AVOIDING COLLISIONS AT SEA – FROM MULTI-SHIP TO SHIP-TO-SHIP ENCOUNTER

Author1[a] Capt. Djani Mohovic, PhD[1]

Author 2[b] Guy King, MSc (Ports), PGCTL(HE), FHEA, MInstLM[2]

Author 3[c]Tomaz Gregoric, Msc[3]

Author 4[d] Reza Ziarati, BSc (Eng), PhD (Eng), Cert Ed, CMechE, CElecE, CMarEng, CEng, FIMechE, FIET, FIMarEST[4]

Author 5[e] Capt. Nicolai Velikov, PhD[5]

Author 6[f] Capt. Renato Ivce, PhD[6]

Author 7[g] Capt. Robert Mohovic, PhD[7]

Author 8[h] Igor Rudan, PhD[8]

Author 9[i] Silja Teege[9]

Author 10[j] Dr Basak Akdemir[10]

Author 11[k] Ana Peric Hadzic, PhD[11]

Author 12[l] Ersin Ahmet Ozturker, BSc (Eng), MSc (Eng), PhD[12]

Author 13[M] German de Melo Rodriguez, MSc (Eng), PhD (Eng), CMarEng, Ceng, MIMarEST, MASME[13]

[a] University of Rijeka, Faculty of Maritime Studies, Studentska 2, 51000 Rijeka, Croatia, dmohovic@pfri.hr

[b] Warsash Maritime Academy, Southampton Solent University | Newtown Road | Warsash SO31 9ZL, guy.king@solent.ac.uk

[c] Spinaker d.o.o., Sončna pot 8, SI-6320 Portorož, Slovenija; tomaz.gregoric@spinaker.si

[d] Centre for Factories of the Future, Warwick University Science Park, Barclay Venture Centre, Sir William Lyon Road. Coventry CV4 7EZ, United Kingdom, reza.ziarati@c4ff.co.uk

[e] Nikola Vaptsarov Naval Academy, 73, Vasil Drumev Str, 9026 Varna, Bulgaria, n.velikov@nvna.eu

[f] University of Rijeka, Faculty of Maritime Studies, Studentska 2, 51000 Rijeka, Croatia, rivce@pfri.hr

[g] University of Rijeka, Faculty of Maritime Studies, Studentska 2, 51000 Rijeka, Croatia, mohovic@pfri.hr

[h] University of Rijeka, Faculty of Maritime Studies, Studentska 2, 51000 Rijeka, Croatia, rudan@pfri.hr

[i] Bahcesehir Unıversıty, Engineering Management Department, Beşiktaş, 34353 Istanbul, basak.akdemir@eng.bau.edu.tr

[j] Managing Director Sea Teach S.L. Port Petit 324 07660 Cala D'or Mallorca/ Spain, www.sea-teach.com

[k] University of Rijeka, Faculty of Maritime Studies, Studentska 2, 51000 Rijeka, Croatia, ana@pfri.hr

[l] Makro Shipping and Ship Management Ltd., Istanbul, Turkey, management@makroshipping.com

[M] Polytechnic University of Catalunya, Faculty of Nautical Studies, Pla de Palau, 18, 08003 Barcelona, Spain, demelo@fnb.upc.edu

Abstract

It has been almost 50 years since the 1972 International Regulations for Preventing Collisions at Sea (known as the COLREGs) were introduced with only some minor amendments added since their introduction. Many studies and accident reports indicate that these incidents were primarily caused by either human error or, are associated with human error as a result of inappropriate human responses. Collisions commonly represent many of these incidents and they often happen in multi-ship encounters. The COLREGs were primarily written for ship-on-ship encounters yet they remain valid in their application in multi-ship encounters. However, teachers report that many students (and also senior officers) appear to have serious problems in applying the COLREGs in multi-ship encounters. This paper discusses the “Divida et Impera” approach of “ACTs plus” Erasmus+ project team to facilitate the application of COLREGs in multi-ship encounters. The “Divida et Impera” approach is based on splitting the multi-ship encounters into several ship-on-ship encounters. Then, usually contrary obligations of a single ship identified in several ship-on-ship encounters are interpreted to finally find the give-way vessel(s) and the most appropriate collision avoiding actions. This paper discusses the “Divida et Impera” approach in one example multi-ship encounter scenario. Many other multi-ship encounter scenarios, enriched with graphics, videos and quiz may be found at ACTs Plus online platform (advanced.ecolregs.com).

Keywords: COLREGs, collision avoidance, multi-ship encounters

1. Introduction

It may be argued that the 1972 COLREGs are one of the most long-standing of the rules that still be applied at sea. They have only suffered minor amendments since their initial adoption. On the other hand, seafaring has considerably changed over the last 50 years and these changes have all occurred since the Rules were first

adopted. Very large vessels with unusual maneuvering characteristics were built (first was the boom of supertanker vessels in the 1970's, followed by the construction of very large bulk carriers and in the last 10 years very large and ultra large container and passenger vessels have appeared). The number of vessels at sea has also increased, and it is suggested that with an increase in traffic density, there is a corresponding increase in the possibility of a collision occurring.

What has greatly increased though, is the general speed of vessels. The High Speed Craft (HSC) with sailing speeds of between 30 and 60 knots are now much in evidence around the world. Additionally, High Speed Ships (HSS) have been built, where ships with a length of over 200m sail with speeds of 32-33 knots. When the fuel prices in the World are lower, even large container ships can sail at speeds of over 30 knots. Further, every new passenger ship can reach the same sorts of speed, regardless of their length. Greater speed leaves the navigator on the bridge with less time to assimilate what is happening and for the overall collision avoidance process to be considered.

However, to assist the Navigator, it is suggested that ARPA Radar is the one device which has greatly facilitated collision avoidance. ARPA however, was not fully developed until the 1980's and 1990's – sometime after the Rules were first adopted. Unfortunately, the limitations of the radar in general and ARPA in particular remain. These limitations revolve around: dense rain; waves; low reflection of smaller objects and other similar limitations which still exist today, despite the associated increase in technology. As a result, it can be suggested that the accuracy of collision avoidance data provided by the ARPA radar remains as satisfactory for ocean passages and possibly coastal navigation where there is not much dense traffic. However, for dense traffic areas and approachable fairways and harbours, the overall accuracy of ARPA can no longer be considered to be as satisfactory.

Other important bridge devices that can have a direct or indirect impact on collision avoidance should be mentioned, such as the development of satellite position systems and ECDIS. The ability to display a very accurate ships position on the electronic chart has greatly reduced the workload of bridge officers. On the other hand, the possibility of almost "perfect" steering and tracking of the ship's movement on the planned voyage have had the effect of creating more congestion, in turn causing more frequent requirement for collision avoidance as vessels converge of the "perfect" track. This also occurs in ocean navigation as the vessels that used to be "off track" due to the limited ability to determine the ship's position and drift caused by external forces acting on the ship, now almost do not exist due to the technology being used. Again, vessels are converging on the "perfect" track.

One of the greatest problems in collision avoidance is that one vessel does not know what the intentions of the other ship are. On the road, using the direction indicator on the car has partially solved this problem. Likewise, in the last 10 years the introduction of AIS has gone some way to enabling Navigating Officers to get some partial data that gives them additional information about another ship such as: status; course; speed; destination and other relevant data about ship and its voyage.

However, AIS does not tell the other vessel what the Watchkeeping officer on one ship is about to do with regard to any collision avoidance manouevre they may make.

In many areas of the World, a VTS service has been introduced. As a result many collision hazards have been elegantly resolved by VTS in the same way that air traffic services keep aircraft apart. However, the main role of the VTS, is at the information service level and not to interfere in the decision-making process required to avoid a collision between two or more ships.

After a short chronological review of the development and changes that have occurred since the current Rule's were adopted, a legitimate question would be whether the Rule's are out of date and whether it is necessary to consider completely amending the Rule's in order to meet today's challenges and the needs of the seafarers?

It is suggested that the authors of this paper answered these questions when they conducted workshops whilst undertaking a previous project - Avoiding Collision at Sea (2013-2015). The organized workshops were where Masters, Deck officers, VTS operators, employees of port authorities, pilots and lecturers all participated in looking at and discussing the Rules and their interpretation. The common conclusion from the workshops was that: The Rules could do with some minor changes or updates to reflect new technology, but drastic changes are unlikely to be required. More importantly was the conclusion that there was a requirement that the current Rules need very careful explanation so that they are fully understood, in the same way, in every language. The authors of this article fully agree with the above mentioned conclusion and as their contribution to better understanding of the Rules, the e-COLREGs Learning Platform (available at www.ecolregs.com) was developed by them.

In order to gain a better understanding of the Rule's, a Rule Learning Platform was developed by the authors, where each Rule was divided into its most simple parts and the corresponding theoretical meaning then explained. The practical scenarios were then further explained in their application together with possible collision avoidance actions.

Active seafarers and students tested the developed Rule Learning Platform and it has been confirmed that it has been very successful in developing and teaching a greater understanding of the Rules. This was exampled by the platform being used for teaching students in the project partners own academic institutions for the last three years and the exam results have shown great improvements in the student's knowledge of the Rules. That the platform has not only been used by Partners on the project shows the data that more than 147.000 users from all countries all over the world used the platform since May 2015.

The ACTs Project Partners have been very proud of the project results but it was clear to everyone that explaining the application of collision avoidance rules between two ships is not enough. This is because in practice, more than two ships are often encountered in the same area. In this case, collision avoidance becomes much more

complex and for this reason, the project has been continued through to the current ACTs Plus (ACTs+) project.

As a result, ACTS+ focuses on where more than two ships are encountered in the same area, or when obligations between encountered ships require the determination of the hierarchy among the applicable Rules.

2. Multi-ship and complex multi-rule encounters

The need to continue further work and develop the ACTS+ project had already come from workshops organized within the original ACTs project where active seafarers, teachers and others involved in seafaring had pointed out that it was necessary in cases where more than one rule is involved. It was found that there was consequently a need to explain the relationships and hierarchy of the rules in order to determine suitable courses of action to avoid the collision. Furthermore, it was emphasized that in explaining the application of the Rules, it would be very useful to use scenarios that occur (or may occur) in practice when more than two ships are encountered or, when multi-ships are encountered that have different constraints or, when ships are encountered in specific areas such as Narrow channels or Traffic Separation Schemes.

The authors proposed the project and made an application for funding of this research. It successfully passed the evaluation requirements and the project "Avoiding Collision at Sea Plus" (2016-2019) which was funded under the Erasmus + program by the European Union, was commenced in October 2016.

Through organized workshops, guidelines were provided to show Complex Multi-rule and Multi-ship Scenarios in an easy and user-friendly manner with a clear interpretation to promote better understanding of the rules. The ACTS+ Project demonstrates various situations involving more than two vessels and clearly explains which rules the mariners should apply. A number of multi-ship and multi-rule scenarios were produced to show training in the three main types of situation: crossing situation, overtaking situation and head-on which can take place on the high seas, in narrow channels, in Traffic Separation Schemes and in coastal waters. A total of 18 scenarios were thus developed.

The greatest challenge was not to determine the scenarios, but the way in which the Rules should be applied and which collision avoidance actions can be taken so that the actions that were taken fully complied with the COLREGs. Normally the number of scenarios in practice can far exceed the 18 that the Project developed on the platform, but using the principle of solving complex collision avoidance situation as shown in the 18 developed scenarios, any other complex situation of encountered ships can also be solved.

As the best way to facilitate the application of COLREGs in multi-ship encounters the ACTs+ team utilized the “Divida et Impera” approach. The “Divida et Impera” approach is based on splitting the multi-ship encounters into several ship-on-ship encounters taking into consideration if the situation is occurring on high seas, in narrow channels, in Traffic Separation Schemes, or in coastal waters. It also takes

into account encounters between ships with different responsibilities, or when ships are navigating in or near areas of restricted visibility.

It was not unusual to discover several contrary obligations of a single ship identified in the ship-on-ship encounters. These needed interpreting to finally find the Give Way vessel(s) most appropriate collision avoiding actions. In this paper the “Divida et Impera” approach is discussed on one multi-ship encounter scenario as an example. Many other multi-ship encounter scenarios, enriched with graphics, videos and a quiz can be found at the ACTs Plus online platform (advanced.ecolregs.com).

3. Case study: Overtaking and crossing situation on the high seas

Every scenario has been developed into five sections:

- Graphics,
- Description of scenario,
- Rule(s) to be applied,
- Applying the Rule(s) and comments,
- Actions.

The first two sections are used to give as short and clear a description of the scenario as is possible. When a graphical scenario view and textual description of the scenario were created, particular care was taken that the amount of data was the minimum required to describe the scenario. However, care was taken that the description does not allow that the reader to make an incorrect or wrong interpretation of the scenario and the subsequent application of the relevant Rules.

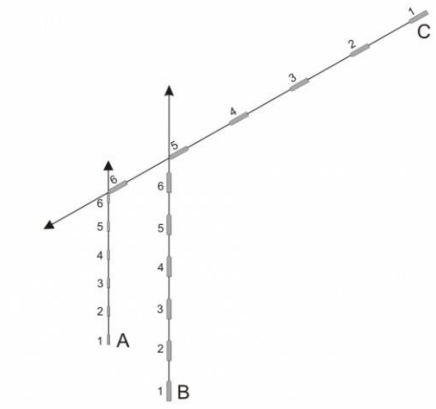
Graphics:	Description of scenario:
	Vessel A: power-driven vessel Vessel B: power-driven vessel Vessel C: power-driven vessel Area: On the high seas Visibility: Good (Vessels in sight of one another) Vessel A and vessel B are sailing in approximately parallel courses and vessel B is overtaking vessel A on her starboard side. Vessel A has vessel C on her own starboard side (relative bearing STBD 035°). Vessel A and vessel C are crossing so as to involve risk of collision. Vessel B and vessel C are crossing but there is no risk of collision.

Figure 1. Example of graphical scenario and its textual description

In the third section (Rule(s) to be applied) only the "main" rules applicable in the present scenario are listed. It is understood that many "general" rules would remain applicable in all the scenarios (such as Rule 1 etc.), but as this platform primarily serves users that are supposed to know the Rules, to avoid too much "unnecessary data" the more "general" rules were intentionally omitted.

Therefore, in the above scenario, the "main" applicable Rules that would need to be considered are: Rule 13 (Overtaking), Rule 15 (Crossing situation), Rule 16 (Action by give-way vessel) and Rule 17 (Action by stand-on vessel).

In the fourth section, the relationship between the ships is shown according to the principle of "Divida et Impera". As the Rules have been written for only the relationship between two ships, the scenario is divided in a way to explain the obligation of avoiding a collision between two ships individually.

The above scenario shows the application of the rules for the Overtaking situation between vessels A and vessel B and the Crossing situation between vessels A and vessel C. In this scenario, there is no risk of collision between vessels B and vessel C and there is therefore no need to demonstrate the application of rules for them. The example of Applying the Rule (s) and comments are detailed below:

Applying the Rule(s) and comments:

Overtaking situation (vessel A and vessel B):

In accordance with Rule 13 (a) (Overtaking situation), notwithstanding anything contained in the Rules of Part B, sections I and II, any vessel overtaking (vessel B) any other vessel (vessel A) shall keep out of the way of the vessel being overtaken (Vessel A).

In accordance with Rule 13 (d) (Overtaking situation), any subsequent alteration of the bearing between the two vessels shall not make the overtaking vessel (Vessel B) a crossing vessel within the meaning of these Rules or relieve her (Vessel B) of the duty of keeping clear of the overtaken vessel (Vessel A) until she is finally past and clear.

In accordance with Rule 16 (Action by give-way vessel), every vessel (vessel B) which is directed to keep out of the way of another vessel (vessel A) shall, so far as possible, take early and substantial action to keep well clear.

In accordance with Rule 17 (a)(i) (Action by stand-on vessel), where one of two vessels is to keep out of the way the other shall keep her course and speed.

Crossing situation (vessel A and vessel C):

In accordance with Rule 15 (Crossing situation), when two power-driven vessels are crossing so as to involve risk of collision, the vessel (vessel A) which has the other (vessel C) on her own starboard side shall keep out of the way.

In accordance with Rule 15 (Crossing situation), vessel A shall, if the circumstances of the case admit, avoid crossing ahead of vessel C.

In accordance with Rule 16 (Action by give-way vessel), every vessel (vessel A) which is directed to keep out of the way of another vessel (vessel C) shall, so far as possible, take early and substantial action to keep well clear.

In accordance with Rule 17 (a)(i) (Action by stand-on vessel), where one of two vessels is to keep out of the way the other (Vessel C) shall keep her course and speed.

Vessel A, in accordance with Rule 17 (Action by stand-on vessel) shall keep her course and speed for vessel B, but in accordance with Rule 15 (Crossing situation) vessel A shall keep out of the way of vessel C.

The section titled “Comments“ is the practical conclusion (or solution) to avoid a collision between the ships for the given scenario. This section discusses the individual obligations of all ships and on the principle of "elimination" it gives the explanation of which Rule(s) should be applied to each ship. The principle of "elimination" is practically the only correct way of applying the Rules when we have complex multi-ship encounters. For example, a ship which has multiple obligations under various Rules normally can not take two actions at once. The above scenario is a classic example of this dichotomy when Vessel A should keep their course speed for Vessel B, but at the same time, is obliged to avoid Vessel C by altering course and/or speed.

The principle of "elimination" therefore discards the Rule(s) and all actions in accordance with those Rule(s) that the vessel(s) should not take, and keep the Rule(s) and all actions in accordance with Rule(s) that can or should be taken by the vessel(s). In the mentioned "elimination" principle, the provisions of Rule 8 (Action to avoid collision) must constantly be followed so that any action to avoid collision does not result in another close-quarters situation. Example of Comments is listed below:

Comments:

In accordance with Rule 17 (a)(i) (Action by stand-on vessel), vessel C shall keep her course and speed for vessel A and vessel B.

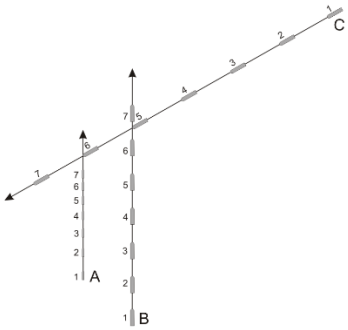
In accordance with Rule 17 (a)(i) (Action by stand-on vessel), vessel A shall keep her course and speed for vessel B, but in accordance with Rule 15 (Crossing situation), vessel A shall keep out of the way for vessel C.

In last part actions to avoid collision or close-quarters situation are shown for all vessels which have an obligation to avoid collision with other vessels. All actions are also taken in accordance with the ordinary practice of seamen. Graphically and Bird's-eye view video has been presented of any possible collision avoidance action, including an ECDIS video where this was applicable. In the scenario presented in this paper, the following actions to avoid collision are possible.

Actions:

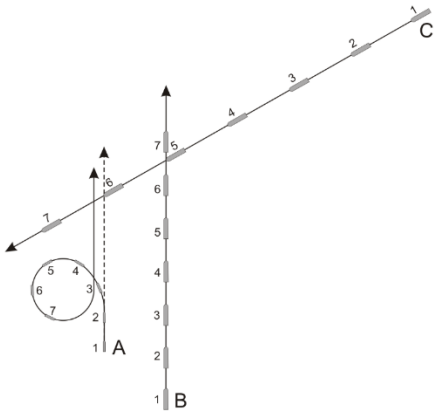
a) Vessel A may reduce speed to enable safe passing of vessel C

Graphics:



b) Vessel A may make 360° turn to port to avoid collision with vessel C

Graphics:



4. Conclusion

Many technical innovations have greatly helped in the conduct of navigation and consequently helped reduced the Watchkeeping Officers' workload. However, the Watchkeeping officer still has to rely on their understanding of the Rules to avoid a collision and they must therefore be capable of applying the correct Rule(s) in whatever situation they may find themselves. Collisions that have occurred in the recent past would tend to prove that the understanding of the Rules and their correct application is unsatisfactory. Therefore any research in this field can be fully justified if it increases knowledge and understanding.

The scenarios which have been developed in the ACTS+ project present even more complex cases of encountering ships when the correct application of the Rules is even more demanding. One of the very good principles for solving such complex cases is presented in this paper and it is based on the principle of "Divida et Impera". It is important to emphasize that this principle can be applied to any complex case of encountering ships, and the result (possible collision avoidance actions) obtained in this way is in compliance with the Rules. Complex cases, which cannot be solved in this way, belong to the category of "special cases" and will require further research in this field.

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