Cooperation and Engagement in the Asia-Pacific Region

Edited by

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CHAPTER 16

Understanding the Challenge: Mass Rescue Operations at Sea

Richard Button and Thomas Gorgol[1]

Abstract

This paper provides an analysis of the challenges associated with a mass rescue operation (MRO) at sea. In particular, the challenges associated with the coordination and conduct of an MRO offshore, with limited resources readily available to render assistance to possibly hundreds, if not thousands of persons in distress. While government agencies and regulatory bodies continue to improve standards and regulations to prevent disasters at sea, search and rescue (SAR) authorities must still assess the risk, plan and conduct response preparedness activities for these low probability, high consequence disasters that may result in a significant loss of life. This paper will discuss the imperative for MRO response planning and preparedness, identify lessons learned from previous maritime disasters and MROs, and challenges SAR authorities must consider when planning, coordinating and conducting maritime MROs.

Keywords

search and rescue – mass rescue operation – maritime disasters – rescue at sea

1 Introduction

> "The thing I constantly think about—we were so, so very lucky. The difference between our ship and the Titanic is we weren't caught in

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> the middle of the ocean," said Kajian. … "If we had been caught in the middle of the ocean, most of these people wouldn't have survived."[2]

Regardless of the sophistication of passenger ship and aircraft design, regulations, inspections, policies and procedures, SAR authorities and the maritime community continue to respond to disasters at sea where large numbers of people in distress must be rescued. With passenger ships sailing worldwide, and passenger aircraft on daily transoceanic flights, there will always be the risk of a maritime disaster and a Mass Rescue Operation (MRO) occurring.[3,4] In these maritime disasters, the challenge will be to mount an effective rescue of a large number of survivors in the water or survival craft, a response complicated by

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Rescue, U.S. Coast Guard Headquarters, Washington, DC. Mr. Gorgol served 21 years on active duty for the U.S. Coast Guard and has served five years in his current position. PowerPoint available at https://colp.virginia.edu/sites/colp.virginia.edu/files/beijing-button.pdf.

2 Mike Kajian, passenger on board Passenger Ship *Costa Concordia*, quoted in: Meg Jones, "A year later, Oshkosh survivor of cruise ship crash still cruising," *Milwaukee-Wisconsin Journal Sentinel* (January 14, 2013); article available on the Internet at http://www.jsonline.com/news/wisconsin/one-year-later-survivor-of-cruise-ship-crash-still-cruising-nh8cn8s-186859382.html.

3 The *International Aeronautical and Maritime Search and Rescue Manual* ("IAMSAR Manual"), Volume 1, defines a *mass rescue operation* as, *"Search and rescue services characterized by the need for immediate response to large numbers of persons in distress, such that the capabilities normally available to search and rescue authorities are inadequate."* International Maritime Organization (IMO)/International Civil Aviation Organization (ICAO), *IAMSAR Manual, Volume 1* (London: IMO, 2016): xii. The IAMSAR Manual goes on to state that, *"MROs are required less frequently than typical rescue efforts, but have high potential consequences. Flooding, earthquakes, terrorism, and large passenger or ship disasters are examples of scenarios that may involve the need for MROs. Extensive preparations and resources are required to conduct MROs successfully."* (paragraph 6.6.3) What is absent from this definition is a specific number of persons requiring rescue. SAR authorities have acknowledged it would be counter-productive to assign a "number of persons in distress" requirement to the MRO definition. How many persons in distress would be required for the incident to be considered an MRO? If there was one less person in distress than the required number, would an incident *not* be considered an MRO? In many instances, the time of day, location, weather, sea state, etc., may be a better determiner of whether a SAR case is an MRO, not necessarily the number of persons in distress.

4 The U.S. National Search and Rescue Committee (NSARC; https://cglink.uscg.mil/NSARC) differentiates between the internationally recognized definition of an MRO and "catastrophic incident," which is defined in the *National Response Framework* (June, 2016) as, *"Any natural or manmade incident, including terrorism, that results in extraordinary levels of mass casualties, damage, or disruption severely affecting the population, infrastructure, environment, economy, national morale, and/or government functions."* (Page 1) Catastrophic incidents involve the destruction of infrastructure (e.g., hurricanes, earthquakes, tsunamis, etc.) and may include an MRO; NSARC considers MRO s to involve passenger transportation systems, such as passenger ships, ferries, aircraft, etc.

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weather and sea conditions, hypothermia, as well as the distance from available search and rescue (SAR) facilities.[5]

Despite all the improvements to aeronautical and maritime passenger transportation safety, low probability and high consequence MRO events continue to occur globally, putting thousands, if not tens of thousands of people at risk.

Through the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO), the international community continues to work towards improving aeronautical and maritime passenger transportation safety to minimize these horrific disasters.[6] Lessons learned from disasters are collected and analyzed; new safety regulations and procedures are adopted and implemented. While these measures are critical in preventing or minimizing the impact of a maritime disaster, they continue to occur. Responding to such a disaster at sea, with many potential survivors, results in an MRO response challenge, with numerous difficulties and extreme challenges for all involved. Furthermore, with the increase in the capacity of passenger ships and aircraft, the challenge has never been greater; especially if a disaster occurs hundreds of miles offshore, from the nearest coastal State, such that Search and Rescue (SAR) resources may be limited in rendering an effective and efficient coordinated response.[7, 8] Even if SAR resources are available, few coastal States are prepared to mount an effective response to a disaster at sea.

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5 The Annex to the *International Convention on Maritime Search and Rescue* ("SAR Convention"), 1979, defines *search* as, *"An operation, normally co-ordinated by a rescue co-ordination centre or rescue cub-centre, using available personnel and facilities to locate persons in distress."* (paragraph 1.3.1) *Rescue* is defined as, *"An operation to retrieve persons in distress, provide for their initial medical or other needs, and deliver them to a place of safety."* (paragraph 1.3.2). *SAR facility* is defined as, *"any mobile resource, including designated search and rescue units, used to conduct search and rescue operations."* (paragraph 1.3.7).

6 IMO is the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships (www.imo.org). ICAO is a specialized agency of the United Nations with responsibility for promoting the safe and orderly development of international civil aviation throughout the world (www.icao.int).

7 There are passenger aircraft capable of transporting up to 850 passengers (e.g., Airbus A380). As of June 2017, the *Symphony of the Seas*, owned by Royal Caribbean Cruises, Ltd., is the largest passenger ship in the world, at 228,021 gross tons and able to carry 6,680 passengers and 2,200 crew. Statistics obtained from Royal Caribbean International Press Center, *Ship Fast Facts*. Available on the internet at: https://www.royalcaribbeanpresscenter.com/fact-sheet/31/symphony-of-the-seas/; accessed on October 19, 2018. If one of these large passenger ships sank requiring the rescue of the passengers and crew, the challenge would be significant. By comparison, in Fiscal Year (FY) 2017, the entire U.S. Coast Guard had 16,046 SAR cases and 4,225 lives saved.

8 The annex to the SAR Convention, defines *search and rescue service* as, *"The performance of distress monitoring, communication, co-ordination and search and rescue functions,*

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SAR authorities are responsible for the coordination and conduct of SAR operations and MROs within their respective SAR regions.[9] For SAR authorities worldwide, the risk and complexity of planning and responding to an MRO has continued to increase as the number of passenger ships and aircraft continues to increase.

Because of the potential significant loss of life associated with a maritime disaster and subsequent MRO, this paper was developed for two reasons. First, while considerable work has been accomplished towards *preventing* maritime disasters, the purpose of this analysis is to draw attention to the challenges associated with the planning of and *responding* to an MRO, with an off-shore MRO event being the worst-case scenario. If SAR authorities can effectively plan, prepare and respond when this low probability, high risk disaster occurs in the maritime environment, then the loss of life can be minimized. Secondly, this paper provides SAR authorities and planners with an awareness of the challenges that must be considered in planning and responding to a maritime MRO.

2 Mass Rescue Operation (MRO)

The International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual describes the worst-case MRO scenario:

> Such incidents might involve hundreds or thousands of persons in distress in remote and hostile environments. A large passenger ship collision, for example, could call for the rescue of thousands of passengers and crew in poor weather and sea conditions, with many of the survivors having little ability to help themselves. Preparedness to mount a large and rapid response would be critical to preventing large-scale loss of lives.[10]

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including the provision of medical advice, initial medical assistance, or medical evacuation, through the use of public and private resources including co-operating aircraft, vessels and other craft and installations." (paragraph 1.1.3) The annex to the SAR Convention goes on to say that, *"Parties having accepted responsibility to provide search and rescue services for a specified area shall use search and rescue units and facilities for providing assistance to a person who is, or appears to be, in distress at sea."* (paragraph 2.1.9) Any resources can be utilized to save lives at sea. Coastal State SAR authorities must be able to coordinate the response to persons in distress, normally though their Rescue Coordination Center (RCC).

9 The Annex to the "SAR Convention" defines *search and rescue region* as, *"An area of defined dimensions associated with a rescue co-ordination centre within which search and rescue services are provided."* (paragraph 1.3.8).

10 IAMSAR Manual, Volume 1: 6–7.

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Additionally, the IAMSAR Manual explains the scope of the challenge SAR Coordinators have in planning and responding to a maritime MRO.[11] Key considerations include:

1. *MROs are a low-probability, high-consequence event that might result in a large-scale loss of life or serious injury to a large number of people.* If a maritime disaster and subsequent MRO has not occurred in several years, then this type of event can become marginalized in planning. MRO response processes and procedures may take a back seat to other types of events that may occur more often. The consequence to lowering the priority of MRO response planning could be disastrous when such an event does occur and SAR authorities are unable to mount an effective response, possibly increasing the number of lives lost.
2. *Capabilities normally available to the SAR Mission Coordinator (SMC) may be inadequate in a maritime MRO scenario.* In many off-shore SAR operations, merchant ships can be diverted to assist vessels in distress. While these operations are extremely difficult when only a small number of persons may be in distress, the rescue of many persons in distress can be an overwhelming and a nearly impossible challenge for one, or even several merchant ships.
3. *Success often depends on immediate, well planned, and closely coordinated large-scale actions, utilizing the use of resources from multiple volunteers and organizations; both national and international.* Depending on the type of distress, location, and other on scene factors, SAR authorities may have to rely on other SAR resources, such as Automated Mutual Assistance Vessel Rescue System (AMVER) to assist persons in an MRO response.[12] These varying resources will be critical in the overall response to an offshore MRO. As such, SAR authorities must continue to work together, as well as with other SAR and industry stakeholders and volunteers in planning for and preparing to respond to an MRO.

11 The IAMSAR Manual defines *search and rescue coordinator* (*SC*) as, *"One or more persons or agencies within an Administration with overall responsibility for establishing and providing SAR services and ensuring that planning for those services is properly coordinated."* For example, as the *U.S. National Search and Rescue Plan* (*2016*) assigns the U.S. Coast Guard as the SC for the U.S. aeronautical and maritime SRRs in the oceanic environment.

12 Established in 1958 by the U.S. Coast Guard, AMVER (Automated Mutual Assistance Vessel Rescue System; www.amver.com) is a computer-based voluntary global ship reporting system used by SAR authorities worldwide to arrange for assistance to persons in distress at sea. There are thousands of vessels enrolled in AMVER, representing over 150 countries. On any given day there are over 7,800 vessels available to divert and assist in a distress situation. In 2017, AMVER contributed to the rescue of 153 persons in distress worldwide.

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4. *A maritime MRO may require activation of other missions in addition to SAR* (e.g., environmental response, law enforcement, maritime security, etc.).
5. *A maritime MRO will generate intense media interest and scrutiny by the public*. Information should be provided to the media and public with minimal delay.[13]

3 Maritime MROs in Context

To properly plan and respond to a maritime MRO, the uniqueness of this type of event must be appreciated. The following two principles provide the argument for why it is important to understand the risk, in order to prepare and then effectively respond to such a maritime disaster and subsequent MRO.

3.1 *Titanic Effect*

In 1974, author Kenneth E. F. Watt wrote, *The Titanic Effect: Planning for the Unthinkable*, which describes possible future economic and energy consumption challenges. Relevant to MRO planning and response preparedness is the "Titanic effect" principle:

> History abounds with parallels of imminent disaster. Public warnings have been ignored when they were outside the range of past experience. Consequently, the appropriate countermeasures were not taken. The *Titanic* and other "unsinkable" ships that nevertheless went down; the cities built on flood plains; Pearl Harbor and other military "surprises"; hospitals and schools destroyed with great loss of life after repeated warnings of what fire or earthquake might do; these are some examples.
>
> There appears to be a basic human tendency to ignore warnings about such possible enormous disasters as "unthinkable." We must understand this tendency and guard against it. … Yet if we examine history, an important generalization, which might be called the "Titanic effect," can be discerned: THE MAGNITUDE OF DISASTERS DECREASES TO THE

13 A good example of poor crisis communications occurred during the March 8, 2014 disappearance of Malaysia Airlines MH370, Boeing 777-200 passenger aircraft with 239 passengers and crew. An analysis of Malaysian Airline and Malaysian Government's poor crisis communications can be found in: Zoe Mintz, "A Disastrous Void: Why the MH370 Public Response Failed," *International Business Times* (June 16, 2014). Available at: https://www.ibtimes.com/disastrous-void-why-mh370-public-response-failed-1598774.

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> EXTENT THAT PEOPLE BELIEVE THAT THEY ARE POSSIBLE, AND PLAN TO PREVENT THEM, OR TO MINIMIZE THEIR EFFECTS.[14]

Understanding the *Titanic Effect* principle is foundational for maritime disaster prevention and MRO planning and response. Despite regulatory, safety, training, and shipboard design improvements, the primary premise is that a maritime disaster will occur again, and SAR authorities must be prepared to coordinate as well as respond to a subsequent MRO.

Even though the maritime community will never be able to eliminate all risk of future maritime disasters, IMO, ICAO, SAR authorities, and various industry stakeholders will continue to work towards improving safety and preventing these disasters from occurring; mitigating potential ways that disasters can occur is the essence of the *Titanic Effect*.

However, despite these efforts to prevent maritime disasters, SAR authorities need to continue to plan and respond to future maritime MROs. Even though disasters may be occurring less frequently, or with less extreme impact than the sinking of *RMS Titanic* or other large passenger ship or aircraft disasters, the risk is still present.[15] SAR authorities cannot be lulled into a false sense of security, succumbing to a less than adequate maritime MRO response preparedness posture.

Additionally, the *Titanic Effect* provides an important recommendation in preparing for the response to disasters in general, and for this analysis, a maritime MRO in particular:

> In general, it is worth taking action in advance to deal with disasters. The reason is that the costs of doing so are so typically inconsequential as measured against the losses that would ensue if no such action were taken.[16]

When considering a coastal State's risk and subsequent impact if a maritime disaster and MRO occurs, and the responsible SAR authority is unprepared or ineffective in conducting the rescue, advance planning and recurring response preparedness activities continue to be critical. Regardless of how or where a maritime disaster occurs (i.e., aircraft ditching, fire, collision, grounding,

14 Kenneth E. F. Watt, *The Titanic Effect: Planning for the Unthinkable* (New York: E. P. Dutton & Co., Inc., 1974): 7.

15 On April 15, 1912, on its maiden voyage, the 883-foot *RMS Titanic* struck an iceberg and sank. A good overview of the *Titanic* disaster: History.com Editors, "Titanic sinks" (A&E Television Networks: March 4, 2010). Available at: https://www.history.com/this-day-in-history/titanic-sinks.

16 Ibid., 7.

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terrorist attack, etc.), its effect can be minimized through identifying potential MRO scenarios, planning, training, development of cooperative relationships with other SAR authorities and industry stakeholders, and conducting exercises to validate MRO plans and procedures.

3.2 *Black Swan*

In 2007, more than three decades after the publication of *The Titanic Effect*, author Nassim Taleb wrote the New York Times best seller, *The Black Swan: The Impact of the Highly Improbable*.[17] *Black Swan* was extremely important in arguing that history generally moves forward, not in a gradual incline, but in singular events that are outside the expected—unpredictable events with massive impact that make history. These unpredictable events, known as "Black Swans," are unforeseen and point to the limits of human knowledge:

> Before the discovery of Australia, people in the Old World were convinced that all swans were white, an unassailable belief as it seemed completely confirmed by empirical evidence. The sighting of the first black swan might have been an interesting surprise for a few ornithologists (and others extremely concerned with the coloring of birds), but that is not where the significance of the story lies. It illustrates a severe limitation to our learning from observations or experience and the fragility of our knowledge. One single observation can invalidate a general statement derived from millennia of confirmatory sightings of millions of white swans. All you need is a single … black bird.[18]

Maritime disasters and the subsequent MRO are examples of Black Swan events. Important for SAR authorities are the three criteria that define a Black Swan event and the rationale for the planning and conduct of MRO response preparedness activities:

> *#1 Black Swans Are Outlier Events.*

In statistical probability, an *outlier* is a data point that significantly deviates from the rest of the data;[19] a rare event that "lies outside the realm of regular

17 Nassim Nicholas Taleb, *The Black Swan: The Impact of the Highly Improbable*, 2nd Ed. (New York: Random House Trade Paperbacks, 2010).

18 Ibid., xxii.

19 Frank. E. Grubbs, "Procedures for Detecting Outlying Observations in Samples," *Technometrics Vol. 11, No. 1* (February, 1969): 1; available at

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expectations."[20] Maritime disasters that result in an MRO can be statistically considered outlier events: low-probability, high-consequence disasters.

However, even with the work accomplished in developing new international and national safety regulations, along with shipboard safety system improvements, infrequent maritime disasters will continue to occur. The challenge for SAR authorities is when risk has been identified, but no maritime disaster and subsequent MRO has occurred over a prolonged period. Complacency can and most likely will ensue. As a result, planning and response preparedness activities have a tendency to be replaced for what is considered "other" higher priority missions and objectives.

Effectively planning the *response* to maritime MROs, even though considered an outlier (low probability) event, is critical. The consequences of a responsible SAR authority being unprepared are exacerbated by a lack of preparation and planning. Preparation and planning, in particular for MROs that may occur offshore, must be a priority in any maritime MRO risk analysis.

#2 Black Swans Will Have a Major Impact.

Historically, maritime disasters that include a significant loss of life have been the incentive for changing both national and international maritime regulations. The table below details maritime disasters and the response to improve safety after the disaster occurred.

However, as previously mentioned, while new shipbuilding standards and safety regulations are important, they will never completely ensure maritime disasters will never occur again. Analyzing historical trends does help to isolate where new regulations and requirements can target specific safety gaps, but this will not assist in predicting when the next maritime disaster will occur.

#3 Black Swan Events Become Explainable and Predictable after the Fact.

Analysis of any disaster will provide conclusions and implementation of new safety regulations, development of new, mandated safety equipment, improved design and construction, etc. All these efforts are beneficial. However, even as attempts are made to understand how an accident occurred, and what

http://www.lithoguru.com/scientist/statistics/Procedures%20for%20Detecting%20Outlying%20Observations%20in%20Samples_Grubbs_1969.pdf.

20 Nassim Nicholas Taleb, *The Black Swan: The Impact of the Highly Improbable*, 2nd Edition (New York: Random House Trade Paperbacks, 2010): xxii.

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Maritime Disasters and Impact[a,b]

Date	Disaster	Outcome
15 APR 12	*Titanic*: Ocean liner sunk after striking an iceberg	1914: International Convention for the Safety of Life at Sea (SOLAS Convention) was established. Required ships to carry enough lifeboats for all persons onboard.
29 MAY 14	*Empress of Ireland*: Struck another vessel and sank; 1,012 people died	Disaster led to widespread changes to the design of ships bows ("raked" bows) to reduce the amount of damage caused in the event of a collision.
08 SEP 34	*Morro Castle*: Fire resulted in the death of 137 people	1936: Merchant Marine Act became U.S. law. 1942: U.S. Merchant Marine Academy was established.
06 MAR 87	*Herald of Free Enterprise*: Capsized with 193 deaths	Led to development of SOLAS amendments regarding ships transporting passengers and vehicles; accelerated the adoption of provisions aimed at further improving passenger ship stability.
28 SEP 94	*Estonia*: Capsized with 852 deaths	1997: Passenger ships carrying 400 persons or more had to comply with the requirements initially only imposed on ferries to avoid capsizing even when the main compartments flood.
23 MAR 06	*Star Princess*: Fire damage 150 cabins with 1 death and 13 injured	2010: New SOLAS regulations introduced to prohibit the use of combustible materials in new cruise ships.

[a] "Cruise ship safety: timeline of disasters and safety regulations," *Telegraph* (January 16, 2012); available at http://www.telegraph.co.uk/travel/cruises/9017985/Cruise-ship-safety-timeline-of-disasters-and-safety-regulations.html

[b] Robin des Bois, "From the Titanic to the Costa Concordia," (April 12, 2012); available at http://www.robindesbois.org/en/du-titanic-au-costa-concordia/

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can be done to prevent disasters in the future, disasters will continue to occur because of *human error*:

> Over the last 40 years or so, the shipping industry has focused on improving ship structure and the reliability of ship systems in order to reduce casualties and increase efficiency and productivity. We've seen improvements in hull design, stability systems, propulsion systems, and navigational equipment. Today's ship systems are technologically advanced and highly reliable.
>
> Yet the maritime casualty rate is still high. Why? Why is it, with all these improvements, we have not significantly reduced the risk of accidents? It is because ship structure and system reliability are a relatively small part of the safety equation. The maritime system is a people system, and human errors figure prominently in casualty situations. About 75–96% of maritime casualties are caused, at least in part, by some form of human error.[21]

Passenger ships and aircraft are "people operated and maintained" transportation systems. As long as people continue to be an integral component of complex ship and aircraft systems, errors will occur that can lead to future maritime disasters requiring an MRO response.

This is the essence of a Black Swan event: 1) outlier; 2) significant impact; 3) explainable after the fact. This is the challenge for SAR authorities in taking the time and effort to plan and prepare for maritime disasters and MRO s.

3.3 *Summary*

The *Titanic Effect* principle and *Black Swan* criterion provide SAR authorities with the foundation for MRO response preparedness: 1) The *Titanic Effect*: Expect a maritime disaster and subsequent MRO to occur and plan for the event to minimize its impact; and 2) The *Black Swan* criterion provides a framework for understanding the MRO challenge and while infrequent, they are a high consequence incident that can have a significant societal impact.

Both principles provide SAR authorities with the basis for understanding why MRO planning and conducting MRO response preparedness activities are so important. While the potential for these disasters is low, the consequences if the planning and subsequent response are ineffective are enormous.

21 Anita M. Rothblum, "Human Error and Marine Safety;" available at http://www.bowles-langley.com/wp-content/files_mf/humanerrorandmarinesafety26.pdf.

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4 Framing the MRO Challenge

SAR authorities must be prepared to respond to a maritime disaster and subsequent MRO offshore, considered the worst-case scenario because an MRO will most likely overwhelm available SAR services. In this scenario there could be many survivors in the water, or in survival craft requiring rescue and delivery to a place of safety.[22] The following assumptions should be considered by SAR authorities concerning maritime MRO s:

1. Based on the risk, SAR authorities should plan and conduct response preparedness activities to effectively respond to a maritime MRO requiring the rescue of many survivors;[23]
2. An MRO that occurs potentially hundreds of miles offshore will severely limit the number of SAR facilities available to respond in a large-scale rescue operation;[24]
3. It is not likely that a SAR authority will independently have the necessary SAR facilities to rescue possibly hundreds or thousands of survivors that may be in the water or survival craft and must rely on assistance from other available SAR facilities from other SAR authorities, commercial shipping and other volunteers in the vicinity;
4. Multiple survivors with life threatening injuries may require immediate medical attention or transportation to medical facilities; and
5. MRO survivor retrieval to any height above water is extremely difficult.[25]

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22 The IAMSAR Manual defines a *Place of safety* as, *"A location where rescue operations are considered to terminate; where the survivors' safety of life is no longer threatened and where their basic human needs* (*such as food, shelter and medical needs*) *can be met; and, a place from which transportation arrangements can be made for the survivors' next or final destination. A place of safety may be on land, or it may be aboard a rescue unit or other suitable vessel or facility at sea that can serve as a place of safety until the survivors are disembarked to their next destination."*

23 Ultimately, the reason an MRO occurs is of secondary importance. The critical issue is that SAR authorities must identify the potential risk and develop plans and procedures to coordinate and conduct the rescue of a large number of survivors.

24 In in reviewing several MRO plans, the authors have seen a bias towards planning for a large-scale MRO occurring *near shore* only, not offshore, the worst-case scenario. In many plans, it is assumed that other local emergency response stakeholders (e.g., Federal, State and local emergency response agencies, commercial stake holders, etc.) will be available to assist in the MRO response. Offshore, this will most likely *not* be the case. Other emergency response stakeholders may be able to assist once the survivors arrive on shore (e.g., assisting in triage of survivors requiring medical treatment), but they will most likely will *not* be able to transit offshore to assist in an MRO response.

25 U.S. Coast Guard Research and Development Center, *Maritime Mass Rescue Interventions; Availability and Associated Technology - Final Report* (December, 2010): 11.

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5 Quantifying MRO Risk

The U.S. Coast Guard and other international SAR authorities, local communities, and industry stakeholders face different maritime MRO challenges based on passenger ferry, ship and aircraft traffic, environmental considerations, distance the event occurs from shore, etc., as well as SAR facilities available to assist in an MRO response.

To appreciate the MRO risk in the U.S. maritime SAR regions, the U.S. Coast Guard Research and Development Center (RDC) was tasked in 2006 to identify potential gaps in MRO planning. As a result of this effort, in 2007, the RDC completed the *Mass Rescue Operations Scoping Study* (MROSS).[26] The MROSS included a historical review of past MRO incidents and provided data on the frequency and consequences of these incidents, as well as on the effectiveness of U.S. Coast Guard response efforts. The MROSS concluded in part that:

> [T]he MRO scenarios of greatest interest to the USCG are those that involve vessels carrying a large number of passengers. In these scenarios, the condition of the vessel, the distance from shore, and the severity of the environment are key factors in determining the level of difficulty of the response. Primary areas of concern are: adequacy of evacuation equipment and procedures aboard the distressed vessel (especially a non-SOLAS passenger vessel subject to less-stringent regulations); ability to provide survival platforms when the survival capability aboard the vessel is compromised; ability to retrieve a large number of people from the water; and ability to evacuate a large number of people from the vessel.[27]

The MROSS recommended development of equipment or techniques to effect rapid evacuation and rescue of multiple survivors.

In 2012, the U.S. Coast Guard conducted a review of the 2007 MROSS. An informal risk assessment analyzing the same scenarios from the 2007 MROSS was conducted to draw a comparison and examine the MRO response preparedness risk and to see if any changes had occurred.

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26 U.S. Coast Guard Research and Development Center, *Mass Rescue Operations Scoping Study, Final Report* (April, 2007). The study identified concepts and technologies that would lead to improvements in mass-rescue operations. This research effort included a review of past successes (and failures), current plans, programs (including interagency agreements) and equipment, assessment of risks and plans for consequence management, and identification of new ideas, techniques, equipment and methods that might help to improve the U.S. Coast Guard's ability to respond to mass-rescue events.

27 Ibid., v.

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After five years, the 2012 analysis revealed that the greatest concern and the number one risk posed to the U.S. Coast Guard and shipping industry stakeholders remained the same as identified in the 2007 MROSS: *a domestic passenger vessel requires evacuation*. In all likelihood, this was due to the three major reasons cited in the original study: 1) a limited number of crewmembers trained in vessel evacuation; 2) limited evacuation information provided to passengers; and 3) less-stringent requirements for safety equipment aboard U.S. domestic passenger vessels and those vessels not required to comply with the Safety of Life at Sea (SOLAS) Convention.[28] The following table shows the MROSS 2007/2012 resulting risk-based ranking of MRO scenarios.

Mass Rescue Operations Scoping Study (2007/2012)

Scenario	MROSS 2007	MROSS 2012
Domestic passenger vessel requires evacuation	1	1
Large vessel sinks, persons on board must be located and rescued	1	4
Natural disaster requiring air, land, sea rescue	3	2
Major casualty aboard cruise ship requires evacuation	4	6
Rescue of large number of refugees/illegal immigrants	4	7
Passenger aircraft crash requiring passenger rescue	6	5
Rescue of people from collapsed or burning waterfront building	7	10

28 Concerning the SOLAS convention, the IMO website states that, *"The SOLAS Convention in its successive forms is generally regarded as the most important of all international treaties concerning the safety of merchant ships. The first version was adopted in 1914, in response to the Titanic disaster, the second in 1929, the third in 1948, and the fourth in 1960. The 1974 version includes the tacit acceptance procedure—which provides that an amendment shall enter into force on a specified date unless, before that date, objections to the amendment are received from an agreed number of Parties. As a result the 1974 Convention has been updated and amended on numerous occasions. The Convention in force today is sometimes referred to as SOLAS 1974, as amended."* Available at: http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-(SOLAS),-1974.aspx.

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Mass Rescue Operations Scoping Study (2007/2012)		
Rescue of individuals from bridge collapse or train derailment	8	11
Small mro (above local sar authority capability to respond)	8	2
Oil rig sinks; crew must be located and rescued	10	12
Waterborne evacuation due to large-scale terrorist action, industrial accident, natural disaster, or nuclear/biological incident	11	9
Rescue of individuals stranded on an ice floe or ship beset in ice	12	13
Rescue of large number of people from flooded (or flooding) tunnel or other need for rescue	13	7

By comparing the 2007 and 2012 MROSS information, the following observations are made: 1) The three scenarios: a) *"Passenger aircraft crash requiring passenger rescue;"* b) *"Major casualty aboard cruise ship requires evacuation;"* and c) *"Large vessel sinks, persons on board must be located and rescued,"* remained in the top six U.S. Coast Guard MRO risks, remaining consistent both in 2007 and in 2012; 2) In 2007 the two MRO scenarios: a) *"Large vessel sinks, persons on board must be located and rescued;"* and b) *"Domestic passenger vessel requires evacuation,"* were both considered #1 (tied), and in 2012 were ranked #4. While still considered the fourth most important MRO challenge, it is the least understood and planned for, especially in an offshore situation with limited U.S. Coast Guard SAR facilities available to assist in the rescue operation.[29]

What the 2007 MROSS and 2012 review did *not* specifically consider, is the *distance* offshore any of these events could occur. Regardless of the type of MRO, the farther offshore from available SAR facilities the incident occurs and

29 For the U.S. Coast Guard, the MRO scenario concerning the sinking and rescue of persons from a large vessel again occurred on October 1, 2015, during Hurricane Joaquin, when the U.S.-flagged cargo ship *SS El Faro* sank in the Atlantic Ocean about 40 nm northeast of Acklins and Crooked Island, Bahamas. All 33 people on board perished. Before the loss of *El Faro*, the last comparable U.S. maritime disaster was the sinking of the U.S. bulk carrier *Marine Electric* off the coast of Virginia in February 1983, in which all but three of the 34 persons aboard lost their lives. National Transportation Safety Board Accident Report, *Sinking of US Cargo Vessel SS El Faro Atlantic Ocean, Northeast of Acklins and Crooked Island, Bahamas October 1, 2015* (December 12, 2017). Report is available at: https://www.ntsb.gov/investigations/AccidentReports/Reports/MAR1701.pdf.

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the more adverse the environmental conditions (i.e., sea water temperature, sea state, wind, etc.), the greater the challenge SAR authorities will have in coordinating and conducting an MRO response.

The authors conclude that the MRO risk in 2018 is comparable to the analyses conducted in 2007 and 2012. Identifying MRO risk, developing comprehensive and effective MRO plans, and exercising plans remain important considerations in U.S. Coast Guard MRO response preparedness.

6 The Importance of MRO Plans

In responding to any MRO event, there will be some level of chaos. The goal is to reduce that chaos; one way of doing so is by developing comprehensive and shared MRO plans. Development of effective MRO plans is critical during a mass rescue response because this type of event will be coordinated and conducted with multiple SAR authorities, military and volunteer stakeholders. Those involved in coordinating the response and the responders will need to clearly understand who is in charge, how to work with who is in charge, the respective roles of all involved, and how to interact with each other. While SAR authorities will be responsible for saving lives and property, there are numerous other facets of MRO response that are outside the purview of SAR authorities (i.e., survivor accountability, medical triage, security, environmental response, transportation, etc.).

This is why it is crucial for SAR authorities to work together with the emergency response community to collectively develop and "own" a shared MRO plan. Such a plan identifies agencies responsible for specific tasks and provides a holistic approach to an MRO response. Though the SAR Coordinator would most likely lead the planning process, response and support organizations should be encouraged to regard the plan as incorporating their agency-specific plan.

The MRO planning process can be thought of as a jigsaw puzzle. Each stakeholder has an important role in the response, with their own emergency response plans setting policy, as well as providing specific roles and responsibilities. Each MRO plan represents a piece of the larger MRO response. MRO plans should include: 1) identification of roles and responsibilities during the response; 2) identification of risk or hazards that may be encountered during the response; 3) any potential resource gaps; and 4) no overlap, or redundancy in authority ("who's in charge" which must be addressed before an incident occurs).

In many MRO s, the problem is the SAR authorities and responders merely react to an incident without having developed comprehensive plans, potentially creating a disjointed and confusing response as responders try to "do the right

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thing." Without effective preplanning, an MRO response may lack effective and efficient coordination, which may cause delays, and ultimately put lives at risk. SAR authorities must proactively plan and prepare for the response to an MRO.

7 The Fundamentals of MRO planning

Generally, there are six stages in MRO planning: 1) identify the stakeholders (authorities and organizations with emergency response roles and/or responsibilities) who should be involved in the planning process; 2) identify response capability gaps; 3) identify the means to fill the capability gaps; 4) prepare the plan; 5) conduct training based on the plan; and 6) test the plan through exercises, revising the plan as required.[30]

MRO plans should provide for the wide array of response requirements: medical triage, immigration, security, shelter, public affairs, transportation, etc., which may also be used in planning for other types of contingency operations that may have a similar response.

It is important to understand that MRO plans are living, breathing documents that need to be reviewed and updated (as people and resources change), and as such, they require testing on a regular basis to validate any recent changes in personnel and available capabilities. In the event of an MRO, no single organization is fully equipped to mount an effective response. The success of an MRO depends on effective coordination between SAR authorities, industry stakeholders, volunteers, and the local community, which is contingent upon having current MRO plans, validated through a recurring exercise program.

MRO planning does have challenges. One of the biggest is bringing together the various SAR authorities, as well as other nongovernmental organizations, volunteer organizations and industry stakeholders to discuss MRO plan development. This could pose a change management dilemma: many response agencies and organizations may only follow their own specific MRO guidance and might be reluctant to make any changes to support a multi-agency response. Therefore, engagement from senior leadership early in the planning process is critical. Senior leadership needs to support the planning and exercise process in order to instill "buy-in" and articulate the

30 International Maritime Rescue Federation, *2.1 General Planning Guidance*. Available at: https://www.imrfmro.org/mro-library-planning-download/file/930-2-1-general-planning-guidance.

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vision, purpose, and goal of an effective MRO response able to save as many lives as possible.[31]

8 MRO Response Considerations

From a response preparedness perspective, the distance from available SAR facilities must be considered one of the most critical, in addition to the number of persons in distress, environmental considerations and other factors that need to be considered in MRO planning and response preparedness.

While this analysis' emphasis is on the challenges in responding to an "offshore" maritime disaster and MRO, the Territorial Sea limit can be an effective demarcation in determining and planning for what could be considered near and offshore MRO s.[32] Within 12 miles of shore, additional SAR facilities from other SAR authorities, commercial shipping, and volunteers can assist in an MRO response, especially if the incident occurs in well traveled sea lanes, traffic separation schemes, or in the vicinity of a major port. Depending on the location of the incident and the time required for SAR facilities to arrive on scene, the loss of life in a near-shore MRO can be minimized. While weather and sea state will also be critical factors, how close to shore a maritime disaster occurs is a critical factor in a successful multi-agency response with multiple SAR organizations, volunteers and industry partners.[33, 34]

The MRO involving the cruise ship *Costa Concordia* is an example of a near-shore MRO that occurred in near ideal environmental conditions.[35] Although

31 MRO planning goes beyond standard SAR practices and delves into basic organizational management. Understanding the basic concepts of change management will greatly enhance the MRO planning process.

32 The *United Nations Convention on the Law of the Sea* defines *Territorial Sea*: *"Every State has the right to establish the breadth of its territorial sea up to a limit not exceeding 12 nautical miles, measured from baselines determined in accordance with this Convention."* (Article 3).

33 In the U.S. Coast Guard Seventeenth District, *Mass Rescue Exercise Lessons Learned Report* (*January, 2007*), a major lesson learned was that in general, local response agencies have limited mass rescue response experience during poor weather conditions. This is another planning factor that must be considered.

34 While the U.S. Coast Guard has an emphasis on the response to passenger ship and ferry MRO s, passenger aircraft carrying potentially hundreds of passengers on daily transoceanic flights must also be considered in MRO planning.

35 Marine Casualties Investigative Body, *Cruise Ship COSTA CONCORDIA Marine Casualty on January 13, 2012, Report of the Safety Technical Investigation*, Available at: file:///N:/CG-SAR%20Program/Articles/MRO%20Article%20(2018)/Costa%20Concordia%20

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the grounding occurred at approximately 9:45 PM, most of the 4,252 passengers and crew on board were able to abandon ship in survival craft or were rescued by the Italian Coast Guard and other responding vessels. Survivors in the water were able to swim ashore. While the *Costa Concordia* disaster did tragically end with the loss of lives, the outcome could have been much worse if the ship were abandoned offshore, with thousands of survivors potentially in the water or in survival craft requiring rescue.[36]

If a maritime disaster and MRO occurred farther offshore beyond the territorial sea, SAR facilities that could have assisted in a near shore MRO might be unavailable, or incapable to assist in an offshore response. Add any inclement weather and sea state challenges to an incident and the number of available SAR resources, again as in the case of a near-shore MRO, shrinks considerably. Any vessels that can assist in the response, whether SAR, military, commercial or recreational vessels, will be critical in saving lives in both near and offshore MROs.

Final%20Report.pdf. Synopsis: On January 13th, 2012, the cruise ship, *Costa Concordia,* struck a rock in the Tyrrhenian Sea near the eastern shore of Isola del Giglio, off the west coast of Italy. A 164-foot gash was torn into the port side hull, which flooded parts of the engine room and caused loss of power to propulsion and electrical systems. With water flooding in and listing, the ship drifted back to Isola del Giglio, where she grounded, lying on her starboard (right) side in shallow water with most of her starboard side under water. The evacuation of *Costa Concordia*, with 4,252 passengers and crew known to have been aboard, took over six hours to complete. Even with these near ideal environmental conditions (i.e., near calm seas, near shore (the ship grounded), etc.), 32 people perished.

36 Another example is the August 17, 2016, engine room fire and subsequent, successful evacuation of all 511 passengers and crew from the 614-foot roll-on/roll-off (Ro/Ro) passenger vessel *Caribbean Fantasy*, near the port of San Juan, Puerto Rico. During the NTSB accident investigation, two important factors were identified: *"First, at the time of the accident, the Caribbean Fantasy was in close proximity to the entrance of the port of San Juan. Coast Guard Sector San Juan and subordinate Coast Guard commands such as the small boat station and the cutter Joseph Tezanos were located either in the port or nearby. Many of the other organizations that responded to the vessel's call for assistance, including CBP, PREMA, and the City of San Juan's EOC, EMS, police, and fire department, were also located in the area and had sufficient staffing and response assets available. Additionally, many of the good Samaritan and commercial vessels that assisted were either based in the port or operating just offshore. … Second, the development, design, and functional exercises of the various elements of Coast Guard Sector San Juan's MRO plan, led by the unit's PVSS* [*Passenger Vessel Safety Specialist*] *and other command personnel, proved significant to the outcome. The written plan addressed all aspects of a response to a large-scale incident by multiple agencies. Just as important, the Coast Guard personnel responsible for managing the plan performed frequent training exercises, above and beyond agency requirements, to educate and better prepare other federal, state, and local response organizations, as well as local maritime stakeholders, for an actual event."* NTSB, *Fire aboard Roll-on/Roll-off Passenger Vessel Caribbean Fantasy Atlantic Ocean, 2 Miles Northwest of San Juan, Puerto Rico, August 17, 2016*, NTSB/MAR-18/01 (June 5, 2018): 65. Available at: https://www.ntsb.gov/investigations/AccidentReports/Reports/MAR1801.pdf.

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Aeronautical SAR facilities, both fixed and rotary wing, will be critical in any near shore or offshore MRO response. Helicopters have greater speed but have different weather constraints as compared with surface SAR facilities.[37] Though an excellent response resource, helicopters are limited by the duration they can remain on scene and by the number of survivors they can rescue. In an offshore MRO, with potentially hundreds or thousands of survivors, relying on helicopters as the primary means of rescue will significantly extend the duration of the response and could potentially increase the number of fatalities.[38]

Fixed wing SAR facilities will also be critical in an offshore MRO response. Fixed wing aircraft, while not being able to rescue survivors, can assist as On Scene Coordinators (OSC), can deploy rafts and can coordinate on scene communications.[39]

9 Passenger Ships and Aircraft

> Evacuating thousands of passengers at sea is everybody's worst nightmare. Maybe we need to rethink our approaches to evacuation.

37 Aircraft and vessels have different weather limitations that affect their ability to be deployed and support the response to an MRO. A clear day with steady high winds may not limit a helicopter response. However, waves produced by high winds may prohibit a vessel from responding. Conversely, a calm day with no wind but with relative humidity nearing 100% forming fog, may limit aircraft from flying, but are conditions in which vessels can operate.

38 How far a helicopter can transit offshore is based on several factors (e.g., on scene weather, water temperature, etc.) and whether it is carrying a rescue swimmer and hoist basket. These factors will reduce the helicopter's range, on scene endurance and number of survivors that can be rescued.

39 IAMSAR Manual, Volume 1, defines *On Scene Coordinator* (*OSC*) as, *"A person designated to coordinate search and rescue operations within a specified area."* IAMSAR Manual, Volume 2 (Mission Coordination), goes on to further describe the OSC position: *"When two or more SAR units are working together on the same mission, there is sometimes an advantage if one person is assigned to coordinate the activities of all participating units. The SMC* [*SAR Mission Coordinator*] *designates this on-scene coordinator* (*OSC*)*, who may be the person in charge of a search and rescue unit* (*SRU*)*, ship or aircraft participating in a search, or someone at another nearby facility in a position to handle OSC duties. The person in charge of the first SAR facility to arrive at the scene will normally assume the function of OSC until the SMC directs that the person be relieved. The OSC may have to assume SMC duties and actually plan the search and/or rescue if the OSC becomes aware of a distress situation directly and communications cannot be established with an RCC. The OSC should be the most capable person available, taking into consideration SAR training, communications capabilities, and the length of time that the unit the OSC is aboard can stay in the search area. Frequent changes in the OSC should be avoided."* (paragraph 1.2.4).

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> Will we ever reach a point at which passenger safety is no longer facilitated by having more lifeboats lining longer rails ever higher above the waterline? Are better lifeboats and stronger davits really the answer? How else could people be evacuated? I can tell you right now that the Coast Guard doesn't have the platforms to do the job, but we do have to figure something out.[40]

While the passenger ship industry is extremely safe, with millions of passengers taking cruises every year, the implications for SAR authorities if a passenger ship must be abandoned at sea are enormous.[41] MRO planning must consider the continued increase in the size of large passenger ships, the number of persons requiring rescue, the potential location where a disaster may occur, and other international, national, regional, shipping industry, and volunteer partners that may assist in the MRO response.

While it is true that in most cases a "passenger ship is its own best lifeboat,"[42] there will be disasters in which large numbers of survivors must be rescued.[43] The greater challenge is to rescue people forced to immediately abandon ship into the water or to cling to floating wreckage. These survivors are less able to help themselves than if they were able to abandon ship in a survival craft.[44]

Comparable to the passenger ship industry, the passenger airline industry also continues to see growth.[45] With this growth is the continued increase in the size of passenger aircraft.[46] Even with the large number of passenger

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40 Admiral James M. Loy, Commandant, U.S. Coast Guard, Excerpt from speech given at SeaTrade Cruise Ship Conference, Miami, Florida (March 6, 2001).

41 Cruise Lines International Association (CLIA), the world's largest cruise industry trade association with over 50 cruise ship companies, routinely analyzes the health of the cruise industry. In their *Cruise Line Industry Outlook* (June 2018), the number of passengers taking cruises worldwide continues to increase. In 2009, 17.8 million people took cruises; in 2018, that number will increase to 28 million. In 2017, CLIA member companies maintained a total of 449 cruise ships, with 27 new ocean, river and specialty cruise ships scheduled to debut in 2018. Available at: http://cruising.org/docs/default-source/research/clia-2018-state-of-the-industry.pdf?sfvrsn=2.

42 This statement implies that abandoning ship should be avoided if possible. However, in some circumstances there may be no other option.

43 Unless a ship appears to be in imminent danger of sinking, it is usually advisable for passengers and crew to remain on board if it is safe to do so.

44 *Guide to Recovery Techniques MSC.1/Circ.1183/Rev.1* (November 21, 2014): Annex, 2.

45 ICAO estimates that in 1970, worldwide 3.1 million people flew on passenger aircraft. In 2017: 3.979 billion people flew on passenger aircraft (statistic available at: https://data.worldbank.org/indicator/IS.AIR.PSGR).

46 Today, the largest passenger aircraft in service is the double-deck Airbus A380, which can carry over 800 passengers with a flying range of 9,756 miles.

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aircraft in use every day worldwide, the industry is considered the safest form of transportation.[47] Because air travel is so safe and fatal accidents are rare, when an incident does occur it is often highly publicized, which heightens the unwarranted perception of danger.

From a SAR/MRO perspective, the challenge for SAR authorities is responding to an aircraft disaster in the maritime environment. For many, it is automatically assumed that if a passenger aircraft ditches at sea, there will be no survivors.[48] However, this may not be the case. SAR authorities must assume there are perhaps hundreds of survivors that must be rescued.

9.1 *Aircraft MRO Challenge: Ditching of U.S. Airways Flight 1549*[49]

On January 15, 2009, U.S. Airways Flight 1549, an Airbus A320-214 on a scheduled commercial flight from LaGuardia Airport, New York City, New York, to Charlotte-Douglas International Airport in Charlotte, North Carolina, experienced an almost complete loss of thrust in both engines after encountering a flock of birds. When the aircraft crew determined they would be unable to reliably reach any airfield, they turned southbound and glided over the Hudson River, finally ditching the aircraft near the *USS Intrepid* museum about three minutes after losing power. At approximately 3:40 p.m., the controller was advised by a nearby helicopter pilot that the airplane was in the water. The U.S.

47 For example, in the U.S., a person has a 1 in 114 chance of dying in a car crash. The odds of dying in air and space transport incidents, which include private flights and air taxis, are 1 in 9,821. (Statistic obtained from: Aric Jenkins, "Which Is Safer: Airplanes or Cars?" Fortune.com (July 20, 2017); available at: http://fortune.com/2017/07/20/are-airplanes-safer-than-cars/.

48 There is no official definition of *ditching* used by the U.S. National Transportation and Safety Board (NTSB) or Federal Aviation Administration (FAA). However, for the purpose of this analysis, a good working definition of ditching is, *"An event where the flight crew intentionally lands an aircraft in some body of water such as a lake, a river, or the open ocean. In addition, the event would have to meet the following conditions or criteria: 1) The water landing has to be intentional (Accidental or unintentional landings or excursions onto water are excluded, such as runway overruns or controlled flight into water); 2) Uncontrolled impacts with water are excluded; and 3) The body of water must be deep enough so that if the aircraft sinks, some or all of the occupants would have to evacuate the aircraft cabin to avoid drowning."* Todd Curtis, "Jet Airliner Ditching Events," available at: http://www.airsafe.com/events/ditch.htm.

49 The information in this section concerning Flight 1549 was obtained from: NTSB, *Accident Report: Loss of Thrust in Both Engines After Encountering a Flock of Birds and Subsequent Ditching on the Hudson River, US Airways Flight 1549, Airbus A320-214, N106US, Weehawken, New Jersey, January 15, 2009* (NTSB/AAR-10-03). Available at: file:///N:/CG-SAR%20Program/Articles/MRO%20Article%20(2018)/NTSB%20Report%20-%20Ditching%20of%20Flight%201549.pdf.

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Coast Guard, New York Police Department, and other SAR authorities were immediately notified. All 155 passengers and crew safely evacuated the aircraft, which was still intact though partially submerged and slowly sinking. The survivors were quickly rescued by nearby passenger ferries and other vessels. Only two passengers and a flight attendant sustained serious injuries.

Modern safety requirements for passenger aircraft continues to improve. Flight 1549 was equipped so that crewmember life vests were at every jump seat location, passenger life vests at every seat for passenger flotation and seat cushions could be used for auxiliary passenger flotation. In addition, Flight 1549 was equipped with two emergency locater transmitters (ELTs), four slide/rafts located at each exit, four survival kits, and four lifelines. Within seconds after ditching, the crewmembers and passengers initiated the evacuation of the airplane.

When Flight 1549 ditched on the Hudson River, it was close to shore, near the Port Imperial Ferry Terminal in Weehawken, New Jersey. Many passenger ferries were operating over established routes in the local waterway, and the ferry captains either witnessed the accident or were notified by the director of ferry operations. Seven ferries responded to the accident and recovered the occupants. The first ferry arrived on scene three minutes after Flight 1549 ditched; the six other ferries arrived on scene just a few minutes later. One NYFD fire rescue boat and two U.S. Coast Guard boats arrived on scene just a few minutes later. Because of the immediate response by vessels in the vicinity, all of Flight 1549's passengers and crew were rescued within approximately 20 minutes of ditching.

On that day the Hudson River water temperature was 41° F, with a wind chill of 2° F. Additionally, the aircraft lacked enough slide rafts due to water entering the aft fuselage. These on scene factors posed an immediate threat of hypothermia to the survivors. Although the airplane continued to float for some time after ditching, many of the passengers who evacuated onto the wings were exposed to water up to their waists within two minutes from the time of the ditching. The passengers who jumped or fell into the water were at the most risk and were fortunate that the ditching occurred near shore. If the rescue vessels had not been near the accident site, or if conditions or procedures caused additional survivors to enter the water, it is likely that some of the airplane occupants would have succumbed to cold shock or hypothermia-related swimming failure.[50]

50 An overview of the life-threatening challenges of cold-water immersion can be found at: Alan Steinman and Gordon Giesbrecht, "The Four States of Cold Water Immersion," *On Scene: The Journal of the U.S. Coast Guard Search and Rescue* (Spring, 2006): 13; available at: http://dispatchingdiscussions.blogspot.com/2014/05/the-four-stages-of-cold-water-immersion.html.

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What if the Flight 1549 incident occurred, not on the Hudson River and near other ships and boats that were able to conduct an immediate MRO operation, but 200 miles offshore? Most MRO scenarios planned and exercised involve passenger aircraft that ditch during takeoff or landing in the vicinity of the airport. While a low probability, high consequence event, planning for a passenger aircraft MRO offshore must be also be considered. SAR authorities should consider the following: 1) Always initially assume there will be survivors that must be rescued; 2) Plan for passenger aircraft MROs both near and offshore; 3) Time is critical: cold water immersion is a life-threatening consideration in any MRO response; 4) Safety and survival equipment (e.g., rafts) on passenger aircraft may be unavailable or not operate due to the impact of ditching at sea; 5) While the position of most passenger ship disasters may be reasonably well known and would require minimal searching prior to the commencement of rescue operations, there may be no prior warning if a passenger aircraft ditches at sea, requiring a search for survivors; 6) Planning and response preparedness activities must be conducted with other international, national, regional SAR authorities, industry stakeholders and volunteer organizations; and 7) MRO plans must be exercised on a periodic basis.[51]

As is the case with any maritime MRO, a passenger aircraft ditching offshore presents an incredibly difficult challenge for SAR authorities. With limited available SAR facilities, the response will likely take much more time. SAR planners must consider both near-shore and offshore scenarios in the unlikely event that a passenger aircraft must ditch in the maritime environment.

51 In the United States, for near-shore MROs involving passenger aircraft, airports must conduct MRO exercises as a regular component of each airport's emergency response plan. The FAA requires all airports to conduct a full-scale exercise every three years (*FAA Advisory Circular 150/5200-31A*). The Airport Emergency Plan provides the framework that enables airport and community fire, security, medical, and other resources to join in an effective, coordinated response to airport emergencies. The FAA requires a full-scale demonstration of the emergency plan every three years of those airports certificated under U.S. Code of Federal Regulations Title 14, Section § 139. In the U.S., many of these airport exercises include SAR authorities such as the U.S. Coast Guard, which also has a requirement to conduct periodic MRO exercises with their local response community and stakeholders (*Coast Guard Mass Rescue Operations Program*, COMDTINST 16711.2 (August 10, 2010)). U.S. Coast Guard MRO exercises are based on a five-year cycle. At a minimum, Coast Guard Districts are required to conduct and/or participate in one discussion-based (e.g. seminar, workshop, or tabletop exercise) and one operations-based MRO exercise (e.g. drills, functional, or full scale) over a five-year period.

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10 The MRO Challenge: Rescue at Sea[52]

> Maritime disasters are not necessarily more numerous than disasters in other modes of transport, but they can be very large. Some of the largest transport disasters in the world, and in Europe, have been maritime disasters.
>
> One can easily think of reasons why maritime disasters can claim many lives. Commercial passenger ships are getting bigger. Large ferries and cruise ships may carry more than a thousand passengers and crewmembers. Disasters at sea can happen very quickly: if a ship capsizes in rough weather, it can go down within minutes, taking everybody with it to the sea bed. Rescue operations can be difficult at sea, particularly in rough weather. Those who jump into the sea will often die soon because of hypothermia. For all these reasons, the potential for great disasters at sea is always present.[53]

One of the most difficult and least thought through challenges that SAR responders will encounter in any maritime disaster is the actual rescue of survivors. Merchant ships that divert to assist persons in distress face difficult challenges in rescuing just one person from a survival craft or from the water. If hundreds or thousands of people must be rescued, or if conditions on scene are less than ideal, the difficulties and risk will significantly increase. Even if the MRO occurs within range of shore-based SAR facilities, SAR responders on scene can become quickly overwhelmed.[54]

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52 Unless otherwise stated, the information in this Section was obtained from: IMO, *Large Passenger Ship Safety: Report of the Correspondence Workgroup, Sub-Committee on Radiocommunications and Search and Rescue, First Report: COMSAR 7/10/1* (November 8, 2002), *COMSAR 7/INF.4* (November 8, 2002) and *COMSAR 7/INF.5* (November 8, 2002); and *Second Report: COMSAR 8/9* (December 18, 2003). The authors wish to thank Mr. David Jardine-Smith, Correspondence Work Group Chair, and the other Work Group members for their invaluable insights into the challenges associated with responding to a large passenger ship MRO. Another excellent resource is the *IAMSAR Manual* (*Volume III*)*: Mobile Facilities*. It should be noted that this Section can apply for passenger aircraft as well as passenger ships. The issue is rescuing large numbers of survivors at sea.

53 Svenn Fjeld Olsen, "The Frequency of Maritime Disasters: A Comparison with Other Modes of Transport;" paper presented at World Maritime University Malmö, Sweden, March 24–25, 2004.

54 Retrieving MRO survivors from the water and survival craft is not a linear relationship when considering the number of persons to be recovered. Rescuing 1,000 people is not simply a question of requiring ten times the SAR unit capacity, or ten times the time as rescuing 100 people. It was the view of the IMO Correspondence Work Group that developed

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An unfortunate example of this problem occurred during the response to the 1994 sinking of the passenger ferry *Estonia*:

> In 1994, the worst civilian ship disaster in modern European history occurred. Although there were 22 ships in the close proximity when the M/S Estonia sank, only 137 persons survived out of the approximately 1,000 persons on board. Ships that arrived at the scene were forced to improvise. They had neither the equipment nor the routines to participate effectively in such a rescue operation. Instead, in spite of all their efforts, they mostly became witnesses to the tragedy.[55]

The following considerations are provided to help SAR authorities, SAR facilities, merchant ships and shipping companies understand the challenges in conducting a maritime MRO.[56]

10.1 *SAR facility considerations*

- When developing MRO plans, SAR authorities should not assume they have enough trained and available SAR units to rescue hundreds or thousands of survivors;[57]
- SAR facilities (e.g., merchant ships in the vicinity) that can divert to render assistance will be critical in any MRO response and must be supported with SAR aircraft and other available surface SAR facilities;
- SAR authorities should anticipate that merchant ships on scene will encounter difficulties in rescuing potentially large numbers of survivors;
- For any SAR facility in other than perfect environmental conditions, it will be extremely difficult to rescue survivors in the water or from survival craft;

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the *Large Passenger Ship Safety Report* that the rate of increase in difficulty is, based on the number of persons to be recovered, more exponential than linear. Recovering five people can be difficult in some circumstances (e.g., bad weather, darkness, moderate to heavy seas, limited survival timeframe, high-sided or otherwise limited rescue units, etc.). Recovering fifty, or five hundred, are step changes of difficulty. Recovering five thousand persons in an offshore MRO could be insurmountable.

55 Captain Christer Lindvall, Captain Jörgen Lorén and Captain Rolf Westerström, "Give all ships the means to assist in major accidents at sea" (March 8, 2012); available at: http://www.first-rescue.org/assets/international-op-ed-on-mass-rescue-by-christer-lindvall-j%C3%B6rgen-loren-rolf-westerstr%C3%B6m-2012-06.pdf.

56 While the focus of this paper is on the challenges of an offshore MRO, these considerations are relevant to any maritime MRO.

57 The SAR Convention defines *SAR unit* as, *"A unit composed of trained personnel and provided with equipment suitable for the expeditious conduct of search and rescue operations."* (paragraph 1.3.8).

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- On-scene surface SAR facilities will need to coordinate their operations closely during the MRO response;
- Use of helicopters in an MRO:
  - While critical in any MRO, SAR helicopters are dependent on the disaster location and fuel usage;[58], [59]
  - Surface SAR facilities may not be experienced in working with helicopters and the associated downwash and noise they produce;[60]
  - A helicopter hoist of a survivor takes time and is limited to the number of survivors it can rescue at one time;[61]
  - An MRO could easily over tax the capability of helicopters in both numbers and time required to rescue each survivor; and
  - Helicopter crew endurance limits or mandatory maintenance may be reached during a prolonged MRO response; additional crews may be required, or maintenance may need to be performed during the response.
- Each MRO response is unique, requiring maritime and aeronautical SAR facilities to accurately assess, coordinate and conduct the rescue operation:
  - Partially submerged vessels with cranes and rigging can challenge or limit the hoisting opportunities of helicopters; and

58 There have been instances in which large passenger ships have been entirely evacuated by helicopter. For example, in the sinking of the passenger ship *Oceanus* off Eastern Cape, South Africa (August 04, 1991) all 571 persons on board were rescued by helicopters. Availability of SAR helicopters and geographic location of the MRO are critical.

59 For example, U.S. Coast Guard helicopters are not equipped with an in-flight refueling capability. Currently, the only such aircraft and helicopters with this specific design capability are in the U.S. Department of Defense (DoD) which may or may not be available due to time, mission requirements and rescue location. When landing on a ship is not an option, U.S. Coast Guard and U.S. Navy helicopters can utilize In-Flight Refueling (HIFR) from certified U.S. Navy and U.S. Coast Guard ships, which allows the helicopter to receive fuel through the cabin while hovering. However, the ship and helicopter will be removed from rescue operations while HIFR is being conducted.

60 Helicopter pilots must be cognizant of their aircraft affects when rescuing persons in distress at sea.

61 An example of this challenge occurred during the December 28, 2014 fire and subsequent MRO on the 610-foot passenger ship *Norman Atlantic*, with 411 passengers and 58 crew, in the Strait of Otranto. While several merchant ships and SAR units responded to the distress, the weather and sea conditions were extremely poor, making any rescues by sea extremely difficult. From 0531, December 28 when the master of *Norman Atlantic* ordered to abandon ship, helicopters were the primary means for rescuing passengers and crew. It was not until 1432, on December 29 that the master declared all passengers and crew rescued and he was subsequently hoisted from the ship. In this MRO, helicopters rescued 349 survivors in *33 hours*. (Note: Information concerning this footnote was obtained from a non-published *Norman Atlantic* after action report provided to the authors by the Italian Coast Guard.)

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  - Survival craft with canopies designed for rescue by vessels may be difficult to hoist from, adding further time delay in rescuing survivors by helicopter.[62]
- Cargo ships, fishing vessels and other craft that divert to assist as SAR facilities are generally ill-equipped to locate and retrieve large numbers of survivors from the water or survival craft and to care for the survivors once onboard;
- Maneuvering a large ship in a seaway to come alongside, and then remain alongside a small target like a survival craft or a survivor in the water is difficult;[63]
- An assisting SAR facility mooring alongside a large passenger ship in distress and offloading survivors in anything but near-ideal circumstances is regarded as potentially dangerous and of questionable benefit;
- Assisting merchant ships have unique challenges in an MRO response due to their relatively small crew and little capability to manage large numbers of survivors:
  - A lack of covered public spaces that provide protection from weather;
  - A lack of sanitary facilities, blankets, clothing, food and water;
  - Insufficient personnel to control and assist survivors, and a lack of training on how to do so; and
  - A lack of medical staff and facilities.
- Assisting ships will likely require substantial support both on board and ashore in handling communications during an MRO response;
- Difficulties with using shipboard recovery systems in recovering large numbers of survivors will be exacerbated if ships' crews are insufficiently experienced and trained in using these systems;
- Not all shipping companies have the capability to quickly stand up and sustain a 24-hour emergency response center with substantial equipment, staffing, information management and communications capabilities, nor is such capability currently required;

62 Survival craft are usually provided with canopies or other covers to protect their occupants. Unfortunately, these covers make getting people *out* of the survival craft difficult. When a helicopter is approaching a survival craft, the cover can cause extra windage that may cause the craft to be blown away or overturned by the helicopter's downwash. If the cover is removed or removable, it may break free in the downwash, hampering hoisting and injuring the survival craft's occupants.

63 IMO, *Guide to Recovery Techniques MSC.1/Circ.1183* (May 31, 2006): Annex, page 7. The issue: running over and/or crushing the survival craft/survivor.

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– If the OSC is not from a SAR authority, then coordinating the response on scene may become difficult if the OSC is not familiar with SAR operations and managing a large MRO;
– Survivor accountability can be a critical issue on scene, especially in a large MRO in which many survivors are rescued by several SAR facilities;[64]
– There may be language difficulties between the SAR facilities and survivors.[65,66]

10.2 *Life Saving Appliance (LSA) considerations*[67]

– Assisting ships generally do not have the capability to retrieve a fully loaded survival craft—even their own.[68],[69]
– If a large passenger ship in distress is listing, some, if not all the ship's lifeboats will be unable to launch, further hampering rescue efforts;[70]

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64 This became a problem in the U.S. Coast Guard, U.S. Air Force and Canadian military response to the fire and subsequent rescue of 520 passengers and crew from the passenger ship *Prinsendam* on October 4, 1980. Two Air Force pararescuemen were deployed to one of the *Prinsendam's* lifeboats to assist in hoisting the survivors by helicopter. It was later determined that one lifeboat was missing, requiring further searches by the on scene SAR facilities. It was not until the early hours of October 5 that the missing lifeboat was located with 18 survivors and the two missing pararescuemen (Commander, Seventeenth Coast Guard District, *M/V Prinsendam Fire Gulf of Alaska, SAR Case Study* (February 3, 1981): Enclosure (1), page 2.).

65 IMO, *Guide to Recovery Techniques MSC.1/Circ.1183* (May 31, 2006): Annex, page 3.

66 The SAR facility crew may not have a language in common with the recovered survivors. Even when they do, the survivors may not understand the instructions.

67 While there is no specific LSA definition, the IMO *International Life-Saving Appliance (LSA) Code*, 2010 ("LSA Code"), generally considers LSAs to be, *"A broad category of rescue devices, including personal life-saving appliances like lifebuoys, lifejackets, immersion suits, anti-exposure suits and thermal protective aids; visual aids, such as parachute flares, hand flares and buoyant smoke signals; survival craft, such as liferafts and lifeboats; rescue boats; launching and embarkation appliances and marine evacuation systems line throwing appliances; and general alarm and public address systems."*

68 The requirements for survival craft launching appliances in the SOLAS Convention and LSA Code address only the lowering of survival craft into the water. There are no provisions for the recovery of the survival craft, particularly in a fully loaded condition. The rescue of persons in a survival craft and transporting them to a place of safety must be conducted via intermediate steps which can be slow and risky. It should also be noted that survival craft are not considered a place of safety.

69 Existing SOLAS Convention requirements (rescue boat, pilot ladder, embarkation ladder, etc.) do not envision an MRO scenario resulting in survivors remaining in survival craft for extended periods.

70 This problem occurred during the response to the *Estonia*, *Oceanos*, *Costa Concordia*, as well as in other large passenger ship disasters.

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– Small rafts and other survival craft in the vicinity of a responding merchant ship are at risk of being crushed as the two vessels move in the seaway;[71]
– An assisting ship using its boat(s) and davit-launched raft(s) as lifts to recover survivors is a difficult operation in anything but ideal weather and sea state conditions;[72, 73]
– Deployable rafts and similar lifesaving apparatus are not considered a "means of recovery," but are intended to help keep people alive until SAR facilities better equipped to recover the survivors arrive on scene, or reduce their exposure to the elements; and
– Requiring survivors to depart the survival craft and enter the water may result in additional, complicating factors, including cold-immersion shock and ingestion of water (survivors in or on a survival craft provide a relative degree of safety).

10.3 *Survivor Considerations*

– In a maritime MRO, the varying degree of survivor condition has a direct effect on the success of the rescue;[74]

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71 IMO, *Guide to Recovery Techniques MSC.1/Circ.1183* (May 31, 2006): Annex, Page 2.

72 Lifting gear may be unable to cope with fully laden craft resulting in only a few survivors being lifted at a time.

73 A raft used for this purpose during the response to the September 28, 1994 sinking of the *Estonia* in the Baltic Sea split while being lifted due to the weight of the persons and water in the raft; one survivor perished. The Final Action Report states in part: *"The passenger ferry Isabella was sailing from Stockholm to Helsinki. … According to the Isabella's master, the vessel arrived at the scene of the accident at about 0252 hrs. … The next Estonia raft came near the Isabella at 0530 hrs. The master steered the vessel so that three voluntary rescue men who had been lowered in one of the Isabella's rafts were able to get hold of it. About 20 people on board the raft were transferred to the Isabella's raft. When the crew of the Isabella tried to winch up this raft, it was too heavy because of the number of people in it and water poured into it. The raft tore in the process and filled with water, upon which at least two of the survivors and the three rescue men fell into the sea. A helicopter called to the scene lifted up one survivor who was hanging on to a lifebuoy, and the three rescue men. … At least one of the persons who had fallen into the sea disappeared. The sixteen survivors still on the damaged raft were pulled one by one up the slide and into the vessel."* The Joint Accident Investigation Commission of Estonia, Finland and Sweden, *Final Report on the Capsizing on 28 September 1994 in the Baltic Sea of the RO-RO Passenger Vessel MV Estonia* (December, 1995): Section 7.5.3.; available at: http://onse.fi/estonia/.

74 There are instances where survivors exhibit an almost superhuman ability to swim and climb to safety, yet in other cases, survivors are incapable or unwilling to assist in their own rescue. Infirmity, injury, and incapacitation can prevent a survivor from climbing a cargo net alongside a vessel's hull, and psychological impairment can hinder the rescue of others.

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– In a rapid or uncontrolled abandonment, when not all survivors are able to get into survival craft, there may be persons in the water, or clinging to floating wreckage who are less likely to survive for a long duration;[75]
– The quantities and types of personal lifesaving appliances may be inadequate in view of passenger demographics of large passenger ships, as well as availability of suitable exposure protection for the on-scene environment;
– A place of safety must be identified in which large numbers of survivors can be delivered to meet their needs;[76,77]
– Survivors may still be on board the ship in distress and require rescue without the intermediate use of survival craft.[78]

75 U.S. Coast Guard Research and Development Center, *Maritime Mass Rescue Interventions; Availability and Associated Technology - Final Report* (December, 2010): 20.

76 The SAR authority, in coordination with the SAR facility, is responsible for determining the place of safety. IMO Resolution MSC.167(78) stipulates that *"[a]n assisting ship should not be considered a place of safety based solely on the fact that the survivors are no longer in immediate danger once aboard the ship. An assisting ship may not have appropriate facilities and equipment to sustain additional persons on board without endangering its own safety or to properly care for the survivors. Even if the ship is capable of safely accommodating the survivors and may serve as a temporary place of safety, it should be relieved of this responsibility as soon as alternative arrangements can be made."* (Paragraph 6.13) *"The Conventions, as amended, indicate that delivery to a place of safety should take into account the particular circumstances of the case. These circumstances may include factors such as the situation on board the assisting ship, on scene conditions, medical needs, and availability of transportation or other rescue units. Each case is unique, and selection of a place of safety may need to account for a variety of important factors."* (Paragraph 6.15) In addition, IMO, United Nations High Commissioner for Refugees, and the International Chamber of Shipping jointly published an excellent resource: *Rescue at Sea: A Guide to Principles and Practice as Applied to Refugees and Migrants, 2015*. In discussing the action required by governments and RCCs in coordinating a merchant ship rendering assistance to persons in distress, it states: *"Governments have to coordinate and cooperate to ensure that Masters of ships providing assistance by embarking persons in distress at sea are released from their obligations with minimum further deviation from the ship's intended voyage, and have to arrange disembarkation as soon as reasonably practicable."* It goes on to state that, *"the Government responsible for the SAR region in which the rescued persons were recovered is primarily responsible for providing a place of safety or ensuring that such a place of safety is provided."*

77 Large passenger ship companies typically have expertise and capabilities to arrange transportation and other needs of survivors who are delivered to a place of safety with adequate infrastructure.

78 IMO, *Guide to Recovery Techniques MSC.1/Circ.1183* (May 31, 2006): Annex, page 2.

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- Recovery nets, scoops, strops, slings, seats, litters, baskets, lines and lifebuoys are subject to the problem of the survivor(s) swinging against the ship's side while being lifted;[79]
- The use of climbable devices (e.g., scramble nets, rope ladders, Jacob's Ladder, etc.) imply that a survivor being rescued is in a fit state to climb, even though these devices are very difficult to use in the best of environmental conditions.[80]
- Due to injury, illness (including sea sickness after a period in a survival craft), the effects of cold or heat, age, or infirmity, survivors awaiting recovery may lack the ability to help themselves, or to help others help them;[81]
- It is likely that people awaiting rescue will have little or no experience in transferring between small craft, or from a survival craft to a large ship;[82]
- Compounding the survivor rescue challenge is the onset of hypothermia, which limits survivor mobility, requiring SAR facilities to expedite the rescue operation; and[83]
- In most cases, survivors in the water should be rescued first over those in survival craft.[84]

10.4 *Example: Racing Yacht Excalibur Rescue at Sea Challenge*

An example of the challenges associated with SAR facilities rescuing persons in distress at sea was described by one of two survivors when their ocean racing yacht *Excalibur* was lost off the coast of Australia in September 2002. After seven hours in heavy seas the two men were eventually recovered from the water by the bulk carrier *Curia*. Concerning their recovery, one of the survivors described their rescue:

79 In rough conditions, the results can be injury or breakage of the gear and loss of the person being lifted. With the exception of some nets and baskets, all these devices are intended for the recovery of one or two persons a time. None of the devices are able to recover large numbers of survivors.

80 While always worth deploying in an MRO, climbable devices should not be considered a viable means of rescue, especially for ships with a high freeboard. Pilot and accommodation ladders may be an effective means to rescue survivors in the water, but may be difficult to climb in other than calm sea conditions, or by people suffering from hypothermia.

81 Ibid., Annex, page 3.

82 Ibid., Annex, Page 3. For example, stepping onto a pilot ladder and then climbing may not appear difficult for a fit person, but this may be extremely difficult for others, even in benign weather and sea conditions.

83 The IAMSAR Manual, Volume 2, defines *hypothermia* as the, *"Abnormal lowering of internal body temperature* (*heat loss*) *from exposure to cold air, wind, or water."* (Page xx).

84 Ibid., Annex, Page 3.

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> If you think you can have a large ocean-going bulk carrier simply pull up beside you and haul you aboard then you're in for a hell of a shock. This was by far the most physically demanding and most dangerous part of our ordeal.
>
> In the prevailing conditions, it took Curia 11 passes to maneuver into a position in which recovery was possible. Even then, the two men had to swim an estimated 40–50 meters to reach the ship's side. But that was just to get into position: the problem of recovery still had to be faced. Mr. Rogers stated:
>
> A variety of methods are available to ships' crew to get you on board but if you are physically incapable then things become doubly serious. Ocean-going cargo vessels are not designed for rescues, so the means of getting you out of the water come down to the basics, cargo or scramble nets over the side, roll-down ladders, lifebuoys and ropes with a loop tied in their ends …
>
> It was the last method—the loop of rope being used as a substitute helicopter sling—that achieved the rescue, but only after Mr. Rogers had slipped out of the loop on the first attempt and fallen back into the sea.[85]

This rescue highlights the challenges for a merchant ship to rescue just two persons in distress. The challenge is significantly greater when multiple ships are conducting the rescue of hundreds or thousands of survivors.

11 Conclusion

Even though maritime disasters requiring an MRO are infrequent, they are high consequence events when considering the potentially large number of lives that could be lost due to a lack of planning and response preparedness. SAR authorities must evaluate the risks and challenges associated with the response to an MRO; especially an MRO occurring offshore.

Significant work has been accomplished, both nationally and internationally, in the prevention of disasters at sea. However, it is the SAR authority's *response* to this worst-case scenario, with many survivors in the water or survival craft, that must be understood, planned for, and a rescue operation effectively coordinated and conducted to minimize loss of life.

85 John Rogers, "Survival," *Yachting World* (September, 2003).

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With the large number of passenger ships and aircraft that transit over and through the world's oceans every day, the threat of a disaster at sea will continue to be a planning and response preparedness challenge. The difficulty of the response significantly increases when an MRO occurs possibly hundreds of miles from available SAR facilities and with hundreds or thousands of persons requiring rescue.

Passenger ship and aircraft industries, along with regulatory and safety organizations and agencies will continue to improve the safety of these transportation systems. However, even with design and structural improvements, accidents will still occur; it's just a matter of time. The rescue of hundreds or thousands of people in distress will demand a national and perhaps even an international response. SAR authorities must be prepared to meet this challenge by applying lessons learned from past MRO exercises and maritime disasters in planning and other response preparedness activities.[86] The U.S. Airways Flight 1549 ditching and rescue, *Costa Concordia* grounding, MH370 search, sinking of the *El Faro*, the *Le Boreal* fire and evacuation, as well as many other MRO exercises and maritime disasters are an opportunity for SAR authorities to learn what went right and what went wrong in the response. Response preparedness must continue to be a continuous process of improvement. The stakes are too high and consequences too great not to be prepared to coordinate and conduct a maritime MRO.

Responding effectively in a maritime disaster and subsequent MRO will be difficult and may very well have a large loss of life. The nature of the incident, on scene weather, location, the passenger ship or aircraft involved, and available SAR facilities will all be important factors determining how many survivors are rescued. The more effectively SAR authorities can analyze and

86 The U.S. Fire Administration's, *Operational Lessons Learned from Disaster Response* (June 2015), provides an important comment concerning the *failure* of understanding and applying lessons learned from previous disasters: *"The complex, chaotic and negative effects of disasters should provide sufficient inducement to learn and translate the lessons into behavioral change, but for some profound reason that is not the case. Without going into deep analysis, it is sufficient for our purpose here to note that humans simply fail to plan and prepare for future events that may or may not occur. While true that disasters may provide a powerful motivation for responders to want to be good at response, the degree of potential for the event gets in the way of things. People have to know intuitively that the potential for an extraordinary disaster—to directly affect them—is great enough to reallocate their time and resources from routine matters to the extraordinary event. … Only in areas or regions that experience potentially hazardous or severe events on a predictable or regular basis will people be motivated to adapt or change their behaviors."* Available at: file:///N:/CG-SAR%20Program/Articles/MRO%20Article%20(2018)/FEMA%20-%20Operational%20Lessons%20Learned%20In%20Disaster%20Response%20(June,%202015).pdf.

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understand potential maritime disaster and MRO risks, develop plans with other SAR authorities and industry stakeholders, and exercise and improve the plans, the more they can make a difference in the number of survivors rescued.

In a maritime MRO, when the potential scenario could involve the rescue of thousands of survivors, a SAR authority will never be able to "go it alone." This is an "all hands on deck" situation requiring the immediate execution of comprehensive MRO response plans, as well as the assistance of any others able to render aid to persons in distress.

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