Shore to Ship Drones – Relevance and Applicability of Maritime Navigation Rules

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Abstract

The use of shore to ship drones for transporting supplies, medical provisions and documents during the COVID-19 pandemic induced port lockdowns and restrictions in many port States was especially needful. However, these drones fly at altitudes which expose them to the risk of accidents or collision with large ships. The orthodox view of the regulatory framework for drones is that it is the internationally agreed air navigation rules as implemented by the coastal State that would apply. This article argues that it is equally important to consider the provisions of the IMO-sanctioned shipping navigation rules (COLREGs) given the fact that the drones are operating in an environment where ships operate. The work identifies how some of the key COLREGs provisions for collision avoidance might be applied in this regard.

Keywords

Unmanned aerial vehicles (UAVs), shore to ship drone delivery, air navigation rules, maritime navigation rules, COLREGs., coastal law.

1. Introduction

Different sectors of the maritime industry are seeing an ever-increasing use of unmanned aerial vehicles (UAVs) in the marine environment. Indeed, during the lockdown of vessels at port as a result of the COVID-19 pandemic, shore to ship drone transport of supplies and necessities was considered by both the industry and port authorities to be needful option.[1] Generally speaking, not only are there

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[1] Harry Valentine, 'Automation Could Aid Port Operations During Pandemic' (*The Maritime Executive*, 09 April 2020) <https://www.maritime-executive.com/editorials/automation-could-aid-port-operations-during-pandemic>. In the UK, the government and industry very much

many different uses[2] for drones, there are also important efficiency benefits to this mode of transport. The Port of Rotterdam for example reported that such shore to ship drone technology can speed up deliveries by up to six times, lower delivery costs by up to 90%, reduce carbon emissions and significantly mitigate risks of accidents associated with launch-boat deliveries.[3] The general expectation is thus that there will be a significant increase in the use of drones over the seas, whether in the port area or in open sea (where the drone is launched from a vessel or an oil and gas platform). There emerges an increased risk of collision incidents involving drones, whether between a UAV and a seagoing vessel, or, between a UAV and an aircraft, or, between UAVs, or between UAVs and offshore structures such as wind turbines.

This article examines one specifically focused question, respecting that there are other important avenues for research. That question is to what extent maritime collision avoidance rules should and would apply to UAVs when used over water and to what extent, if any, maritime navigation rules would complement, or not (as the case may be), air navigation rules where such rules are applicable.[4] For context, the first part of this article sets out the conventional regulatory[5]

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encouraged the use of drones for carrying supplies during the pandemic. See Graham Brown, 'Video: Footage Shows Drone being Used to Fly Coronavirus Test Kit to Angus Boat' *The Courier*, 30 April 2021; <https://www.thecourier.co.uk/fp/news/local/angus-mearns/2180836/montrose-medidrone-shore-to-ship-covid-kit-trials-pass-first-uk-test-with-flying-colours/>. Also, because of the health risks, delays and reduced ferry crossings between Hampshire and the Isle of Wight caused by the pandemic, the UK Government granted funding for drones to carry medicines, personal protective equipment (PPE) and time-critical supplies such as blood and organs from Hampshire to the Isle of Wight (see 'Coronavirus: Drones to deliver NHS supplies to Isle of Wight' *BBC News*, 24 April 2021; <https://www.bbc.co.uk/news/technology-52419705>). (NB: All websites referred to in the footnotes were checked and accessed on 7 October 2021.)

[2] Drones can be used for detecting air pollution (see 'RPAS Drones Monitored Ship Emissions in Danish Waters' (*EMSA*, 12 April 2019) <http://www.emsa.europa.eu/emsa-homepage/2-news-a-press-centre/news/3513-rpas-drones-now-monitoring-ship-emissions-in-danish-waters.html>.), surveying ships for classification societies ('Drones Herald in New Era of Inspections' *DNV GL*, 25 June 2019; <https://www.dnvgl.com/expert-story/maritime-impact/Drones-herald-in-new-era-of-inspections.html>), combating illegal activities such as people smuggling, drug trafficking, dumping etc. and search and rescue activities (see report by the European Maritime Safety Agency - 'Remotely Piloted Aircraft Systems (RPAS)' <http://www.emsa.europa.eu/operations/rpas.html>)

[3] 'Drone Delivers Package to Vessel in the Port of Rotterdam for the First Time' (*Port of Rotterdam*, 23 May 2020) <https://www.portofrotterdam.com/en/news-and-press-releases/premier-drone-delivers-package-to-vessel-in-the-port-of-rotterdam-for-the>

[4] In some cases, of course, there may be no **navigation** rules imposed by the coastal State. In such cases, the introduction of maritime navigation rules in a port area should be equally, if not more, important.

[5] For example, the UK Ministry of Defence and the US Department of Defense routinely treat UAVs as aircraft. See 'Unmanned Aircraft Systems, Joint Doctrine Publication 0-30.2' (*The UK Ministry of Defence*, 2017) – Available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/673940/doctrine_uk_uas_jdp_0_30_2.pdf>; and 'DoD Directive 4540.01: Use of

approach – namely that the international air navigation rules[6] apply to UAVs. The second substantial part reasons that UAVs when operating at low altitudes over water would also qualify as "vessels" for the purposes of the maritime navigation rules, notably, the International Regulations for Preventing Collisions at Sea 1972 (commonly called COLREGs). In particular, the article points out the gaps in the air navigation rules and argues that in certain circumstances the COLREGs are better suited to prevent collisions between UAVs and other sea-borne vessels. The maritime context cannot be ignored when today's largest container vessels can be well over 70 m (approx. 230 feet) tall whilst UAVs may be required by some national laws to fly at an altitude lower than 200 feet[7] or 400 feet[8] above mean sea level. The UAVs are thus likely to be flying at a height which places them at risk of collision with the ships.

The work, in the main, adopts a text-based inquiry when interrogating the relevant rules and interpreting how they might extend (or not as the case may be) to UAVs in this water-based context. That said, there is also an important theoretical facet to the inquiry. An objective of this study is to test how the current positive international rules should be construed – notably whether there should exist certain presumptive positions to be adopted when interpreting such rules, noting that a literal interpretation is not likely to be very useful but appreciating the lack of certainty caused if any teleological, purposive or mischief-based interpretation is to be adopted.[9] This question has a useful practical impact given that changes to the regulation occur slowly and some quick but harmonised response from the international community is needful.

The article concludes by demonstrating how the operational[10] (as against the navigational) aspects of the COLREGs might apply, in practice, to UAVs flying over water and questioning any ensuing policy implications from the extension of COLREGs to UAVs.

Research questions falling *outside* the scope of this present work include questions of liability, fault, non-collision incidents (such as privacy law,

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International Airspace by U.S. Military Aircraft and for Missile and Projectile Firings' (*The US Department of Defense*, 2015) <https://www.hsdl.org/?abstract&did=801464>.

[5] For example, Singapore (Part 2 of Air Navigation (101 – Unmanned Aircraft Operations) Regulations 2019) – available at <https://sso.agc.gov.sg/SL/ANA1966-S833-2019?DocDate=20191219>.

[6] As contained in Annex 2 to the Chicago Convention 1944 entitled 'Rules of the Air'

[7] For example, Singapore (Part 2 of Air Navigation (101 – Unmanned Aircraft Operations) Regulations 2019) – available at <https://sso.agc.gov.sg/SL/ANA1966-S833-2019?DocDate=20191219>.

[8] For example, the US (§107.51 of Part 107 of the US Federal Aviation Administration rules), and the UK (Art 94(4)(c) Air Navigation Order 2016 as amended by Air Navigation (Amendment) Order 2019).

[9] See below.

[10] Such as visual control, lights and signals.

nuisance, trespass etc.), reporting duties and an administrative law matters such as which agency bears the responsibility for regulating UAVs etc.

2. Legal Status of UAVs under Aviation Regulatory Regime

The development of the legal framework for international civil aviation started with the 1919 Paris Convention[11] which was later replaced by the 1944 Chicago Convention on International Civil Aviation. In 1928, the International Commission for Air Navigation had adopted a glossary of terms which defined 'aircraft' as 'any machine which can derive support in the atmosphere from reactions of the air'.[12] In 1967, the ICAO amended the definition and re-defined aircraft as 'any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface'. The second part of this new definition was added to exclude all air cushion type vehicles (such as hovercraft) that derive support from the reactions of the air with the earth's surface from the definition. The ICAO then included this definition in Annex 7 to the Chicago Convention. Since the definition is found in an annex developed by the ICAO pursuant to the Chicago Convention and not within the text of a treaty, the precise legal status of the definition is open to debate.[13]

In the light of the continuing development of unmanned aircraft in the civil aviation industry, a question regarding the amended definition is whether a machine that derives support from reactions of the air but has no operator/pilot on board, may be an 'aircraft' within the meaning of and therefore subject to the Chicago Convention. Article 8 of the Chicago Convention which is entitled 'Pilotless aircraft' reads:

> No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Each contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft.

Since remotely-controlled and autonomous aircraft were already in existence at the time of the First World War and were operated by both civil and military entities,[14] a 'pilotless aircraft' i.e. an 'aircraft flown without a pilot' refers to the

[11] 'Manual on Remotely Piloted Aircraft Systems (RPAS)', ICAO Doc 10019 (2015) para 1.2.1.
[12] Benjamyn I Scott and Andrea Trimarchi, *Fundamentals of International Aviation Law and Policy* (Routledge, Abingdon, 2020) para 3.2.2.1.
[13] *Ibid.*
[14] 'Manual on Remotely Piloted Aircraft Systems (RPAS)', ICAO Doc 10019 (2015) para 1.2.4.

situation where there is no pilot on board the aircraft.[15] Thus, the phrase 'without a pilot' means *without a pilot-in-command on-board*. This understanding of UAVs i.e. a particular type of 'aircraft' which is subject to Article 8 of the Chicago Convention, was endorsed by the Eleventh Air Navigation Conference held in Canada in 2003[16] and also by the ICAO Assembly in its 35th Session in 2004.[17] Similarly, in 2015, the Legal Committee of the ICAO held its 36th Session to discuss, *inter alia*, legal issues relating to 'remotely piloted aircraft' and the Secretariat of the ICAO presented the Legal Committee with a Paper[18] which offered, *inter alia*, an interpretation of the term 'aircraft'. The Paper sufficed to state that Annex 7 to the Chicago Convention 'makes it clear that remotely piloted aircraft (RPA) are simply one type of unmanned aircraft'. The Paper also stated that 'pilotless aircraft' includes all unmanned aircraft 'whether remotely piloted, fully autonomous, or combinations thereof' and thus they are all subject to Article 8 of the Chicago Convention. *Ergo*, in the context of international aviation law, the legal status of UAVs is established by the ICAO as 'aircraft' entitled to enjoy navigational rights in the international airspace.

Based on Article 8, therefore, UAVs are 'pilotless aircraft' that have the right to fly in any airspace other than over the territory of foreign States without authorisation. All UAVs 'whether remotely-piloted, fully autonomous or a combination thereof, are subject to the provisions of Article 8'.[19] UAVs being recognised as 'aircraft' under the Chicago Convention, raises the question of which aeronautical navigational rules UAVs must comply with.

2.1 Aviation Regulations Applicable to UAVs

Being classified as 'aircraft', a UAV must comply with regulations which are applicable to aircraft. In a general requirement, Article 8 of the Chicago Convention obliges the State of registry of a pilotless aircraft to ensure that the flight of such a pilotless aircraft does not pose a danger to civil (manned) aircraft.

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[15] Ron Bartsch, James Coyne and Katherine Gray, *Drones in Society: Exploring the Strange New World of Unmanned Aircraft* (Routledge, Abingdon, 2017) 53. See too ICAO, Global Air Traffic Management Operational Concept (1st edn 2005) Doc 9854 AN/458 [Appendix B: Glossary, page B-6] <https://www.icao.int/Meetings/anconf12/Document%20Archive/9854_cons_en%5B1%5D.pdf> (emphasis added).

[16] Ron Bartsch, James Coyne and Katherine Gray, *Drones in Society: Exploring the Strange New World of Unmanned Aircraft* (Routledge, Abingdon, 2017) 53.

[17] ICAO, Unmanned Aircraft Systems (UAS) (2011) Cir 328 AN/190, para 2.1; available at <https://www.icao.int/Meetings/UAS/Documents/Circular%20328_en.pdf>.

[18] Study of Legal Issues Relating to Remotely Piloted Aircraft; LC/36-WP/2-4 (2015); available at <https://www.icao.int/Meetings/LC36/Working%20Papers/LC%2036%20-%20WP%202-4.en.pdf>.

[19] ICAO, Unmanned Aircraft Systems (UAS) (2011) Cir 328 AN/190, para 2.1. – available at <https://www.icao.int/Meetings/UAS/Documents/Circular%20328_en.pdf>.

Article 37 of the Chicago Convention empowers the ICAO to adopt and amend international standards and practices dealing with the 'rules of the air'. Such rules which lay down standards and practices to ensure safe operation of aircraft and protection of persons and property are currently contained in Annex 2 to the Chicago Convention entitled 'Rules of the Air'. Pursuant to Article 12 of the Convention, aeronautical rules in force over the high seas are the Rules of the Air established under the Convention. The text of the Rules of the Air also makes it clear that over the high seas, the rules apply without exception.[20] Although contracting States may have their own national rules in force over their land territory and territorial waters, Article 12 makes it clear that in order to facilitate and improve air navigation, such national rules cannot be radically different and must be uniform to the highest possible degree with the Rules of the Air adopted by the ICAO. Thus, the Rules of the Air, particularly Section 3.2 which lays down collision avoidance principles, would invariably be applicable to all civil aircraft operating in any national or international airspace. Any natural or legal person violating the national or international rules must be prosecuted by the relevant contracting State.[21]

How each State ensures compliance with the rules depends on each individual State's policy and whether the State recognises UAVs as aircraft. In 2011, in an attempt to encourage better consistency between policy and practice of States, the ICAO published Circular 328 AN/190 which stated that unmanned aircraft should have, as a minimum, an equivalent level of safety as manned aircraft.[22] A number of States have adopted the policy that UAVs 'must not present a hazard to persons or property that is any greater than that attributable to manned aircraft of equivalent category'.[23] For instance, the UK Ministry of Defence guidance refers to UAVs as 'unmanned aircraft' and defines them as '[a]n aircraft that does not carry a human operator, is operated remotely using varying levels of automated functions, is normally recoverable, and can carry a lethal or non-lethal payload'.[24] Likewise, the US defines 'unmanned aircraft' as an aircraft operated without the possibility of direct human intervention from within or on the aircraft.[25] The UK Civil Aviation Authority requires any person intending to operate an unmanned aircraft with a mass of more than 25 kg within the UK to obtain a specific authorisation.[26] Similarly, in the US,

[20] The Rules of the Air, Chapter 2, paragraph 2.1.1.
[21] Article 12, Chicago Convention.
[22] ICAO Cir 328 AN/190, Unmanned Aircraft Systems (UAS), para 2.9.
[23] *Ibid.*, at p. 35.
[24] The UK Ministry of Defence, 'Unmanned Aircraft Systems, Joint Doctrine Publication 0-30.2' (2017) – Available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/673940/doctrine_uk_uas_jdp_0_30_2.pdf>.
[25] §1.1, Title 14 Code of Federal Regulations; also § 44801, Part A of subtitle VII of title 49, United States Code.
[26] 'Flying in the open category' (Civil Aviation Authority) <https://www.caa.co.uk/Consumers/Unmanned-aircraft/Recreational-drones/Flying-in-the-open-category/>.

unmanned aircraft in excess of 25 kg (55 lbs) must satisfy the Federal Aviation Agency's airworthiness requirements[27] and all drones weighing more than 250 grams must be registered, either under the so-called Part 107 license or Exception for Recreational Flyers.[28] The requirement for a Part 107 license is to ensure that flyers are properly trained to handle the aircraft. The US has gone further than many jurisdictions in integrating civil unmanned aircraft into the national airspace legal system.[29]

It should be noted that 'model aircraft' which are intended for 'recreational purposes' only, fall outside the remit of the Chicago Convention and are exclusively governed by the relevant national regulations, if any.[30]

2.2 Legal Status of UAVs under Maritime Regulatory Regime

A UAV flying at high altitudes is undoubtedly an 'aircraft' within the meaning of international civil aviation law and must comply with the applicable aviation rules. However, if the UAV descends to lower altitudes and flies close enough to water surface, as explained earlier it is conceivable that it could and possibly should come within the sphere of maritime navigation regulations. For our purposes, the relevant regulations are the International Regulations for Preventing Collisions at Sea 1972 (commonly called COLREGs).

COLREGs apply to all 'vessels' on the high seas and in all waters connected therewith navigable by seagoing vessels.[31] The Convention defines the term 'vessel' as 'every description of water craft, including non-displacement craft, WIG [Wing-in-Ground] craft and seaplanes, used or capable of being used as a means of transportation on water.'[32] This raises the matter as to whether a UAV

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[27] 'Special Authority for Certain Unmanned Aircraft Systems (Section 44807)' (*Federal Aviation Administration*, 02 December 2020) <https://www.faa.gov/uas/advanced_operations/certification/section_44807/>.

[28] 'Register Your Drone' (*Federal Aviation Administration*, 02 December 2020) <https://www.faa.gov/uas/getting_started/register_drone/>.

[29] See the changes introduced by the FAA Reauthorization Act of 2018 (section 341) to Part A of subtitle VII of title 49, United States Code.

[30] ICAO, Unmanned Aircraft Systems (UAS) (2011) Cir 328 AN/190, Chapter 2, para 2.4. – available at <https://www.icao.int/Meetings/UAS/Documents/Circular%20328_en.pdf>.

[31] COLREGs, Rule 1(a).

[32] COLREGs, Rule 3(a). Incidentally, this description mirrors the definition in the US Code of vessel at 1 USC sec 3, which was considered in Lozman v City of Riviera Beach 568 US 115 (2013). There the US Supreme Court had to decide whether a floating home constructed of plywood structure with empty bilge space underneath to keep it afloat was a vessel for the purposes of admiralty jurisdiction and Rules of Construction Act, which define a "vessel" as including "every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water,". The Supreme Court held that the definition of "transportation" must be applied in a practical way; a structure does not fall within its scope unless a reasonable observer, looking to the home's physical characteristics and activities, would consider it designed to a practical degree for carrying people or things

flying above water might be considered as a vessel within the meaning of this definition.

Although to classify a UAV which is not waterborne and flies *above* water a *vessel* may seem a misnomer, it is noteworthy to observe that under the definition, even a Wing-in-Ground craft which in its main operational mode flies *above* water surface, is a vessel and must comply with COLREGs. A seaplane is another example of a craft that despite being a type of aircraft, it is considered as a *vessel* when operating close to or on the water surface.[33] This is simply because although construction and operation of such craft have a high degree of commonality with those characteristics of aircraft, they operate with other waterborne craft and must necessarily follow the same collision avoidance rules as conventional shipping.[34] The possibility of a UAV operating at a low altitude above water but close enough to the surface to be considered as a vessel, therefore, cannot be ruled out. The IMO and ICAO guidelines provide some limited guidance as to the altitude required for the UAV to be brought within the COLREGs.

As mentioned above, in 1967, the ICAO amended the definition of 'aircraft' to exclude machines such as hovercraft that derive support from reactions of the air 'against the earth's surface'. In recent years, however, particular types of craft have been developed that can fly *both* at low altitudes by utilising ground or surface effect and at high altitudes by utilising the reactions of the air. A wing-in-ground (WIG) craft is one such craft that uses the same surface effect as a hovercraft, but instead of an engine and fan, uses forward speed and large wings to force the air under the craft and create a dynamic cushion which lifts the craft clear of the surface.[35] WIG craft are categorised into three types:

- **Type A:** a craft which is certified for operation only in ground effect;
- **Type B:** a craft which is certified for main operation in ground effect and to temporarily increase its altitude outside ground effect to a maximum height of 150 metres above the surface, in case of emergency and for overcoming obstacles; and

over water. But for the fact that it floats, nothing about the floating structure in question suggested that it was designed to any practical degree to transport persons or things over water. It had no steering mechanism, had an un-raked hull and rectangular bottom 10 inches below water, and had no capacity to generate or store electricity. It lacked self-propulsion, unlike an ordinary houseboat. It was therefore not a vessel.

[33] COLREGs, Rule 3(a).

[34] IMO MSC.1/Circ.1592 (2018) – available at <http://www.imo.org/en/OurWork/Safety/Regulations/Documents/MSC.1-CIRC.1592.pdf>.

[35] Jan Babicz, *Wartsila Encyclopedia of Ship Technology* (2nd edn, Wartsila Corporation 2015) 214.

- **Type C:** a craft which is certified for the same operation as type B and also for limited operation at altitude exceeding 150 metres above the surface, in case of emergency and for overcoming obstacles.[36]

It appears clear that since a type A WIG craft derives motion support only from the reactions of the air against the surface and can fly only close to the surface, strictly speaking they do not fall under the ICAO definition of aircraft. However, because type B and C WIG craft can fly *both* at low altitudes in ground effect and at higher altitudes outside ground effect, it is unclear whether they can be considered as aircraft under the ICAO definition.

In addressing the issue, the IMO and the ICAO recently agreed that any WIG craft capable of sustained flight outside the influence of ground effect at an altitude of more than 150 metres (i.e. type C WIG craft) should in such a flight be considered as an *aircraft* by the ICAO[37] and should be subject to the rules and regulations of ICAO.[38] Other WIG craft i.e. type A and B WIG craft should be covered only by the maritime regulatory regime.[39] Type C WIG craft are, therefore, subject to the rules of both ICAO (in aircraft mode) and IMO (in all other modes of operation).[40]

Using these guidelines as a benchmark, as a general rule, UAVs *might* be considered as vessels when operating at an altitude of less than 150 metres and as aircraft when flying at higher altitudes. The rationale behind such inference is the fact that type C WIG craft and UAVs share the characteristic of being capable of operating at low and high altitudes above water surface. It is submitted, however, that while the height of 150 m is high enough to cover and safeguard navigation of virtually (but currently) all vessels in the world, the reference to 150 m should only be treated as a general guidance and not an absolute threshold.

Strictly speaking, whether a UAV can be considered as a vessel or aircraft should depend on the prevailing circumstances irrespective of the altitude at which the UAV is flying. For instance, a UAV flying at a height of 60 metres above water level in an area where the air draught[41] of all vessels in that area is less than 30 metres, is not *necessarily* a vessel within the meaning of COLREGs as there is no risk of collision between the UAV and the vessels in the area. By contrast, the same UAV even when flying at an altitude of 80 metres above water where very tall ships are operating, may constitute a vessel obliged to follow COLREGs in order to avoid collision with those tall ships. While the *Symphony of the Seas*,

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[36] IMO MSC.1/Circ.1592 (2018) – available at <http://www.imo.org/en/OurWork/Safety/Regulations/Documents/MSC.1-CIRC.1592.pdf> at para 4.45.
[37] *Ibid.*, at para 3.4.
[38] *Ibid.*, at para 4 of the Preamble.
[39] *Ibid.*
[40] *Ibid.*, para 3.4.
[41] The vertical distance from the water surface to the highest point on a vessel.

one of the tallest ships in the world, has a height of 72.5 metres[42] which is even less than half of the 150 m threshold, there are also very tall marine structures such as mobile offshore drilling units exceeding 150 m in height that are towed on the water. Under such circumstances, a UAV flying at an altitude even higher than 150 m, should still be considered as a vessel and obliged to follow COLREGs if risk of collision exists. The legal status of a UAV flying at intermediate altitudes, therefore, cannot be determined with certainty without knowing the existing circumstances.

This uncertainty does not exist as such in relation to seaplanes as they usually fly either in their main operational mode at relatively very high altitudes in which case they are considered as aircraft, or very close to water surface when landing or taking off in which case they are considered as vessels. In other words, seaplanes do not normally operate at intermediate altitudes where the legal status of a craft can be uncertain. A UAV, however, may fly at various altitudes during a single operation depending on its mission and the environmental obstacles, and in the absence of authoritative guidelines the uncertainty, it is submitted, should be resolved by considering the prevailing circumstances of each case.

A noteworthy uncertainty arises where a number of UAVs are operating at a height of, for instance, 30 metres above a body of water on which no vessel exists. Considering the IMO Guidelines for WIG Craft, since all the UAVs are operating close to water surface at an altitude way below 150 m above the surface, it seems reasonable to conclude that they are all within the sphere of maritime rather than aviation regulatory regime. However, in the absence of any specific guidelines for UAVs, the 150 m threshold may not be accurate or absolute for craft other than WIG craft in which case the question arises as to whether a number of UAVs flying at a height of, for instance, 160 metres above water must comply with COLREGs or the Rules of the Air when there is a risk of collision between them. The answer to this question, it is submitted, can only be of theoretical importance because in practice, maritime and aeronautical rules for preventing collisions on the water and in the air are founded on the same principles. There are three possible types of encounters between vessels on the water or aircraft in the air and the required action to avoid collision in each encounter is almost identical under maritime and aeronautical collision avoidance rules:

1) **Head-on situation:** under maritime rules, when two power-driven vessels are approaching head-on or approximately so and there is a risk of collision, each must alter her course to starboard (right) side.[43] The same

[42] 'Top 10 Largest Cruise Ships in 2020' (*Marine Insight*, 10 March 2020) <https://www.marineinsight.com/know-more/top-10-largest-cruise-ships-2017/>.
[43] COLREGs, Rule 14(a).

rule applies to two power-driven aircraft involved in a head-on or nearly head-on situation under aeronautical rules.[44]

2) **Crossing (or Converging) situation:** when two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side must give way.[45] This rule is the same for two converging power-driven aircraft too.[46]
3) **Overtaking situation:** any vessel overtaking any other vessel, must keep out of the way of the vessel being overtaken.[47] Any overtaking aircraft is also under the same obligation to keep out of the way of the aircraft being overtaken,[48] the only nuance being that while an overtaking vessel can alter its course to either port (left) or starboard, an overtaking aircraft must only alter its heading to starboard.[49] However, as will be observed below, this nuance is immaterial for aircraft operating in close proximity to water surface.

Thus, in a head-on situation involving two UAVs flying very close to the water surface, even if one of the UAVs follows the maritime rule applicable to vessels and the other follows the aeronautical rule applicable to aircraft, their actions will be consistent and the result will be the same: each will alter its course to starboard and the situation will be cleared. Thus, from a collision avoidance perspective, the legal status of a number of UAVs operating in close proximity to water surface (whether vessel or aircraft) is not of significant practical importance. Such UAVs must follow collision avoidance rules; maritime and aeronautical navigational rules in this regard are broadly similar and have the same effect.

The upshot from the above discussion is therefore that a rational argument could be made that any UAV operating at an altitude less than 150 m above water might legitimately be considered as a vessel that should comply with COLREGs to prevent collision with other vessels on or above the water. That does not mean the UAV should also not be governed by applicable rules of air navigation and other drone-related regulations in domestic law. The argument however is that given the increased risk of collision with other seagoing vessels, compliance with COLREGs is needful, given the fact that the Rules of the Air are not comprehensive or satisfactory in their treatment of aircraft-ship events.[50]

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[44] Rules of the Air, Rule 3.2.2.2.
[45] COLREGs, Rule 15.
[46] Rules of the Air, Rule 3.2.2.3.
[47] COLREGs, Rule 13(a).
[48] Rules of the Air, Rule 3.2.2.4.
[49] *Ibid.*
[50] See below at … relating to cases of vessels overtaking each other and incidents of restricted visibility, for example.

3. The Interpretive Exercise in the Light of the Gaps

A word about the interpretive method used to test the applicability of the air and maritime navigation rules. The purposive reading of the navigation rules, air or maritime, is consistent with the scope of rational decision taking conferred by the international rules on the officers responsible for the navigation of the vessel, for example. The COLREGs, for example, do not provide for every contingency. Rule 2(b) provides that in construing and complying with the 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. The Rules provide for the maintenance of good seamanship in all circumstances,[51] and even departure from the Rules if good seamanship dictates. COLREGs clearly anticipate that there will be gaps in the governance system. Similarly, the Rules of the Air provide that it will be the pilot who would be responsible for the operation of the aircraft in accordance with the Rules of the Air, but they may depart from the rules if necessary in the interest of safety.[52]

Indeed, the pilot shall have the final authority as to the disposition of the aircraft whilst in command.[53]

As to the matter of methodology, the issue of shore to ship drones has not been directly addressed by international navigational rules. As such, a gap in the law has arisen. This article contends that there are three ways to characterise this gap. First, as a real or axiological gap. This is where the matter in question has been patently omitted either expressly or by implication. If the matter of shore to ship drones is a real gap in the law, the solution or remedy would lie in the establishment or creation of specific legal norm. Secondly, the matter could be a thetic or apparent gap, that is to say, the law provides for the matter imprecisely. The remedy lies then in making argument by making an analogy from other similar matters or cases regulated in the law. The third gap relates to that which is regulated by two or more legal acts or norms. In attempting to establish which legal act would apply there, it is possible to turn to the sequence or chronology of the legal acts (thus apply the legal act which is the most recent as prevailing over the previous ones), or adopt a hierarchical approach by turning to the legal act which is of the higher order, or rely on a scope-based solution, namely apply the law or legal norm which describes the matter in most detail.

The foregoing paragraphs suggest that no real or axiological gap exists, in that although UAVs flying over water were not specifically provided for in the international maritime and air navigational rules, there have been analogous vessels since the inception of those navigational rules. Treating the matter as a

[51] Rule 2(a), COLREGs.
[52] Rule 2.3.1, Rules of the Air.
[53] Rule 2.4, Rules of the Air.

thetic or apparent gap in the law, analogous 'cases' (such as seaplanes) are analysed to tease out a workable solution. However, there too are limitations to such an interpretive approach.

The following discussion follows up with the assumption that the gap in question is one where at least two different legal acts, the air navigation rules and COLREGs, might apply. The examination relies on the premise that the navigation rules are not intended to be comprehensive and exhaustive.

4. Interrelationship between COLREGs and the Rules of the Air at Altitudes Close to Water Surface

This section tests whether COLREGs would totally replace the Rules of the Air at altitudes below 150 m (or whatever accurate height it may be) where UAVs must follow COLREGs entirely and disregard the Rules of the Air altogether. The interrelationship between COLREGs and the Rules of the Air at low altitudes is unclear.

When it is said that a UAV flying in close proximity to water surface is *considered as a vessel* that must observe COLREG rules, it cannot mean that every single rule of COLREGs will apply to that UAV. Where there is a risk of collision between a waterborne conventional vessel and a UAV flying close to water surface, if the UAV is expressly required by COLREGs to take action as a give-way vessel or otherwise, it must obviously take such action to avoid collision. The uncertainty, however, arises from situations where the conventional vessel seems to be the give-way vessel and the UAV appears to have the right of way under COLREGs. Assume, for instance, that in a crossing situation between a large conventional ship and a small parcel delivery UAV, a risk of collision has developed. Since these two *vessels* are power-driven vessels, if the ship has the UAV on her own starboard side, then *prima facia* the ship should keep out of the way as required by Rule 15 of COLREGs[54] and the UAV has the right of way i.e. it must maintain its course and speed, as provided for in Rule 17 of COLREGs.[55] However, it is submitted that for the following reasons, not only in crossing situations but in any aircraft-vessel encounters, it is always the UAV that is under an obligation to keep out of the way.

First, Rule 15 which governs crossing situations, applies to two power-driven vessels i.e. vessels which are propelled by machinery.[56] Although in this sense a UAV can be regarded as a power-driven vessel which is propelled by machinery,

[54] The Rule states: 'When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel.'
[55] COLREGs, Rule 17(a)(i).
[56] *Ibid.*, Rule 3(b).

Rule 15 applies to *ordinary* power-driven vessels and not to particular category of power-driven vessels. Under COLREGs, a power-driven vessel can be a vessel engaged in fishing,[57] a seaplane,[58] a vessel not under command,[59] a vessel restricted in her ability to manoeuvre,[60] a vessel constrained by her draught,[61] or a WIG craft.[62] These vessels are all particular categories of vessels which, depending on their degree of (dis)ability to manoeuvre, have different rights and responsibilities laid down in Rule 18 of COLREGs. A UAV is, obviously, like a seaplane, a *particular* category of power-driven vessel for it is capable of operating both close to water surface and in the air. WIG craft and seaplanes are also particular categories of vessel for the same reason. Thus, because Rule 15 applies to two ordinary power-driven vessel and a UAV is not an ordinary power-driven vessel, instead of Rule 15, Rule 18 will apply to a situation between an ordinary power-driven vessel e.g. a conventional ship and a UAV. Although Rule 18 does not understandably make any reference to UAVs that have only recently appeared on the scene, it does make reference to two particular categories of vessels which are taxonomically and characteristically very close and related to UAVs: seaplanes and WIG craft. Given the high speed of seaplanes when landing or taking off, a seaplane on the water is obliged by Rule 18(e) to 'keep well clear of all vessels and avoid impeding their navigation'. The very same obligation is also exactly imposed on a WIG craft when taking off, landing and 'in flight near the surface': it must 'keep well clear' of all other vessels and 'avoid impeding their navigation'.[63] By way of inference, given that among all particular types of COLREGs power-driven vessels, UAVs are characteristically most similar to seaplanes and WIG craft, it is safe to say that a UAV 'in flight near the surface' must 'keep well clear of all vessels and avoid impeding their navigation'.

Second, even if, only for the sake of argument, a UAV is considered to be an ordinary category of power-driven vessel, Rule 2(b) of COLREGs provides that when construing and complying with COLREGs, due regard must be had to *special circumstances*, including the *limitations of the vessels involved* which may make a *departure* from COLREGs necessary to avoid immediate danger.[64] An encounter between a conventional ship and a UAV constitutes *special circumstances*. This is because a parcel delivery UAV is so small that it can be observed neither visually nor on radar by the officer of the watch (OOW) on board the conventional ship until it is too late. Also, during hours of darkness, navigation lights of a small UAV are so small and so closely positioned that they may not be distinguishable in the distance or even be completely undetectable in the night skyline of a port like Singapore which is always awash with

[57] *Ibid.*, Rule 3(d).
[58] *Ibid.*, Rule 3(e).
[59] *Ibid.*, Rule 3(f).
[60] *Ibid.*, Rule 3(g).
[61] *Ibid.*, Rule 3(h).
[62] *Ibid.*, Rule 3(m).
[63] COLREGs, Rule 18(f)(i).
[64] Emphasis added.

background lights. These are all *limitations* for the conventional ship to detect the UAV in ample time. Even if in such a situation the UAV is hypothetically replaced with a large (un)manned aircraft that has large distinguishable navigation lights such that the OOW can detect the aircraft with eyes or on radar in the distance, since the average operational speed and also the manoeuvrability of aircraft are much higher than that of conventional ships, a ship will not have sufficient time nor the swiftness required to take effective evasive action. Even if a UAV is flying at a relatively low speed so that the ship has enough time to take avoiding action, a large ship in a congested and shallow body of water like Singapore Strait cannot and will not alter its course or even speed merely to avoid collision with a small unmanned aircraft. Doing so carries the risk of colliding with other manned vessels in the area resulting in loss of life or the risk of running aground and causing pollution and environmental damage. The master or the officer in charge of the navigational watch of the ship will not be exonerated from the consequences of the neglect of the said precautions which are required by the special circumstances of the case.[65] Such a ship, therefore, is under physical (shallow depth of water) and/or navigational (speed, manoeuvrability and heavy maritime traffic) *limitations*. Thus, in a crossing situation (or indeed any other situation for that matter) where a risk of collision is developing and a conventional ship *prima facia* seems to be a give-way vessel which is required to keep out of the way, the special circumstances including the limitations of the ship necessitate a *departure* from COLREGs i.e. the ship must keep her course and speed and the UAV must keep out of the way as the give-way vessel. Not only is the UAV not under any of the limitations as the ship is, but it also has always the option of simply increasing its altitude in order to avoid collision; an advantage that no conventional vessel enjoys. Thus, even if Rule 18 does not apply, Rule 2 makes it clear that due to the special circumstances and the limitations of the vessel, the aircraft must take the required precaution i.e. 'keep well clear' of the vessel and 'avoid impeding its navigation'. Rule 18 or Rule 2, the result is the same.

Third, even if, again only for the sake of argument, COLREGs do not apply to UAVs in flight near water surface, Section 3.2.6 of the Rules of the Air entitled 'Water operations' would cover the situation. The title 'water operations' implies that the rules in that section apply to aircraft when in flight close to surface but the rules do not specify how close to surface an aircraft must be for the rules to trigger, and rightly so. As observed above, collision avoidance rules (whether maritime or aeronautical) will apply when a risk of collision is likely to develop between a vessel on water and an aircraft in the air. Thus, the rules could trigger when an aircraft is operating at a height of 10 metres above water and the vessel involved is short, or when the aircraft is flying at an altitude as high as 80 metres above the surface and the vessel involved or the structure being towed is tall. Rule 3.2.6.1 reads:

[65] COLREGs, Rule 2(a).

> When two aircraft or an aircraft and a vessel are approaching one another and there is a risk of collision, *the aircraft* shall proceed with careful regard to *existing circumstances and conditions* including the *limitations* of the respective craft.[66]

Three points may be made here. First, this rule clearly applies to situations where there is a risk of collision between 'an aircraft and a vessel'. Thus, even if one argues that COLREGs do not apply to collision situations between an aircraft and a vessel, such situations have not been left in ambiguity or to be dealt with uncertainly; they have been explicitly addressed in the Rules of the Air. Second, the rule expressly requires 'the aircraft' and not the vessel, to have careful regard to the existing circumstances including the limitations of the other craft. This means that the prime responsibility to avoid collision in an aircraft-vessel encounter rests with the aircraft and not the vessel. Third, by making reference to 'existing circumstances and conditions including the limitations of the respective craft', this rule strongly resembles the principles laid down by Rule 2(b), COLREGs: an aircraft involved in a risk of collision with a vessel must have careful regard to the special circumstances and the vessel's limitations such as the vessel's slow speed, its sluggish manoeuvrability, its inability to change altitude, shallow depth of water and the traffic density around the vessel. Having due regard to all these limitations should lead the aircraft only to one conclusion: it must 'keep well clear' of the vessel and 'avoid impeding its navigation'. It is no coincidence that following the Rules of the Air results exactly in the same thing as following the COLREGs. In an aircraft-vessel situation, the aircraft is the faster and more manoeuvrable craft and must therefore 'keep well clear' of the vessel and 'avoid impeding its navigation'.

Fourth, Section 3.2.6 of the Rules of the Air stresses at the outset in a 'Note' that 'in addition' to the provisions of 3.2.6.1, rules set forth in COLREGs 'may be applicable in certain cases'.[67] This is the most direct and authoritative guidance that indicates COLREGs may apply to aircraft flying in close proximity to water surface. Since Section 3.2.6 does not specify the cases where Rules of COLREGs may apply to aircraft, it is reasonable to assume that any case or situation not covered by the Rules of the Air should be covered by COLREGs. Rules 3.2.6.1.1, 3.2.6.1.2 and 3.2.6.1.3 of the Rules of the Air, respectively deal with converging (crossing), head-on and overtaking situations between an aircraft flying at low altitudes and another aircraft or a vessel. These rules are virtually the same as their COLREGs counterparts and, the previously mentioned nuance for an overtaking aircraft in high altitudes, does not exist here. In other words, an aircraft overtaking a vessel or another aircraft close to water surface can alter its course to starboard or port. Thus, all three possible types of encounters i.e. head-on, crossing and overtaking situations between an aircraft and a vessel are covered by the Rules of the Air. However, the converging

[66] Emphasis added.
[67] Emphasis added.

(crossing) situation dealt with by rule 3.2.6.1.1 does not cover a specific case: a situation where an aircraft has a vessel on its port side and a danger of collision is developing. This is exactly the same scenario that was introduced at the beginning of this section of the paper. Under the Rule of the Air, this scenario may be analysed in two ways. First, based on rule 3.2.6.1, 'the aircraft' must proceed with careful regard to existing circumstances and conditions including the limitations of the vessel which means the aircraft must keep well clear. Second, since this case is not covered by the Rules of the Air, based on the 'Note' at the beginning of Section 3.2.6, it can be one of those cases where COLREGs is applicable. If so, it was showed previously that under COLREGs, such a scenario will be governed by either Rule 18 or Rule 2 both of which will require the same action: the aircraft or the UAV must keep well clear of the vessel and must avoid impeding its navigation.

It does not however necessarily follow that in *any* aircraft-vessel situation where there is a danger of collision, it is always 'the aircraft' that must keep out of the way. There are a couple of situations where the vessel, *at least in principle*, may not have the right of way. The first exception is the overtaking situation. Under COLREGs, 'any vessel' overtaking 'any other' must keep out of the way of the vessel being overtaken.[68] Similarly, the Rules of the Air also state that 'the aircraft' or vessel which is being overtaken has the right of way and the overtaking craft must keep well clear.[69] Thus, a conventional waterborne vessel overtaking a UAV must, in general, keep out of the way of the UAV. However, in real-life situations due to higher operational speeds of UAVs this scenario is unlikely to arise, and even if such a scenario does arise, the UAV may still not have the right of way. Under Rule 2 of COLREGs and rule 3.2.6.1 of the Rules of the Air, if the overtaking vessel is unable to change its course due to the surrounding shallow water or high traffic density, then Rule 2 or rule 3.2.6.1 will take precedence over and will override other rules applicable to overtaking situations under normal conditions i.e. the UAV must keep out of the way of the overtaking vessel e.g. by changing course or altitude. This is very likely to be the case for a parcel delivery UAV operating in busy and/or shallow coastal waters.

The second exception is 'restricted visibility' which appears to be another example of 'certain cases' where in addition to the Rules of the Air COLREGs will apply too. Navigation of vessels in restricted visibility is governed by Rule 19 of COLREGs under which no vessel has the right of way and all vessels are required to take avoiding action if a close-quarters situation is developing or if risk of collision exists.[70] Thus, one may argue that, at least in theory, in a UAV-vessel encounter, in addition to the UAV the vessel is also required to take avoiding action. Be that as it may, in practice, an encounter between a vessel and a UAV in restricted visibility e.g. dense fog is extremely improbable if not impossible. A

[68] Rule 13(a).
[69] Rule 3.2.6.1.3.
[70] Rules 19(d) and (e).

large ship without operational radar that departs in dense fog is likely to be found in breach of Rule 2(a) of COLREGs that obliges the shipowner, the master and the crewmembers to take any precaution which may be required by the ordinary practice of seamen (otherwise known as good seamanship) or by the special circumstances of the case. This is because it is an established rule of good seamanship that a moored[71] or anchored[72] vessel without operational radar should not get under way[73] when the foreseeable conditions of visibility preclude safe navigation. Since a small UAV not equipped with radar or fog-signalling equipment can neither detect vessels in the area of restricted visibility nor likely to be detected by those vessels, operation of such a UAV in restricted visibility will constitute a violation of the requirements of good seamanship and due care under Rule 2(a). Thus, if a UAV does fly in conditions of restricted visibility and personal injury and/or physical damage involving a vessel follows, the owner and/or operator of the UAV are most likely to be held liable regardless of whether or not the vessel involved in the accident was required to take any action under Rule 19.

To sum up, COLREGs and the Rules of the Air are both applicable to situations where there is a risk of collision between a UAV and a vessel. However, although these rules are consistent and compatible i.e. they require the same type of action from the UAV and the vessel, certain situations such as operation in restricted visibility are specifically covered by COLREGs only. Broadly speaking, in aircraft-vessel situations, COLREGs and the Rules of the Air are complementary to each other.

4.1 *When* Must the UAV Take Action?

As observed above, virtually in every UAV-vessel situation, the UAV has the prime responsibility to take action in order to prevent collision. The question then arises as to *when* and *how* the UAV must take action. In situations involving two vessels of different categories, Rule 18 of COLREGs determines the rights and responsibilities of each vessel. Rule 18 establishes a hierarchy among different categories of vessels based on presumptions of comparative manoeuvrability i.e. the more manoeuvrable vessel is directed to keep out of the way of the less manoeuvrable vessel.[74] For instance, a power-driven vessel underway (being more manoeuvrable) must 'keep out of the way' of a sailing vessel.[75] While some steering and sailing rules of COLRGs,[76] expressly state that they apply when the situation involves 'risk of collision', Rule 18 does not specify

[71] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 87.
[72] *Ibid.*, at p. 89.
[73] Rule 3(i) defines 'underway' as a vessel that is not at anchor, or made fast to the shore, or aground.
[74] Allen (n 71), at p. 282.
[75] COLREGs, Rule 18(a)(iv).
[76] E.g. Rules 12, 14 and 15.

when the give-way vessel must take action in order to 'keep out of the way' of the other vessel. The term 'risk of collision' and when a situation can be said to 'involve' such a risk is best understood by considering the stages that typically occur in an approach situation between two vessels in sight of one another:[77]

- **Stage 1:** the two vessels are at such a distance that their respective courses and speed pose no present risk that they will collide. In this stage therefore the situation does not involve risk of collision, the Steering and Sailing Rules do not apply and both vessels are generally[78] free to manoeuvre as they wish.
- **Stage 2:** the two vessels have approached to such a distance that the situation now involves risk of collision. In this stage therefore the Steering and Sailing Rules trigger. In a typical give-way/stand-on situation, the give-way vessel must take early and substantial action in accordance with Rules 8 and 16 to keep out of the way of the stand-on vessel, and the stand-on vessel must maintain her course and speed in accordance with Rule 17(a)(i).
- **Stage 3:** as soon as it becomes apparent to the stand-on vessel that the give-way vessel is not taking timely and appropriate avoiding action, the stand-on vessel is relieved of her obligation to keep her course and speed and *may* take action to avoid collision in accordance with Rules 17(a)(ii) and (c) and Rule 8.
- **Stage 4:** the two vessels have approached so close that collision cannot be avoided by the action of the give-way vessel alone. The stand-on vessel *must* now in accordance with Rule 17(b) take such action as will best aid to avoid collision.

These stages as a whole are sometimes referred to as the collision avoidance funnel because the options for vessels may narrow as the situation progresses from one stage to another.[79] Some steering and sailing rules of COLREGs apply when the two vessels are in stage two. For example, in a crossing situation between two power-driven vessels, Rule 15 is triggered only when the two vessels have approached close enough 'so as to involve risk of collision'. In other words, if the two vessels are far away i.e. in stage one, neither is under any obligation to take any specific action. Under situations covered by Rule 18, however, since there is no reference to 'risk of collision', the obligation to 'keep out of the way' may be triggered even in stage one. That is to say, the duty to keep out of the way under Rule 18 entails more than merely an obligation to avoid collision and may require the give-way vessel to avoid 'interfering' with the operation of the less manoeuvrable vessel.[80] For instance, a power-driven vessel is required to keep out of the way of a vessel not under command when in sight of one

[77] Allen (n 71), at p. 170.
[78] As will be discussed below, under some Rules e.g. Rules 9 and 10 the duty 'not to impede' may require the relevant vessel to take action even in stage 1.
[79] Allen (n 71), at p. 225.
[80] *Ibid.*, at p. 284.

another.[81] The vessel not under command is also under an obligation to maintain her course and speed as a give-way vessel[82] so that the power-driven vessel can freely manoeuvre around her in order to keep out of her way. However, a vessel not under command, as the name suggests, cannot be reasonably expected to be able to hold her course and/or her speed; she may swerve at any moment. The power-driven vessel must, therefore, avoid the not under command vessel even in stage one when no risk of collision is involved. It follows that due to the operational restrictions present in situations covered by Rule 18, the give-way vessel should give as wide a berth as possible, realising that the stand-on vessel may not be able to control its own manoeuvres and that the entire burden of avoiding collision may well fall on the give-way vessel.[83]

While the provisions of Rule 18 require the more manoeuvrable vessel to 'keep out of the way', when it comes to seaplanes and WIG craft, the language of Rule 18 changes: seaplanes (when on water) and WIG craft (when taking off, landing or in flight near the surface) must 'keep well clear' of all other vessels and 'avoid impeding their navigation'.[84]

Three observations may be made here.

First, the obligation to 'keep well clear' appears to be more extensive and a stronger obligation than to 'keep out of the way'.[85] There is some support for this interpretation in the Rules of the Air because when addressing interactions between two aircraft in high altitudes, the Rules of the Air use the phrase 'keep out of the way'[86] but for interactions between an aircraft flying close to water surface and a vessel, the Rules of the Air state that the aircraft must 'keep well clear' of the vessel.[87] Due to the relative operational restrictions of a vessel on water, it is clear that the duty to 'keep well clear' is stronger than to 'keep out of the way' e.g. the aircraft must keep a greater distance from the vessel.

Second, there is a second obligation for seaplanes and WIG craft to 'avoid impeding' the navigation of any other vessels. The duty not to impede the navigation of other craft appears only once in the Rules of the Air[88] with no further clarification of the meaning of such a duty. The duty also appears in Rules 9 and 10 of COLREGs where some vessels are directed not to impede the

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[81] COLREGs, Rule 18 (a)(i).
[82] *Ibid.*, Rule 17(a)(i).
[83] BA Farnsworth, Larry C Young and Steven D Browne, *Nautical Rules of the Road: The International and Inland Rules* (4th revised edn, Cornell Maritime Press 2010) 51.
[84] *Ibid.*, Rules 18(e) and (f).
[85] Simon Gault (ed), Steven Hazlewood (ed), Andrew Tettenborn (ed), Stephen D Girvin (ed), Edward Cole (ed), Thomas Macey-Dare (ed) and Maureen O'Brien (ed), *Marsden and Gault on Collisions at Sea* (14th edn, Sweet & Maxwell 2016) para 5-438.
[86] E.g. rules 3.2.2.1 and 3.2.2.4.
[87] Rules 3.2.6.1.1-4.
[88] Rule 3.2.6.1.4.

passage[89] or the safe passage[90] of other vessels. Although it is not entirely clear whether the obligation to 'avoid impeding' the navigation of other vessels is equivalent to the duty not to impede the passage or safe passage of other vessels, it seems only logical that this duty under Rule 18 should be interpreted in the light of Rule 8(f) of COLREGs that explains the duty.[91] To clarify the implication of the words 'not to impede', the Maritime Safety Committee of the IMO approved the following item of Guidance in 1982:

> When a vessel is required not to impede the passage of another vessel, such a vessel shall so far as practicable navigate in such a way *as to avoid the development of risk of collision*. If, however, a situation has developed so as to involve risk of collision, the relevant Steering and Sailing Rules shall be complied with.[92]

The essence of this Guidance then found its way to COLREGs through an IMO Resolution in 1987 where paragraph (f) was added to Rule 8.[93] Rule 8(f)(i) reads:

> A vessel which, by any of these Rules, is required not to impede the passage or safe passage of another vessel shall, when required by the circumstances of the case, take *early action* to allow *sufficient sea-room* for the safe passage of the other vessel.[94]

The duty 'not to impede' therefore requires an early action so as to provide sufficient sea room for the safe passage of the not-to-be-impeded vessel and to avoid the development of risk of collision in the first place. In other words, such action must be taken at long range i.e. in stage one when even no risk of collision has developed.

Third, Rule 18 requires a seaplane 'on the water' to keep well clear and avoid impeding. Although it is not entirely clear whether the phrase 'on the water' also includes landing on or taking off from the water, the Rules of the Air make it abundantly clear that it does: 'Aircraft landing on or taking off from the water shall, in so far as practicable, keep well clear of all vessels and avoid impeding their navigation'.[95]

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[89] E.g. Rules 9(b), (c) and (d).
[90] E.g. Rule 10(j).
[91] Allen (n 71), at p. 287.
[92] AN Cockcroft and JNF Lameijer, *A Guide to the Collision Avoidance Rules: International Regulations for Preventing Collisions at Sea* (7th edn, Butterworth-Heinemann 2012) 43 (emphasis added).
[93] IMO Resolution A.626(15) (1987) – available at <https://www.navcen.uscg.gov/pdf/navRules/IMO_A626_15_COLREGS_Amd_19NOV87.pdf>.
[94] Emphasis added.
[95] The Rules of the Air, rule 3.2.6.1.4.

In sum, in a UAV-vessel situation, the UAV must take early action in such a way so as to prevent the situation from advancing from stage one to stage two. A particular troublesome situation is where despite all these warnings to an aircraft to keep well clear of all vessels and avoid impeding their navigation, a UAV, for some reason, does impede the navigation of a vessel and the situation progresses from stage one to stage two, thereby triggering the steering and sailing rules. Suppose, for example, that a UAV is flying dead ahead of but far from a vessel in the same direction as the vessel. The UAV then dramatically reduces its speed such that the distance begins to reduce and the vessel starts catching up with the UAV. As the distance reduces, the risk of collision starts to develop and the situation changes from stage one to stage two where the give-way vessel must take action to avoid collision. As observed above, in overtaking situations, COLREGs and the Rules of the Air both require the overtaking craft (in this case, the vessel) to steer clear of the craft being overtaken. Although this is an overtaking situation in which the UAV is the craft being overtaken, the UAV does not have the right of way as a stand-on craft that must keep its course and speed and the entire responsibility to avoid collision does not shift onto the vessel as the give-way vessel. The amendment to Rule 8 of COLREGs makes it clear that whenever a vessel is directed not to impede the passage of another vessel, if she does impede, then she will still have the prime responsibility to avoid collision even if in the new situation she appears to be the stand-on vessel:

> A vessel required not to impede the passage or safe passage of another vessel *is not relieved of this obligation* if approaching the other vessel so as to involve risk of collision and shall, when taking action, have full regard to the action which may be required by the Rules of this Part.[96]

By suddenly reducing its speed, the UAV in the above example impeded the passage of the vessel and escalated the collision situation from stage one to stage two. Thus, in the new situation, the UAV is still under an obligation to take avoiding action. Under the Rules, a vessel the passage of which is not to be impeded *remains fully obliged* to take action when the two vessels are approaching one another so as to avoid the risk of collision'.[97]

There is an exceptional (and unlikely) situation where a vessel *might* be under an obligation to take action to avoid collision with a UAV. If the speeds of the two craft are such that the vessel is catching up with the UAV so slowly that she can visually or on radar observe the UAV in front of her, and if she has sufficient sea room and navigable waters around her, then she must take an effective avoiding action e.g. make a substantial alteration of course in good time[98] to avoid collision with the UAV if it is safe to do so. However, if, for example, the vessel is navigating along a traffic lane in the Singapore Traffic Separation Scheme (TSS),

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[96] COLREGs, Rule 8(f)(ii) (emphasis added).
[97] *Ibid.*, Rule 8(f)(iii) (emphasis added).
[98] *Ibid.*, Rule 8(c).

then alteration of course may result in grounding and pollution, and a sudden reduction of speed may also mean risk of collision with the vessel approaching from behind. Thus, under the overarching rule of good seamanship, the vessel may have to hold her course and speed and collide with the small UAV in order to avoid a more serious accident. If collision occurs between two vessels, the breach of the duty 'not to impede' will be an important factor for allocating fault for the collision.[99]

Thus, in a UAV-vessel encounter, the UAV is required by both nautical and aeronautical collision avoidance rules to 'keep well clear' of the vessel and 'avoid impeding' her navigation. These obligations require a sufficiently early action at long range so as to give a wide berth to the privileged vessel and to avoid development of danger of collision in the first place. If the UAV nevertheless does impede the vessel's navigation and risk of collision does develop, then the UAV will remain under a continuing obligation to provide the vessel sufficient sea room and to take avoiding action even if it becomes a stand-on vessel in the developed situation. Other steering and sailing rules of COLREGs also apply and, depending on the special circumstances of the case, the vessel may or may not be required to take avoiding action.

International collision avoidance regulations apply to UAVs both directly (under the Rules of the Air) and *by necessity* (under COLREGs).

4.2 Operational Aspects of Navigation

The concluding part of this Article deals briefly with the provisions of COLREGs which are related to navigation but are not immediately navigational in nature (such as the Rules contained in Part B, COLREGs, as discussed above). These provisions are relevant not only for practical and operational reasons but also for the formulation of policy.

4.2.1 Visual Flight Control

Keeping watch and lookout is an important facet in the safe navigation of vessels under COLREGs. As Rule 5[100] anticipates the use of visual and auditory senses as part of the collision avoidance strategy in vessel navigation, that would not apply to UAVs where the operator is clearly not in the bridge. The air navigation rules expressly apply to this matter of "visual alertness". In the UK, for example, the drone code[101] requires the operator to have the UAV in *direct* sight.

[99] *The Antares and Victory* [1996] 2 Lloyd's Rep 482, 498.
[100] 'Every 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 or the risk of collision.'
[101] 'The Drone Code' (*UK Civil Aviation Authority*, October 2019) <https://dronesafe.uk/wp-content/uploads/2019/11/Drone-Code_October2019.pdf>.

Unfortunately, such a requirement would seriously limit the usefulness of UAVs in port use – remote flying or artificial intelligence guided UAVs are becoming commercially and operationally necessities. Indeed, the drone code has very much the casual enthusiast or hobbyist in mind. As regards the Rules of the Air, the accompanying Note 1 to rule 3.2 states:

> It is important that vigilance for the purpose of detecting potential collisions be exercised on board an aircraft, regardless of the type of flight or the class of airspace in which the aircraft is operating, and while operating on the movement area of an aerodrome.

The visual flight rules (VFR) in the Rules of the Air instruct how an aircraft is to be flown in conditions of visibility.[102] From a literal reading of those provisions, the Rules whilst accentuating the importance of sensory vigilance in accident prevention, do not extend to the remote control of the aircraft.

However, a number of States,[103] including the UK, have introduced rules which modify the application of the Rules of the Air to UAVs. In the UK, the Unmanned Aircraft System Operations in UK Airspace – Guidance[104] requires equivalence between UAVs and manned aircraft in matters relating to vigilance and collision avoidance. The Guidance mirrors the position in all members of the European Union Aviation Safety Agency.[105] The new rules make a distinction between Visual Line of Sight (VLOS) and Beyond Visual Line of Sight (BVLOS) operations for the purposes of visual awareness. In the case of the former, the principle is that the remote pilot must be able to see clearly the unmanned aircraft and the surrounding airspace at all times, while it is airborne.[106] The remote pilot is required to monitor the aircraft's flight path and so manoeuvre it clear of anything that it might collide with and while corrective lenses may be used, the use of binoculars, telescopes, or any other forms of image enhancing devices are not permitted.[107] However, in the case of BVLOS operations, the UAV must be equipped with Detect and Avoid (DAA) capabilities which are "at least equivalent to the 'see and avoid' principle used in manned aviation to avoid collision with other aircraft and obstacles".[108] When operating VLOS, the rules apply to Unmanned Aircraft Systems (UAS) in the same way that VFR apply to

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[102] Rule 4.1.
[103] All members of the European Union Air Safety Agency (EU States, Switzerland, Norway, Liechtenstein, Iceland and the UK) are legally bound to introduce such rules prior to 31 December 2020.
[104] 'Unmanned Aircraft System Operations in UK Airspace – Guidance (CAP 722)' (*Civil Aviation Authority*, November 2020) available at <https://publicapps.caa.co.uk/docs/33/CAP722%20Edition8(p).pdf>.
[105] As introduced by EU Regulations 2019/947 and 2019/945.
[106] Section 2.1, Cap 722; the US FAA has a similar rule in Part 107 Small Unmanned Aircraft Systems, Code of Federal Regulations, § 107.31.
[107] *Ibid.*, at section 2.1.1; that means the remote pilot cannot rely simply on the visuals captured by the UAV's camera.
[108] Section 3.6.1, Cap 722.

manned aircraft.[109] However, BVLOS UAS operations in a non-segregated airspace will not normally be permitted without an acceptable DAA capability.[110]

4.2.2 Lights and Signals

The legal requirement under COLREGs for vessels to be equipped with appropriate lighting[111] applies to vessels of varying lengths – the lowest thresholds for those vessels shorter than 12 m in length.[112] The lighting required for such vessels are impractical for small UAVs. There are two additional provisions which might be of help. Rule 22(d) applies to 'inconspicuous, partly submerged vessels or objects being towed', where the requirement is for a white all-round light with a 3-mile visibility range. The other is Rule 31 which applies to seaplanes and WIG craft. There the requirement is for equivalence. The rule states, 'where it is impracticable for a seaplane or a WIG craft to exhibit lights and shapes of the characteristics or in the positions prescribed in the Rules of this Part she shall exhibit lights and shapes as closely similar in characteristics and position as is possible'. In order to prevent confusion between objects and vessels at port areas which are likely to be busy, it is preferable for UAVs not to be equipped with lighting similar to partly submerged objects or seaplanes/WIGs despite the possibility of applying a didactic reasoning in legal interpretation to extend the equivalence rule to UAVs.

The EU approach as regards UAV regulation, instead of preferring equivalence, is to ensure that, for heavier UAVs,[113] the lighting is sufficient to increase visibility to avoid collision, improve navigation and enable the person on the ground to distinguish the UAV from a manned aircraft.[114] The US Part 107 Regulations[115] allow operation of a small UAV at night or during periods of civil twilight only if the UAV is exhibiting anti-collision lighting that is visible for at least 3 miles and has a flash rate sufficient to avoid a collision.[116]

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[109] *Ibid.*
[110] *Ibid.*
[111] Part C, COLREGs.
[112] For such vessels, Rule 22 specifies the range of the lights that they may exhibit: a masthead light, 2 miles; a sidelight, 1 mile; and a sternlight, 2 miles. Additionally, Rule 23(d)(i) specifies the number and type of navigation lights that such vessels may display.
[113] UAVs classed as C1, C2 and C3 UAVs for example. See Art 2(1)(a) EU Regulation 2019/945.
[114] Regulation 2019/945 Annex 1, Pt 2 para (16), Pt 3 para (18), Pt 4 para (14) for example.
[115] 'Part 107 – Small Unmanned Aircraft Systems' (*Electronic Code of Federal Regulations*, 10 May 2021) <https://www.ecfr.gov/cgi-bin/text-idx?SID=dc908fb739912b0e6dcb7d7d88cfe6a7&mc=true&node=pt14.2.107&rgn=div5>.
[116] *Ibid.* at §107.29(a) and (b); in §107.29(c) civil twilight refers to the following: (1) Except for Alaska, a period of time that begins 30 minutes before official sunrise and ends at official sunrise; (2) Except for Alaska, a period of time that begins at official sunset and ends 30 minutes after official sunset; and (3) In Alaska, the period of civil twilight as defined in the Air Almanac.

That said, research has shown that the profusion of lights at ports, especially city ports, does lead to confusion by users which in turn compromises safety.[117] There are thus policy considerations as to the type of lighting to be carried on UAVs at busy and built-up port areas which should be science-led and evidence-based. The US Federal Aviation Administration (FAA) Part 107 rules do allow for the remote pilot to reduce the intensity of the anti-collision light in the interest of safety.[118] It is probably safe to say that whilst the lighting requirements in COLREGs could be interpreted to include UAVs, the matter should be properly evaluated based on the best scientific evidence.

5 Conclusion

This Article has shown that the UAV, especially when flying at low altitudes, could and should be characterised properly as a vessel for the purposes of COLREGs and simultaneously, as an aircraft under the Chicago Convention. That proposition is not as controversial as might be first assumed – seaplanes have consistently been legally treated as being subject to a dual regime.[119]

When an aircraft operates in close proximity to waterborne vessels, logically it should comply with COLREGs given that the majority of the other users at the port area are waterborne vessels compulsorily subject to COLREGs. Consistency of navigation and collision avoidance protocols for either craft must surely be considered essential. This Article has shown that despite the awkward question of the UAV's status, compliance with COLREGs as *a general rule* will make for a safer port area where UAVs are regularly flown. That said, clearly a preferred solution would be for the IMO and ICAO to come together again as they did when responding to the emergence of type C WIG craft and address navigation of UAVs flying over water. A *sui generis* protocol expressed in a legally binding instrument could resolve the question of the status of UAVs, hopefully once and for all.

[117] See, for example, a study of Taiwanese ports – C Liu, G Liang, Y Su, and C Chu, 'Navigation Safety Analysis in Taiwanese Ports' (2006) 59(2) Journal of Navigation 201-211, at p. 208.
[118] §107.29(a)(2) and (b).
[119] See Rules 3(e) and 18(e) COLREGs.