs.[147] These amendments were not adopted by the Coast Guard, and as this Part suggests, amendments to the COLREGS are not necessarily a precondition for UMSs to operate under the Rules. However, the proposed amendments to list "autonomous operations" as a category of work that expressly qualifies for RAM status and exempts UMSs from the look-out requirement,[148] would better account for UMSs without compromising an obvious military requirement. Along with an amendment to exempt UMSs from the radio communications provisions, discussed *supra* in Section A of this Part, these amendments would be useful for the United States to advocate in the IMO exercise. Other amendments proposed by NAVSAC to require AIS and specific light and flag requirements for UMSs would provide greater clarity but may unduly constrain military requirements, unless waivable.[149]

IV. ADMIRALTY LAW CONSIDERATIONS

UMSs also raise a host of novel issues in admiralty law including questions about how the doctrines of seaworthiness, limitation of liability, in rem liability, and others apply to this new technology.[150] At first glance, the issue of maritime liability for UMS operations seems like something that should concern the civilian shipping industry more than the Navy, DoD, and the United States government in general. However, the United States government has a broad waiver of sovereign immunity for civil liability in admiralty incidents involving its public vessels.[151] Much like

[147] NAVSAC RESOLUTION 11-02, *supra* note 104; NAVSAC RESOLUTION 12-08, *supra* note 104; Norris, *supra* note 10, at 49–51 (commenting on the proposed amendments by NAVSAC, noting that NAVSAC "appears to have implicitly recognized that at least some UMSs satisfy the broad COLREGS definition of "vessel," but cautioning that as of publication of his article, they have not been formally adopted by the Coast Guard or forwarded to the IMO).

[148] NAVSAC RESOLUTION 11-02, *supra* note 104; NAVSAC RESOLUTION 12-08, *supra* note 104.

[149] COLREGS, *supra* note 6, Rule 1(e) (discussing waivers for vessels of special construction or purpose); *see id.* Parts C and D.

[150] *See generally* Michal Chwedczuk, *Analysis of the Legal Status of Unmanned Commercial Vessels in U.S. Admiralty and Maritime* Law, 47 J. MAR. L. & COM. 123, 156–66 (2016) (discussing implications of unmanned vessels for admiralty and maritime law including an issue of *in rem* liability for unmanned vessels that could be an important consideration for civilian unmanned vessels, but generally inapplicable to U.S. government unmanned vessels because the U.S. cannot be sued *in rem* under the waiver of sovereign immunity in the Public Vessels Act).

[151] *See* Suits in Admiralty Act, 46 U.S.C. § 30901–30918 (2018); Public Vessels Act, 46 U.S.C. §§ 31101–31113 (2018); Canadian Aviator, Ltd. v. United States, 324 U.S. 215

other areas in tort law in which the Federal Government faces liability, the United States waives sovereign immunity for collisions involving the operation of its public vessels under the Suits in Admiralty Act and the Public Vessels Act.[152] This waiver allows the United States to be sued in a federal district court for operations of its public vessels worldwide, subject to limitations in the Public Vessels Act.[153] If a Navy or other United States government-owned or operated UMS falls within the scope of the Public Vessels Act as a "public vessel," the United States government may be liable for damages caused by the operation of the UMS and potentially for compensation for towage or salvage services rendered to the UMS.[154]

On one level, definitive application of the COLREGS over most UMSs as vessels would provide greater clarity to how courts would analyze a mishap involving a UMS. For example, assume a manned vessel and a UMS collide. In a normal scenario, involving two manned vessels, the admiralty presumptions related to COLREGS compliance would apply to both vessels. As vessels, both the manned vessel and the UMS vessel would be subject to the COLREGS, and the vessel at fault would be found liable under normal negligence principles. However, given uncertainty about COLREGS' application to a UMS, it is possible that a court would find the UMS to be a vessel for COLREGS' purposes. As a vessel, courts may place a high burden on the UMS for any procedural non-compliance with the COLREGS that could result in its operator being found liable.[155]

(1945) ("Since we hold that the Public Vessels Act was intended to impose on the United States the same liability (apart from seizure or arrest under a libel *in rem*) as is imposed by the admiralty law on the private shipowner . . . ."). Note that waiver of sovereign immunity in the admiralty context is a waiver for civil liability purposes only and does not implicate the waiver of sovereign immunity in the UNCLOS context mentioned, *supra* note 32.

[152] 46 U.S.C. § 31102.

[153] *Id*.

[154] *Id*. A related consideration is that if the United States takes the position that an UMS is definitively a vessel under the COLREGS, it could become more difficult for the United States to later to assert that its UMSs are not public vessels under the Public Vessels Act, should it desire to attempt to limit exposure in future litigation.

[155] The Pennsylvania, 86 U.S. 125, 1998 AMC 1506 (1873) (holding that both parties are liable for violations of procedural rules, one for exceeding safe speed and the other for using a bell instead of a foghorn in dense fog).

> But when, as in this case, a ship at the time of a collision is in actual violation of a statutory rule intended to prevent collisions, it is no more than a reasonable presumption that the fault, if not the sole cause, was at least a contributory cause of the disaster. In such a case the burden rests upon the ship of showing not merely that her fault might not have been one of the causes, or that it probably was not, but that it could not have been. Such a rule is necessary to enforce obedience to the mandate of the statute.

Id. at 136.

It is equally possible for a court to find that a UMS is not a vessel, and therefore not subject to the COLREGS, removing any burden against the UMS and resulting in the opposite conclusion.

As demonstrated by this scenario, COLREGS violations are important to the issue of causation and apportionment of liability in admiralty law.[156] The *Pennsylvania Rule* is the controlling precedent on this issue in the United States.[157] This rule derived from *The Pennsylvania* case in which the Supreme Court found two vessels colliding in dense fog to be equally at fault when each violated a statutory rule, one for exceeding safe speed and the other for using a bell instead of a foghorn as required.[158] Under the *Pennsylvania Rule*, a vessel that is involved in an accident and is found to be in violation of a safety statute or regulation (e.g. a COLREGS Rule) is presumed to be at fault unless it meets the high burden to prove that the violation could not have caused the accident.[159] For example, a vessel that alters course to port in a meeting situation instead of altering to starboard as required by the COLREGS Rule 14,[160] and then collides with another vessel, would have the burden to show that its non-compliance with the Rule did not and could not have caused the collision.[161] Uncertainty about whether the COLREGS govern UMSs confuses this presumption for UMS mishaps, resulting in uncertainty about liability for UMS operators, including the United States military.

A clearer regulatory environment in which the COLREGS definitively apply to a broad range of UMSs would not only remove this uncertainty but could also incentivize technological development. If a broad range of UMSs, including lower technology devices that meet vessel requirements discussed in Part II, Section B,[162] are recognized as vessels subject to the COLREGS, owners and operators of less-than-fully-compliant UMSs would face a more certain risk of liability under the *Pennsylvania Rule* for any mishap involving a UMS if the UMS violates one or more of the COLREGS.[163] This risk of liability would impact the

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[156] *See* Pritchett, *supra* note 103, at 206 (discussing *The Pennsylvania Rule* that "[i]n addition to preventing collisions, the navigational rules play an important part in apportioning liability when accidents do occur").
[157] *The Pennsylvania*, 86 U.S. at 125.
[158] *Id.* at 125, 136.
[159] *Id*. at 136.
[160] COLREGS, *supra* note 6, Rule 14(a) (altering course to starboard is generally required in head-on situations to allow for a port-to-port passage).
[161] *See id.* (referring to crossing situation (Rule 15)).
[162] *See* discussion *supra* Part II, Section B (arguing that UMSs that possess a baseline technology level of steering and propulsion should not be excluded as COLREGS vessels per se even if they are less capable and have lower technology).
[163] *See supra* notes 155–59 and accompanying text.

least COLREGS-compliant, lowest technology, UMSs the most[164] and would therefore incentivize development of better, more compliant technology. In the long-term, these incentives may result in advances to unmanned technology benefitting private industry and the military alike.

To date, few UMSs' collisions with other vessels have resulted in lawsuits, perhaps, because UMSs have not yet become prevalent in the maritime environment.[165] With the anticipated increase in UMSs in future years, however, this will undoubtedly change. Accordingly, definitive action by the IMO on COLREGS application to UMSs will help lessen uncertainty about liability for UMSs, while potentially spurring technological development. In the meantime, operating UMSs in a cautious manner, perhaps in close-proximity to launching platforms and outside busy shipping lanes, taking advantage of mitigation measures such as RAM status,[166] and following best practices (when available) that are appropriate for DoD UMSs, would help to mitigate these risks.

V. ALTERNATIVES TO VESSEL STATUS UNDER COLREGS

The argument for definitive recognition of UMSs as vessels subject to the COLREGS is not universally accepted, so it is also important for decision-makers working on these issues to consider regulatory options other than the COLREGS to govern UMS navigation. This section analyzes four alternatives to the position that UMSs should be governed by the COLREGS: (1) identifying UMSs as something other than COLREGS vessels, such as military devices that would follow a navigation regime distinct from the COLREGS;[167] (2) linking UMS navigational status to that of its launching platform;[168] (3) classifying

[164] *See* Savitz, *supra* note 26, at 11 (indicating that the "overwhelming majority" of higher technology UMSs at TRL 8 or 9 are developed in the United States and friendly countries).

[165] *See* Halle v. Galliano Marine Serv., L.L.C., No. 15-5648, 2016 U.S. Dist. LEXIS 51572 at *1 (E.D. La. Apr. 18, 2016) (citing to prior hearing involving the status of an ROV in a non-collision context where no reported cases involving a collision with a UMS has been located); *see also* MLAUS response to CMI Questionnaire, *supra* note 32, at 12 (stating that research revealed no case involving a collision with a remote-controlled or autonomous UMS for which the principle of "good seamanship" was in question); British MLA response to CMI Questionnaire, *supra* note 88, § 4.3 (stating that the issue whether a UMS can meet Rule 5 look-out requirements has yet to come before its (United Kingdom) courts).

[166] *See supra* Part III, Section C.

[167] Vallejo, *supra* note 9, at 428 ("Defining UMVs as 'military devices' would be consistent with previous definitions of military devices and could shield the United States from liability in the event of a tort at sea. UMV technology is not compatible with the COLREGS as they are currently formed.").

[168] Norris, *supra* note 10, at 23–24.

certain UMSs that qualify as warships;[169] and (4) keeping the status quo for which COLREGS application remains uncertain.

A. Novel Category

The first alternative, posed by author Daniel A. G. Vallejo, against COLREGS governance for UMSs is to identify UMSs as something other than a vessel, such as military devices, to obviate the requirement for UMSs to comply with the COLREGS.[170] This position is primarily based on two concerns with COLREGS application (also raised in Part III, Sections A and B); first, that UMSs cannot comply with the COLREGS as written without the physical presence of humans, which Mr. Vallejo asserts is necessary, and second, UMSs are technologically incapable of complying with the Rules as asserted by Mr. Vallejo and others.[171] The same author suggests that the time to amend the COLREGS to encompass UMSs would result in long delays and that governments are unlikely to delay UMS operations until the COLREGS are amended.[172] Therefore, Mr. Vallejo argues, an interim and separate navigation regime for UMSs as military devices to exist outside the COLREGS is preferable to granting UMS vessel status.[173]

Assuming that amending the COLREGS is a precondition to UMS operations,[174] this paper asserts that the challenges associated with amending the Rules should not divert the IMO and maritime community into developing a second set of rules for UMSs. Moreover, the creation of two separate sets of rules, one for manned vessels and the other for UMSs, is ill-advised, even as an interim step, because it would cause unnecessary confusion. Under the COLREGS, it is reasonably certain that if vessel A does X, vessel B is supposed to do Y. A second set of rules would throw these basic presumptions in doubt and would require mariners to learn another set of rules that would operate simultaneously with the COLREGS

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[169] *See id.* at 27–30.

[170] *See* Vallejo, *supra* note 9, at 428; *see also* Pritchett, *supra* note 103, at 207.

[171] *See* Vallejo, *supra* note 9, at 422–28 ("As they are written, the COLREGS are too based on human action and thought, and right now technology doesn't have the capability to mimic such foresight.").

[172] *See id.* at 408, 415–16 ("Further, amending the COLREGS would not be in the best interest of time because the military will most likely deploy UMVs before the regulations can be amended.").

[173] *See id.* at 427.

[174] *But see* discussion *supra* Part III (concluding that amendment to the COLREGS to account for UMSs is not necessary, subject to certain caveats, because the Rules as written do not present an insurmountable hurdle for UMSs, while best practices and certain amendments are desirable).

in the same sea space,[175] increasing complexity in an already complicated maritime environment.

B. UMS as Adjunct or Component of Launching Platform

Another alternative to COLREGS vessel status, discussed by some authors, is to consider a UMS to be an adjunct or component of a launching platform, like an ROV in admiralty law.[176] This is similar to a position taken by certain other states with respect to UMS warship status.[177] Under this paradigm, a UMS would not exist as an independent entity under the COLREGS, but instead a UMS would be considered as a part of the platform that launches it for navigation purposes.[178] This option also may be workable for UMSs that operate in close proximity to launching platforms, but it would be impractical for UMSs as a whole for several reasons. First, UMSs increasingly operate at distances far from their launch platforms for extended periods of time.[179] Therefore, it would be difficult and often impossible for vessels that encounter remote UMSs to link a UMS to a particular launch platform. Second, classifying a UMS as a component of a launch platform is also unsatisfactory for UMSs that are not launched from sea-based platforms, such as UMSs that launch from shore or from the air. Furthermore, the United States Navy has long taken the position that its UMS vehicles possess sovereign immunity and navigation rights that are independent of their launch platforms.[180] The Navy could change its doctrine on this point, but this may have other undesirable ramifications in doctrine and policy (e.g. if UMSs no longer have independent status, it may impact assertions of independent sovereign immunity or passage rights for its unmanned vehicles), so a change in this direction is unlikely.

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[175] Distinct rules for UMSs and manned vessels operating in the same sea space is unlike the International and Inland Rules in the COLREGS that do not operate in the same geographical space. Instead, they operate different geographic spaces divided by demarcation lines. See *supra* note 13 and accompanying text.

[176] *See* Norris, *supra* note 10, at 23–24 (Discussing whether UMSs can be treated as adjuncts or components of their deploying platforms and arguing against this position "based upon an assumption that, in accordance with U.S. Navy doctrine, UMSs are separate entities, with a controlling legal regime that is separate and independent from that of its deploying platform."). See generally *supra* note 59 for a discussion of ROVs.

[177] *See* Logan, *supra* note 11, at 30.

[178] *See id*.; Norris, *supra* note 10, at 23–24.

[179] Benecki, *supra* note 40 (describing extended deployment capabilities of the ACTUV).

[180] COMMANDER'S HANDBOOK, *supra* note 37, §§ 2.3.6, 2.5.2.5; Norris, *supra* note 10, at 23.

C. UMSs as Warships

Another important consideration for the UMS-COLREGS discussion is that some UMSs operated by the military could potentially meet the requirements under international law and United States policy to be classified as warships.[181] Warship classification for UMSs would be similar to unmanned aerial systems (UAS) that DoD considers to be "military aircraft" and classifies as manned military aircraft.[182] Warship status is critical to a variety of considerations under the law of armed conflict, but by itself, granting certain UMSs warship status would not increase navigational certainty for these UMSs under the COLREGS. Additionally, it is likely to be much more difficult to achieve a consensus for UMSs to be internationally recognized as warships as opposed to achieving consensus on basic vessel status.[183]

First, warships, as a subset of ships or vessels, must comply with the COLREGS like any other vessel with minor exceptions for some light, shape, and sound requirements,[184] so the impact of the COLREGS on warships is largely the same as for other vessels. Without definitive recognition by the international community that a UMS can qualify as a warship, designating UMSs with warship status would not advance navigational certainty for UMSs any more than vessel status until this issue is resolved. Second, UMSs do not easily meet the definition of a warship in UNCLOS or in customary international law.[185] Among other criteria, a "warship" must be "under the command of a commissioned officer" and "manned by a crew which is under regular armed forces discipline."[186] Some commentators have indicated that the definition for a warship could be read broadly to cover some types of UMSs, much like UASs, insofar as remote human operators could stand in as "commanding

[181] *See* Norris, *supra* note 10, at 27–32.
[182] COMMANDER'S HANDBOOK, *supra* note 37, § 2.4.4.
[183] *See* Groves, *supra* note 89, at 3, 6, 10 (discussing strong opposition by certain state and non-governmental organizations to recognition of international norms to govern autonomous weapons systems).
[184] *See* COLREGs, *supra* note 6, Rule 1(c); Norris, *supra* note 10, at 27.
[185] *See* Norris, *supra* note 10, at 27–30; Henderson, *supra* note 63, at 67 ("A UUV is, of course, unmanned by definition and therefore lacks a crew or commanding officer. It cannot then be a warship per se, even if deemed a vessel in its own right. But under the "component" theory discussed supra, UUVs might still be considered extensions of the launching/controlling warship."); Logan, *supra* note 11, at 24–28 (discussing policy considerations and practical impediments to designating a UMS as a warship, arguing for a "use-based" test to classify a UMS).
[186] UNCLOS, *supra* note 5, Art. 29 (providing the definition of a warship).

officers" and "crew."[187] If this hurdle is overcome, the United States could designate a UMS as a warship by policy, so warship status is theoretically possible.[188] However, from a practical perspective, aside from the need to meet the same requirements for vessel status, warships also carry additional legal implications beyond peacetime issues encountered by regular vessels such as entitlement to exercise belligerent rights.[189] Based in part on these implications, reaching consensus for the status of unmanned warships is likely to be much more controversial than achieving consensus that UMSs are COLREGS vessels.[190] As such, this paper recommends that the United States seek to clarify the status of its military UMSs as COLREGS vessels via the IMO independently of the question of warship status.

D. Retaining the Status Quo

A final alternative to considering UMSs vessels for COLREGS purposes is to keep the status quo in which COLREGS application would remain uncertain. One argument in support of the status quo is that ambiguity may afford the United States (and DoD) flexibility to continue designing, testing, and operating UMSs without a concern for whether the COLREGS apply.[191] Similar flexibility for UMSs based on an uncertain status may or may not be advantageous to DoD's UMSs in the law of the sea context.[192] However, given the projected increase in UMS numbers and operations in future years, uncertainty about the COLREGS will become more dangerous to navigation safety over time and would not appreciably benefit UMS operators or manned vessels, whether they are civilian or military. The fact that autonomous vessels like the ACTUV Sea Hunter are now able to operate at extreme distances from their launch

[187] *See* Norris *supra* note 10, at 27–30 (for an explanation on the definition of warship within UNCLOS and the position that there is no absolute bar within UNCLOS art. 29 to define an unmanned maritime system as a warship).
[188] *See* Logan, *supra* note 11, at 26.
[189] *See* Norris, *supra* note 10, at 30–59 (discussing the legal ramifications involved with vessel and warship status, to include considerations on the entitlement to exercise belligerent rights); *id.* at 24–28.
[190] *See* Groves, *supra* note 89, at 3–10.
[191] *But see* DoD Integrated Roadmap, *supra* note 1, at 81–82 (Asserting that USVs must comply with COLREGS as a planning factor in the physical and policy and regulatory environment, "[u]nmanned systems programs must consider all the policies and regulations of the appropriate authorities as program planning begins" and "USVs must operate in accordance with collision regulations (COLREGS).").
[192] *See, e.g.*, Norris, *supra* note 10, at 40 (describing the uncertain status of UMS navigation rights under UNCLOS).

platforms and controllers only increases the risks of regulatory uncertainty of navigational safety for all parties on the world's oceans.[193]

VI. CONCLUSION AND RECOMMENDATION

A decision by the IMO to definitively recognize that most UMSs are governed by the COLREGS as vessels should not negatively impact DoD and Navy UMS operations for four primary reasons. First, because most of DoD's UMSs would likely qualify as vessels at the present time under broad domestic and foreign standards; (except for immobile, unpowered or physically-connected types as discussed, *supra* at Part II, Section B) definitive recognition of UMSs as vessels would simply increase certainty on this issue.[194] Second, the COLREGS only present a major challenge to a subset of UMSs that operate autonomously or mostly-autonomously. Most UMSs are not autonomous and will not be in the near-term, or even the middle-term,[195] and aside from rules, like Rule 5, that arguably require human presence, remote-controlled variants should be able to comply with the COLREGS without much difficulty. Third, the Rules do not govern UUVs when they are below the surface, which accounts for a significant portion of UMS operations.[196] Finally, at least since 2013, DoD has assumed its UMSs will follow the COLREGS as a planning factor for future development, so COLREGS application aligns with planning.[197] Overall, the most serious challenges of COLREGS compliance are limited to the subset of UMSs that operate autonomously (or mostly-autonomously) on the surface.[198] The challenges for this UMS subset can be mitigated by RAM status, especially while

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[193] Benecki, *supra* note 40.

[194] *See generally* Part II, Section B. As of the date of this writing, no reported decisions have been found that precisely illustrate this point. Nonetheless, this paper asserts that a broad or inclusive interpretation of vessel status to cover most UMSs is in accordance with existing law and regulations.

[195] *See* DoD Integrated Roadmap, *supra* note 1, at 72 (indicating that higher levels of automation are planned by DoD in the long-term future state).

[196] *See supra* note 43 and accompanying text; *see also* ASS'N FOR UNMANNED VEHICLE SYS. INT'L, UNMANNED MAR. VEHICLES: CORE CAPABILITIES & MKT. BACKGROUND 5 (Aug. 8, 2013), https://higherlogicdownload.s3.amazonaws.com/AUVSI/b657da80-1a58-4f8f-9971-7877b707e5c8/UploadedFiles/AUVSIUMVCoreCapabilities08-08-13.pdf [https://perma.cc/3FJM-T8Q7] (stating that in 2013, UUVs comprised 28% of all unmanned maritime vessels).

[197] DoD Integrated Roadmap, *supra* note 1, at 82.

[198] *See* COLREGS, *supra* note 6, Rule 1(a) (stating that COLREGS do not govern subsurface operations in Rule 1(a)); NAVSAC RESOLUTION 11-02 *supra* note 104, Section III (indicating that remote-controlled UMSs should be treated like manned vessels and should not have as many concerns as autonomous vessels); NAVSAC RESOLUTION 12-08, *supra* note 104.

engaged in missions envisioned by DoD for UMSs that easily qualify for RAM status under the COLREGS,[199] and later by following best practice recommendations or regulatory guidance as appropriate.

Although this paper asserts that UMSs can operate under the COLREGS framework, subject to caveats and mitigation measures discussed *supra* in Part III, the evolution towards full regulatory recognition of UMSs as vessels and certainty of COLREGS application will not occur quickly. Instead, the regulatory environment for UMSs likely will go through three general phases before the IMO takes action, which likely will not occur until years after the regulatory scoping exercise is complete in 2020.[200] During the first phase, UMSs will continue to operate in advance of adequate guidance in an uncertain regulatory environment, as they do today. During this period, it is advisable for UMSs to operate cautiously and to minimize risks of liability, for example, by using RAM status (if applicable), remaining close to launch platforms, and by staying away from busy ports, sea lanes, and congested waters, to the extent possible.

The second phase towards greater regulatory certainty will likely involve UMSs operating under interim guidance, like the Code of Practice published by the United Kingdom Marine Industries Alliance and best practices that may be promulgated by the United States Coast Guard.[201] DoD should be involved in shaping and following best practices and interpretive guidance that contribute to navigation safety and do not compromise military requirements. The third phase will involve action by the IMO. As a result of the regulatory scoping exercise, at a minimum, the IMO and international community should reach a consensus that the COLREGS definitively govern UMSs. This consensus should be pushed by the United States, based on military and non-military perspectives, but resolution on the issue within the International Rules must come from the IMO.[202]

Definitive recognition by the IMO that UMSs are COLREGS vessels, to the extent they meet the definition, could take several forms including an official pronouncement by the IMO, publication or

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[199] *See supra* Part III, Section C.

[200] *See* IMO Maritime Safety Committee Ninety Eighth Session, *supra* note 82 (describing the regulatory scoping exercise and its expected completion date of 2020).

[201] *See* NAVSAC RESOLUTION 16-01, *supra* note 21 (recommending a series of best practices for UMSs to provide guidance, information and awareness for UMS operators).

[202] *See* NAVIGATION RULES AND REGULATIONS HANDBOOK, *supra* note 13, at i (showing that amendments to the International Rules are made through the IMO).

modification of interpretive guidance,[203] or possibly an amendment to modify Rule 1 on Application. This amendment should read: "These Rules shall apply to all vessels, *manned and unmanned* (inserted language), upon the high seas and in all waters connected therewith navigable by seagoing vessels."[204] While amendments to clarify the COLREGS to better account for UMSs are not a necessary precondition for COLREGS application, assuming broad interpretation of the Rules, workarounds using remote human operators, and mitigation measures like RAM status, this paper recommends the adoption of three amendments discussed *supra* in Part III, Section D: (1) exempting UMSs from look-out requirements,[205] (2) explicitly recognizing unmanned autonomous navigation as a RAM category,[206] and (3) exempting UMSs from radio communication requirements for safe operations.[207] These amendments would be particularly helpful to navigation safety and are unlikely to interfere with military interests.

Recent efforts by the United States, the IMO, and other maritime organizations to address the challenges of UMSs are encouraging. The United States, informed by its military's unique perspective, should take the lead on this issue at the IMO and help achieve consensus to place unmanned technology squarely within the international framework on maritime navigation. Definitive recognition of UMSs as COLREGS vessels by the IMO would benefit not only the civilian industry but also the United States military by providing a more certain operating environment, limiting the ability of adversaries to exploit regulatory uncertainty against its operations,[208] and incentivizing the development of UMS technology in the long-run.[209]

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[203] *See* CMI IWG Position Paper, *supra* note 21, at 20–21 (asserting that interpretative guidelines may be sufficient for remote-controlled UMSs, but amendments to the COLREGS are likely necessary for autonomous vessels).
[204] COLREGS, *supra* note 6, Rule 1(a).
[205] NAVSAC RESOLUTIONS 11-02, *supra* note 104.
[206] *Id.*
[207] *See* COLREGS, *supra* note 6, Annex iv; Coast Guard Letter, *supra* note 81 (Stating that the "IMO Conventions, such as the COLREGS and SOLAS, will likely need amendments to address ship-to-ship movements and communication requirements for their safe operation.").
[208] *See* Kraska & Pedrozo, *supra* note 18 (arguing that the Chinese seizure of the UMS violated the COLREGS, among other violations of international law). As shown by recent high-profile incidents *supra* Part I, greater certainty that the COLREGS govern UMSs as vessels under the rules may also limit the ability of foreign adversaries to ignore the COLREGS to the detriment of United States UMS operations.
[209] *See* discussion *supra* Part IV.