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Mass Rescue Operations Scoping Study

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16. Abstract (MAXIMUM 200 WORDS)

Search and Rescue (SAR) is a primary Coast Guard (CG) mission. Generally, the ability of the CG to respond, rapidly deploy, and effectively resolve SAR cases regularly meets or exceeds program performance standards. However, even with this success, there is room for improvement.

The CG Research & Development Center conducted a study to identify concepts and technologies that would lead to improvements in mass-rescue operations. Within this study, a well researched determination of the definitions, limits, range or bounds, types and concerns associated with mass rescue was conducted.

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 Coast Guard's ability to respond to mass-rescue events.

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EXECUTIVE SUMMARY

Search and rescue is a primary mission for the United States Coast Guard (USCG). Each day, the USCG is called upon to rescue persons in distress on the water and sometimes on land. For the most part, the USCG is highly successful in these rescues, which generally involve a limited number of persons aboard a single vessel, aircraft, or facility. However, the USCG occasionally encounters rescue missions, referred to as Mass Rescue Operations (MROs), that involve large numbers of people in distress. Rapid growth in the cruise-ship industry and the role of the USCG in large-scale rescue-and-evacuation incidents, such as the 9/11 terrorist attacks and Hurricane Katrina, have created increased interest in the USCG's capability to conduct MROs.

In keeping with the Commandant's vision of the Coast Guard's role as "all threats, all hazards, always ready," the USCG Research and Development Center has identified, and has ranked on the basis of risk, 13 MRO scenarios for which the USCG could have a major response role.

This scoping effort included a historical review of past MRO incidents, as well as an assessment and analysis workshop attended by safety, response, and transportation professionals. The historical review identified past MRO incidents, and provided data on the frequency and consequences of these incidents, as well as on the effectiveness of USCG response efforts. The workshop participants discussed MRO incidents in detail, ranked them by category according to risk, and identified specific response needs and areas of concern associated with each category, or scenario. The five MRO scenarios of greatest concern, as prioritized by the workshop participants, are summarized below:

1. Domestic passenger vessel requires evacuation.

   This scenario was determined to be of greatest concern for three major reasons: limited numbers of crewmembers trained in vessel evacuation; limited evacuation information provided to passengers; and less-stringent requirements for safety equipment aboard smaller vessels and vessels not required to comply with the Safety-of-Life-at-Sea (SOLAS) Convention.

2. Large passenger vessel sinks; passengers and crew must be located and rescued.

   This scenario would likely involve a large cruise ship sinking rapidly at a distance from shore preventing rescue assets from reaching it within an hour or two. Although the vessel would have personal flotation devices (PFDs), and lifeboats, there might be insufficient time to launch all lifeboats, and some individuals might be in the water without PFDs. Once assistance arrived, a means of extricating individuals (who might be immobile from hypothermia) from the water would be required.

3. Natural disaster requires air, land, or sea rescue.

   This scenario would likely involve a hurricane, a major flood, or an earthquake. Such natural incidents occur with regularity (once every one to two years), and require a significant USCG response, particularly for water rescue and evacuation.

4. Major casualty aboard a cruise ship requires evacuation.

   Worldwide, these incidents occur more frequently than in the United States, and are generally associated with cruise-ship fires. While most evacuations are successful, a fire and unsuccessful evacuation could result in significant loss of life. Passengers might be

able to remain on board while awaiting assistance, allowing the USCG to remove passengers directly from the vessel versus extricating them from the water.

5. Rescue and interdiction of a large number of refugees/illegal immigrants.

   Rescue in incidents involving refugees/illegal immigrants is problematic. The rescue attempt itself could cause fatalities: Refugees who panic during an interdiction or rescue operation might either capsize an overloaded vessel in an effort to abandon it, or enter the water directly to avoid being taken into custody.

The other eight MRO categories identified are, in order of priority:

6. Airliner crash requiring passenger extrication and water rescue.
7. Rescue of people from collapsed or burning waterfront building or facility.
8. Rescue of individuals necessitated by a bridge collapse or train derailment.
9. Small MROs (rescue needs that exceed local capability).
10. Offshore rig sinks; crew must be located and rescued.
11. Waterborne evacuation necessitated by a large-scale terrorist action, industrial accident, natural disaster, or nuclear/biological incident.
12. Rescue of individuals stranded on an ice floe or on a ship beset in ice.
13. Rescue of a large number of people from a flooded (or flooding) tunnel or similar 'trap.'

The study team concluded that the 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.

Specific areas warranting further investigation include: Requirements for non-SOLAS vessels for equipment carriage and number of trained crew; methods to provide buoyancy, as well as protection from the environment, to persons in the water; and equipment and procedures for rapidly extricating individuals from stricken vessels.

The study team also concluded that natural disasters will continue to be a significant MRO scenario. The critical area of concern for these incidents is effective contingency planning and interoperability with other rescue organizations. In addition, the ability within the USCG to transfer assets from areas unaffected by a disaster is important, because coastal natural disasters might result in significant damage to local USCG infrastructure.

With respect to transportation incidents not involving vessels, an area of concern is extricating and rescuing individuals trapped in an airplane, rail car, or vehicle. Also of concern is the adequacy of the current training and equipment available to USCG rescue units confronting such incidents.

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LIST OF ACRONYMS AND ABBREVIATIONS

ABS	American Bureau of Shipping
AIRSTA	Air Station
AIS	Automatic Identification System
AMVER	Automated Mutual Assistance Vessel Rescue
CFR	Code of Federal Regulations
CGADD	USCG Addendum to the National SAR Supplement to the National SAR Plan
CG-SAILS	Coast Guard Standard After-Action Information Lessons Learned System
COMSAR	Radiocommunications and Search and Rescue
DART	Disaster Assistance Response Team
DoD	Department of Defense
DRU	Disaster Response Unit
EEP	Emergency Evacuation Plan
EEZ	Exclusive Economic Zone
EPIRB	Emergency Position-indicating Radio Beacon
GANTSEC	Greater Antilles Section
HAZMAT	Hazardous Material
HQ	Headquarters
ICS	Incident Command System
IMO	International Maritime Organization
MODU	Mobile Offshore Drilling Units
MRO	Mass Rescue Operation
MSO	Marine Safety Office
NIMS	National Incident Management System
NSS	National SAR Supplement
OCMI	Officer in Charge of Marine Inspection
OSV	Offshore Supply Vessel
PFD	Personal Flotation Device
PVSS	Passenger Vessel Safety Specialist
R&D	Research and Development
RBDM	Risk-based Decision Making
R&DC	Research and Development Center
RoRo	Roll on, Roll off
SAR	Search and Rescue
SART	Search and Rescue Transponder
SOLAS	Safety of Life at Sea
U.S.	United States
USCG	United States Coast Guard
USCGC	USCG cutter

2 INTRODUCTION

This report provides the results of a scoping effort to (1) identify the situations, consequences, and operational challenges the United States Coast Guard (USCG) might encounter in conducting rescue operations involving large numbers of people in distress; (2) assess the potential severity of various mass-rescue scenarios; and (3) identify initiatives that the USCG might undertake to enhance its capability to respond to mass-rescue scenarios.

Traditionally, the USCG has excelled in maritime search and rescue (SAR) operations. These operations have routinely included rendering assistance to or evacuating stricken vessels, as well as locating and retrieving persons after a vessel has sunk or been abandoned. The majority of these operations have involved single vessels and a small number of individuals.

Occasionally, SAR and evacuation operations have involved multiple vessels or a single vessel with a large number of individuals at risk. In some cases, the situation has required operations over a wide geographic region and the resources of multiple units, Sectors, or Districts. Two recent examples of this situation are the USCG response in New York to the terrorist attacks of September 11, 2001, and the USCG response to Hurricane Katrina.

These larger SAR and evacuation operations have become known as Mass Rescue Operations, or MROs. Although these incidents are relatively infrequent, the potential consequences of an unsuccessful response in terms of fatalities, injuries, and adverse public opinion require that these incidents receive ongoing consideration in USCG SAR strategic planning.

2.1 THE NATURE OF MASS RESCUE OPERATIONS

Although MROs are somewhat difficult to define, they have specific characteristics, as described by the International Maritime Organization Guidance for Mass Rescue Operations[1] (IMO Guidelines). The more important attributes of MROs include:

- The incident requires delivering immediate assistance to a large number of persons, exceeding normally available SAR resources.
- The incident is a low-probability, high-consequence event that might result in large-scale loss of life or serious injury to a large number of people.
- Success often depends on immediate, well-planned, and closely coordinated large-scale actions, and the use of resources from multiple organizations, on a national or even international basis.
- The incident might require operations in addition to SAR (for example, environmental response, law enforcement, maritime security, or marine salvage).
- The incident generates intense interest and scrutiny by the media and the general public.

According to the IMO Guidelines, incidents that might require MRO include major ship or aircraft casualties, casualties in the offshore oil industry, natural disasters (for example, flooding and earthquakes), and hazardous-material releases. These incidents can be accidents, or they can be deliberate actions, such as terrorist attacks or acts of war.

The IMO Guidelines also provide general guidance for conducting MROs, both in terms of the procedures, coordination, communications, rescue resources, and rescue techniques that might be employed, and also in terms of the specific factors that should be considered in MRO planning. Additional information regarding MRO planning (provided in the IMO Guidelines appendices) includes the following:

Appendix 1	Guidelines on how to structure, conduct, and evaluate MRO exercises.
Appendix 2	Guidelines on industry planning and response.
Appendix 3	Guidelines on using the Incident Command System (ICS).

The IMO Guidelines also form the basis of the MRO guidance in the USCG Addendum (CGADD) to the U.S. National SAR Supplement (NSS) to the National SAR Plan.[2] The CGADD provides specific guidance on how U.S. agencies should deal with MROs, in terms of coordinating rescues and implementing the ICS, as well as specific guidance for contingency planning and exercises. An MRO Checklist, and a Quick Response Card template, are provided for agencies responding to MROs.

2.2 APPROACH

The MRO scoping team used a 3-part approach: First, the team conducted a review of past MRO incidents around the world to determine the general nature, location, frequency, causes, consequences, response actions, and complicating factors associated with the more significant incidents. This historical review focused on incidents occurring in the past 20 years, although some older incidents that uniquely characterized "worst-case" scenarios, or that involved USCG response, were included as well. This review provided a historical basis for future MRO scenarios and the responses to them. Results of this review are provided in Section 3.

Second, concurrent with the incident review, the team conducted a risk assessment using a standard risk-based decision-making (RBDM) tool to characterize and rank the risks and areas of concern associated with MROs that might occur in the future. This assessment was conducted in the context of a workshop attended by USCG SAR and passenger-vessel safety-program personnel, port and airport managers, and state and local-agency response managers who might be involved in MROs with the USCG. The goal of this workshop was to identify MROs to which the USCG is likely to respond, and to evaluate and rank these scenarios in terms of the risk posed (frequency of event, and consequence in terms of potential fatalities) as well as in terms of the current capability to mitigate risk (successfully rescue or evacuate individuals at risk). The proceedings and results of this workshop are summarized in Section 4. The full minutes of the workshop are available from the USCG Research and Development Center (R&DC).

Third, on the basis of the results of the historical review and the MRO workshop, the team compiled a list of findings, which are discussed in detail in Section 5. The team's recommendations concerning follow-on initiatives and investigations are also presented in Section 5.

3 HISTORICAL REVIEW OF MRO INCIDENTS

The first step of this scoping study was to identify and analyze some of the more significant MROs over the past 20 years. This step was undertaken to gain insight into the nature, frequency, cause, and consequences of MRO incidents, as well as insight into the nature of the complications, and the level of success, associated with rescue efforts in general.

The 20-year timeframe was chosen in order to ensure that the factors creating the need for MROs had not changed significantly due to, for example, regulatory or safety improvements. Incidents that occurred prior to 20 years ago were included if they uniquely characterized a particular type of MRO, or involved a USCG MRO. The goal was to characterize each category of MRO in terms of the severity of the incident and the likelihood that the USCG could successfully respond to such an incident in the future.

The types of incidents identified and categorized included those discussed in the IMO Guidelines, as well as several others encountered by the USCG in recent years. These incidents include:

- Cruise-ship, ferry, and other significant vessel sinkings
- Oil-rig disasters (explosions, fires, sinkings)
- Cruise-ship fires
- Natural disasters (hurricanes, floods, and earthquakes)
- Land and air-transport incidents requiring marine rescue
- Refugee rescue/interdiction
- Miscellaneous incidents involving marine rescue and evacuation

Sinkings and fires on naval warships were not included, because rescue and evacuation for these incidents would be coordinated by the Navy. Sinkings, fires, and other casualties on commercial cargo vessels (tankers, freighters, container ships, etc.) have not been extensively addressed, because these vessels typically operate with a limited number of crew members; they are required to have drills, and their crews are, in general, well trained. In addition, it is unlikely that MROs involving these types of vessel would pose more of a challenge than would a cruise ship or a ferry. Four smaller vessel casualties (two charter fishing vessels, and two commercial vessels) were included under ‘other significant vessel sinkings’ because the difficulties encountered in these rescue and evacuation operations might complicate MROs in general.

3.1 CRUISE-SHIP, FERRY, AND OTHER VESSEL SINKINGS

The sinking of a major cruise ship or ferry can result in a significant loss of life. Perhaps the most famous example is the loss in 1912 of the *RMS Titanic,* which hit an iceberg and sank en route from Ireland to New York[3]. This ship sank in less than three hours, killing 1,502 of the 2,207 persons on board.

On July 25, 1956, the ocean liner *SS Andrea Doria* collided with the *SS Stockholm* off Nantucket Island, with 51 fatalities and 1,660 people rescued.[4] Launching lifeboats from the listing ship proved difficult; however, rescue of the ship’s passengers was facilitated by proximity to the coast and a prompt and effective response by the passenger liner *SS Ile de France* and other, smaller vessels, including USCG cutters.

Table 1 lists the more significant cruise-ship and ferry sinkings in the past 20 years. Worldwide, a major disaster of this type occurs every one to two years, with fatalities ranging from 100 to several thousand. Ferry accidents have been particularly deadly, with three resulting in over a thousand fatalities each (*Dona Paz, Joola,* and *Al Salam Boccaccio 98*). In two of these three incidents, negligent overcrowding of the vessel was a contributing factor. Two other ferry sinkings (*Herald of Free Enterprise* and *Estonia*) involved problems with securing the vehicle doors on the bow of the ferry, resulting in the vehicle decks being flooded. In general, all of these incidents involved the rapid capsizing and sinking of the vessel, leaving little time for abandoning ship.

It is notable that none of these incidents occurred in U.S. waters, and several involved vessels operating in third-world countries. A casualty of this nature might be less likely in U.S. waters, due to stricter enforcement of maritime safety regulations. In addition, cruise ships entering U.S. ports are now monitored and escorted for port-security reasons, making mishaps less likely; however, the possibility of a major collision at sea still exists.

In addition to the incidents in Table 1, four incidents have occurred involving other commercial vessels, which, although they placed fewer individuals at risk, posed a significant challenge to USCG rescuers. Each of these incidents required rescuing individuals during severe weather, and in a cold-water environment. On December 2, 1989, the *M/V Bronx Queen*, a charter fishing vessel, sank off Breezy Point, NY, after the steering compartment in the stern began to flood.[5] A USCG 41-foot utility boat responded.[6] When the USCG boat reached the sinking vessel, all 19 persons were on the bow of the vessel. A crewmember on the USCG boat instructed the persons on the *Bronx Queen* (all of whom were wearing personal flotation devices) to swim to the USCG boat one at a time. Instead, all 19 persons entered the water at once. Because of difficulties in getting all of the victims onto the 41-footer, it took two hours to remove everyone from the water. Consequently, two individuals died of hypothermia, and another died of a heart attack.

A similar incident occurred on December 5, 1993, when the *M/V El Toro II*, another charter fishing boat, sank at the mouth of the Potomac River in gale-force winds and in 50^{o} F water.[7] The vessel sank due to failure of the hull, forcing 16 persons onto a life float, where they were immersed in cold water and exposed to the environment. Three persons remained on the boat and one person entered the water alone. Although all persons were rescued and evacuated by a USCG boat and USCG and Navy helicopters, three persons died of hypothermia.

The *Bronx Queen* and *El Toro II* incidents highlight the need to try to prevent people from entering the water, or to remove them rapidly when they do enter the water and the water is cold. In both cases, there was significant difficulty getting the victims aboard the rescue boats and the helicopters, and getting them to a warm environment before hypothermia led to fatalities. Each case involved approximately 20 individuals; it is likely that a similar incident that involved hundreds of individuals could result in a proportionate loss of life.

Two other incidents show the difficulties involved in evacuating individuals from larger ships in adverse weather conditions, or when a ship is listing, or both. On December 6, 2004, the *M/V Selendang Ayu*[8, 9] lost power due to an engine failure in gale-force winds and 15-foot seas in the Bering Sea. Over the next two days, the vessel drifted toward the coast of Unalaska Island, while the crew attempted to repair the engine. Attempts to have a tug tow the vessel to safety failed when the tug could not restrain the much larger vessel and the towline parted. As the vessel neared the coast, a USCG HH-60 Jayhawk helicopter evacuated nine persons to the USCGC *Alex Haley*, under very hazardous conditions. Because of the dangers in lowering the survivors from the helicopter to the rescue vessel, another Jayhawk took an additional nine survivors to a landing area on shore. An attempt was made by one of the HH-60 helicopters to evacuate the remaining crew from the vessel after it had grounded on the coast, but as the helicopter was winching the last of seven persons aboard, a wave was thought to be ingested into the helicopter's engines, and the helicopter crashed into the sea. Although a second helicopter (USCG HH-65 Dolphin) subsequently rescued the three USCG aircrew and one vessel crewmember, six other vessel crewmembers perished.

Most recently, the *M/V Cougar Ace* – a roll-on/roll-off (RoRo) car carrier – lost stability while transferring ballast water on July 23, 2006.[10] Twenty-three crewmembers were rescued from the ship on July 24. All 23 crewmembers were removed from the superstructure of the partially capsized vessel by National Guard helicopters within an hour. Before the helicopter evacuation, a USCG C-130 aircraft had attempted to drop life rafts to the vessel so that the crewmembers could escape if the ship went down. Because of the extreme list, however, and the high freeboard on the vessel, the ship drifted over the rafts before they could be retrieved.[11]

Both the *Selendang Ayu* and the *Cougar Ace* incidents highlight the potential difficulties in evacuating large numbers of individuals from very large ships, particularly when the ships might be unstable, listing, and unable to use their own lifeboats and life rafts. For cruise ships, where passengers might be elderly and unfamiliar with abandon-ship procedures, evacuation under these circumstances would be extremely hazardous, and could result in a large number of fatalities and injuries.

The worst-case scenario for this category of MRO would be the rapid sinking of a cruise ship, a large coastal ferry, or a gaming vessel distant from shore and from other vessels such that rescue vessels might not reach the stricken vessel for several hours. The cause of the distress leading to an MRO could be a collision or even a terrorist action. The rapid sinking or listing of the vessel might preclude launching all available lifeboats; large numbers of individuals could be adrift in the water in lifejackets at best. Heavy weather and cold water could further complicate rescue attempts. Many individuals would suffer from hypothermia and fatalities could range from 100 to over 1,000.

Table 1. Cruise-Ship, Ferry, and Other Vessel Sinkings

Date	Vessel Type/Name	Location	Cause	Passenger & Crew Fatalities	Circumstances/Response
08/31/86	*Admiral Nakhimov* Cruise ship	Black Sea	Collision	1,234 aboard 425 fatalities	Cruise ship rammed by freighter. Ship sank in 8 minutes.[12] No lifeboats launched.[13]
03/06/87	*Herald of Free Enterprise* RoRo* passenger ferry	Zeebruge, Belgium	Flooding; capsizing	650 aboard 193 fatalities	Vessel ballasted down by bow. Bow door left open. Vessel capsized in seconds - half-submerged.[14]
12/21/87	*Dona Paz* Passenger ferry	Tablas Strait Philippines	Collision; fire; overcrowded	Over 4,000 aboard Over 4,000 fatalities Only 24 survivors	Collided with tanker. Tanker caught fire; fire spread to *Dona Paz*. *Dona Paz* sank within minutes. Vessel was licensed to carry 1,500 but over 4,000 were aboard.[15, 16, 17]
02/16/93	*Neptune* Ferry	Caribbean	Unknown	1,215 aboard 1,215 fatalities	USCG units participated in SAR and recovery operations.[18]
09/28/94	*Estonia* RoRo passenger ferry	Baltic Sea	Rough weather; structural failure	989 aboard 852 fatalities	Bow visor failed, flooding car deck. Vessel capsized and sank. Many passengers trapped inside.[19, 20]
05/21/96	*Bukoba* Passenger ferry	Lake Victoria, Tanzania	Vessel capsized	Over 800 aboard Over 500 fatalities	Vessel was seriously overloaded.[21, 22]
09/26/02	*Joola* Passenger ferry	Off Gambia	Overcrowding; rough weather	Possibly 2,000 aboard Almost 2,000 fatalities 64 rescued	Vessel licensed to carry about 500. Ship capsized at night; official rescue not mounted until following morning.[23, 24]
02/27/04	*Superferry 14* Passenger ferry	Manila, Philippines	Explosion and fire	900 aboard 130 fatalities	Ferry destroyed by fire resulting from suspected terrorist bomb.[25, 26]
02/02/06	*Al Salam Boccaccio 98* RoRo passenger ferry	Red Sea	Fire, Weather	Over 1,400 aboard Over 1,000 confirmed dead	Fire reported. Water used in firefighting made vessel so unstable it capsized.[27, 28]
03/22/06	*M/V Queen of the North* RoRo ferry	Canadian Pacific Coast	Grounding and sinking	101 aboard 2 fatalities	Autopilot failed, vessel ran off course and grounded, 99 safely evacuated.[29, 30, 31]
04/06/06	*al-Baraqua II* Passenger ferry	Off Djibouti	Capsizing: overcrowded	About 200 aboard 109 confirmed dead	Few details, under investigation.[32, 33]

*RoRo = roll on, roll off

3.2 OIL-RIG DISASTERS

Table 2 provides a listing of the significant offshore oil-rig and drill-ship casualties since 1968. Although worldwide these incidents are relatively infrequent (one incident every 5 to 10 years), they are often deadly, claiming the lives of all or most of the crew. The two main causes of oil-rig and drill-ship casualties are extreme weather (for example, typhoons, hurricanes, and 100-foot waves) and explosions or fires. Any of these conditions are likely to complicate a rescue attempt unless the crew involved is able to safely abandon their rig or drill ship by means of onboard rescue equipment.

Early oil rigs lacked onboard survival equipment and procedures, as was demonstrated by the Ocean Ranger disaster in 1982. Modern oil rigs operating on the U.S. continental shelf and beyond are far better equipped. It is notable that there have been no major oil-rig disasters in U.S. waters in the past thirty years. In the last incident in the United States, which occurred in 2000, a USCG helicopter rescued all 51 crew members from a burning oil rig. USCG and oil-company assets would likely be able to rescue survivors in any other such situation, provided weather conditions and conditions aboard the oil rig in distress allowed safe approach.

The worst-case scenario for this type of MRO is the capsizing of a rig or fire and explosion aboard the rig that forces immediate abandonment under severe weather conditions. The rig is in deep water, and 50 miles or more offshore, thereby delaying response.[34] The crew is in the water in rafts or survival suits and drifting away from the initial position. Potential fatalities could be 100 or more.

Table 2. Oil-Rig Disasters

Date	Rig/Vessel Name	Location	Cause	Passengers/Fatalities	Circumstances/Response
08/21/68	Chevron Rig "Little Bob"	25 miles east of Grand Isle, LA	Blowout; fire	33 aboard 2 fatalities	USCG cutters (USCGCs) *Point Verde* and *Point Sal* and 2 USCG helicopters responded.[35]
03/27/80	Alexander L. Kielland	North Sea	Heavy weather; structural failure	212 aboard 123 fatalities	Platform listed, hampering launch of lifeboats. Only 2 of 7 lifeboats launched. Rig sank in 15 minutes. Near-freezing water and waves hampered rescue.[36]
02/15/82	Ocean Ranger	Grand Banks Newfoundland, 170 miles offshore	Severe weather; flooding	84 aboard 84 fatalities	Giant wave smashed porthole; 100-foot waves reported. Rescue vessels unable to retrieve survivors. No survival suits. Disaster provoked upgrade of safety procedures and equipment.[37]
10/25/83	Glomar Java Sea Drill Ship	Off China, 63 miles offshore	Capsized in tropical storm	81 aboard 81 fatalities	Distress calls were made and at least one lifeboat was launched, but there were no survivors.[38]
07/06/88	Piper Alpha	North Sea off Scotland, 120 miles offshore	Natural gas explosion & fire	225 aboard 167 fatalities	Improper maintenance procedure caused explosion. Fire hampered rescue attempts.[39]
11/03/89	Seacrest Drill Ship	South China Sea, 200 miles offshore	Capsized in typhoon	97 aboard 95 fatalities	Drill ship capsized in heavy seas caused by Typhoon Gay.[40]
07/05/00	Ocean Crusader[41] offshore rig	Gulf of Mexico	Fire and explosion	51 aboard 0 fatalities	USCG HH-65 helicopter safely evacuated 51 crewmembers from a burning rig. Fifteen crew members evacuated to another rig and 36 to awaiting boats. All four USCG aircrew received Distinguished Flying Cross.[42]
03/15/01	Petrobras P-36	Off Brazil, 78 miles offshore	Explosion and flooding	175 aboard 10 fatalities	Salvage attempted but unsuccessful. Potential 400,000-gallon oil spill.[43, 44]

3.3 CRUISE-SHIP FIRES

Cruise-ship fires are not included with cruise-ship sinkings because passengers may be able to remain on the vessel until assistance arrives, rather than evacuating the vessel immediately as in a sinking. Cruise-ship fires (Table 3) occur with some regularity (every few years) and, depending on the circumstances, can be very deadly. Two historical incidents that demonstrate the potential consequences of a cruise-ship fire are the *SS Morro Castle* incident in 1934, off Asbury Park, NJ, and the *SS Yarmouth Castle* incident in 1965, in the Bahamas. The *Morro Castle* fire resulted in 137 fatalities; the *Yarmouth Castle* fire in 90 fatalities. In both cases, inadequate standards, lack of emergency procedures, and gross negligence on the part of the crew contributed to the loss of life. The *Yarmouth Castle* incident led to recommendations to amend the Safety of Life at Sea (SOLAS) Convention, which specifies safety equipment and emergency procedures designed to minimize loss of life resulting from fires and other casualties at sea. Ship construction, firefighting systems and equipment, and emergency procedures on modern cruise ships operating from the United States minimize the likelihood that incidents such as the *Morro Castle* or *Yarmouth Castle* will be repeated. In addition, it is unlikely that a fire aboard a modern cruise ship would immediately affect the stability of the ship in a way that precludes launching lifeboats.

Some factors still make cruise-ship fires problematic. These factors include the large number of individuals traveling aboard modern cruise ships (often 1,000 or more), the potential for a fire and explosion due to terrorist action, and the large number of elderly passengers traveling on cruise ships operating from U.S. ports. In addition, although only one cruise-ship fire in recent times resulted in a large number of deaths (*Scandinavian Star* in 1990, with 158 fatalities), cruise-ship fires continue to occur on a regular basis, and often result in fatalities and injuries. In many cases, the injuries are caused by the evacuation process rather than by the fire itself.

The benchmark for cruise-ship fires requiring a USCG response is the *Prinsendam* incident in 1980, in which a modern cruise ship with 520 aboard caught fire, necessitating evacuation of the ship. The vessel was 120 miles offshore; it took several hours for rescue vessels to reach the scene. Luckily, the *T/V Williamsburgh* was able to reach the *Prinsendam* in seven hours to render assistance. USCGC *Boutwell* was on scene within 20 hours, and with support from USCG and Air Force aircraft, supervised the safe evacuation and rescue of all passengers and crew. Because the incident took place in cold Alaskan waters, abandoning the vessel altogether could have resulted in significant loss of life.

The worst-case scenario for this type of MRO is most likely a *Prinsendam*-type incident in which passengers are forced to leave a ship in a hostile environment (heavy weather and cold water), long before rescue assets arrive. The potential cause could be a collision with another vessel, or a fire started by a bomb planted on the ship, that destabilizes the ship in addition to igniting a conflagration. Fatalities could be in the hundreds, with numerous persons in the water and drifting away from the scene.

Table 3. Cruise-Ship Fires

Date	Vessel Name	Location	Cause	Passengers/ Fatalities	Circumstances/Response
09/07/34	*Morro Castle*	Off Asbury Park, NJ	Fire	134 fatalities	USCGCs *Tampa* and *Cahoone* and small boats responded and rescued at least 140 survivors.[45, 46]
11/12/65	*Yarmouth Castle*	120 miles east of Miami, FL	Electrical fire	552 aboard 90 fatalities	No alarm sounded. Sprinkler system was ineffective. Crew members abandoned passengers. Disaster led to the amendment of the SOLAS Convention.[47]
10/04/80	*Prinsendam*	Off Yakutat, AK, 120 miles offshore	Engine room fire	520 aboard 0 fatalities All passengers evacuated	USCG immediately responded with HH-3 helicopter and C-130. *T/V Williamsburgh* rendered assistance in seven hours. USCGC *Boutwell* on scene within 20 hours. USCGCs *Mellon* and *Woodrush* also assisted. SAR conducted for 1 missing lifeboat (subsequently found).[48, 49]
08/12/84	*Scandinavian Sea*	5 miles off FL	Fire	744 aboard 2 fatalities	Passengers mustered on weather decks. USCGCs *Diligence*, *Reliance*, and *Steadfast* responded. Fire extinguished after 2 days.[50]
04/07/90	*Scandinavian Star*	North Sea	Fire: arson	482 aboard 158 fatalities	Ship's ventilation might have suffocated trapped passengers. Crew abandoned ship without evacuating passengers.[51]
07/14/91	*Starship Majestic*	Off Freeport, Bahamas	Engine room fire	1,120 aboard 0 fatalities	Passengers called to lifeboats but fire contained. No evacuation.[52]
11/30/94	*Achille Lauro*	Off Somalia	Engine room fire	1,000 aboard 4 fatalities	Vessel evacuated. Three persons died during evacuation, fourth person unaccounted for.[53]
06/18/95	*Celebration*	Off San Salvador	Engine room fire; lost power	1,735 aboard 0 fatalities	Vessel's Halon system extinguished fire. USCGCs *Forward* and *Vigorous* responded. USCGC *Forward* towed vessel.[54, 55]
07/22/95	*Regent Star*	Prince William Sound, AK	Engine room fire	1,280 aboard 0 fatalities	Vessel evacuated. Two injuries during evacuation.[56]
05/08/96	*Discovery I*	Freeport, Bahamas	Engine room fire	1,200 aboard 0 fatalities	Vessel evacuated. No injuries.[57]
07/27/96	*Universe Explorer*	Off AK	Laundry room fire	732 aboard 5 fatalities	Five crewmen died from smoke and chemical fumes; 70 injured.[58, 59]
04/06/97	*Vistafjord*	Off Bahamas	Laundry room fire	991 aboard 1 fatality	Vessel diverted to Freeport. Vessel had similar fire in same location a year earlier.[60]
07/20/98	*Ecstasy*	Off Miami Beach, FL	Fire	3,475 aboard 0 fatalities	Apparent hot-work fire spread to aft mooring deck. Fire contained and extinguished. Fifty-four injuries.[61]
03/23/06	*Star Princess*	Caribbean	Fire	3,813 aboard 1 fatality	Passengers evacuated to safe part of ship. Fire was contained and extinguished. One fatality due to smoke inhalation.[62]

3.4 NATURAL DISASTERS

A cursory review of USCG rescue operations over the past 20 years produces numerous examples of USCG response to natural disasters. Even when the USCG is not the primary response agency, it might be called upon because of its existing rescue coordination infrastructure and training; the availability of waterborne assets and expertise in operating them; and the availability of helicopters outfitted for rescue and evacuation. The USCG also has experience and training in working with other response organizations (National Guard, Corps of Engineers, and local fire departments) as well as in working with private industry in emergency response situations. The three types of natural disasters most likely to involve USCG response are hurricanes with coastal flooding, flooding of major river systems, and earthquakes in coastal areas.

3.4.1 HURRICANES

Since 1900, 37 hurricanes and major storms have impacted the U.S. coast. If this history is extrapolated into the future, a major storm can be expected every few years[63]. Fatalities associated with recent hurricanes have ranged from several to over 1,000 (1,800 for Hurricane Katrina)[64]. Property damage can cost billions of dollars ($35 billion for Hurricane Andrew in 1992, for example, and $100 billion for Hurricane Katrina in 2005)[65]. It is likely that any such hurricane or storm would require USCG rescue, evacuation, and relief operations well above and beyond what is normally encountered. In many cases, this response would need to be provided despite damage to the USCG's own infrastructure.

Table 4 provides a listing of USCG responses to hurricanes and tropical storms since 1988. Typically, the USCG is well positioned to provide rescue and evacuation services in coastal areas, using smaller USCG cutters, small boats, and helicopters. USCG response also might involve port-security, pollution-response, and waterways-management activities. The USCG has generally been successful in these response efforts, working effectively with other Federal agencies and with local responders.

The worst-case scenario for this type of MRO, and benchmark for future USCG hurricane responses, is undoubtedly Hurricane Katrina. This Category 4 hurricane devastated a wide area in southern Mississippi and Louisiana in August 2005, and resulted in the New Orleans levee system being breached, and a major portion of the city being flooded. It also caused substantial flooding along the Mississippi River. The hurricane required a massive USCG rescue-and-evacuation effort over a 90,000-square-mile geographic area, despite serious damage to USCG infrastructure and hardships encountered by USCG personnel as a result of the storm. At the height of rescue operations, at least 62 aircraft, 30 cutters, and 111 small boats were involved in rescue and recovery operations.[66]

Operations in response to Hurricane Katrina typically involved using small boats to access and search residences for survivors, and using small boats and helicopters to evacuate persons stranded in the flooded city of New Orleans. Approximately one third of the USCG air fleet was deployed to the region. More than 5,290 USCG personnel participated in the operation. The USCG response effort resulted in the rescue and evacuation of more than 33,520 individuals, response to numerous pollution incidents, and rapid restoration of waterway traffic.

Table 4. Natural Disasters - Hurricanes

Date	Incident	Location	Population affected People rescued	Circumstances/Response
09/16/88	Hurricane Gilbert	Mexico	Unknown 109 persons rescued	USCG units assisted in rescue and evacuation operations.[67] USCG assets included 75 personnel and 12 aircraft.[68]
09/18/89 09/21/89	Hurricane Hugo	Puerto Rico, St. Croix, GA, and SC	Unknown	USCG units conducted SAR, evacuation, relief, law enforcement, and emergency communications operations. In PR, USCG HH-65 helicopters and C-130 flew 154 sorties for evacuation and relief. In St. Croix, USCGCs *Vashon* and *Nantucket* evacuated persons and controlled looting.[69] Air Stations (AIRSTAs) Savannah, Traverse City, and Mobile provided aircraft.[70]
08/26/92	Hurricane Andrew	South FL, Gulf Coast	Tens of thousands	USCG units in 7th and 8th Districts conducted SAR, relief, and transport operations.[71] Evacuated 1,000 persons by aircraft; 447 relief flights moved 306,000 lbs of supplies.[72]
08/15/95	Hurricane Marilyn	Virgin Islands	Unknown	USCGCs *Vigorous*, *Escanaba*, *Point Ledge*, and USCG helicopters responded. Ops included SAR, maritime security, and environmental response.[73]
09/06/95	Hurricane Luis	Leeward Islands	Unknown	Greater Antilles Section (GANTSEC) units conducted SAR, relief operations, and evacuations.[74]
06/09/01	Tropical Storm Allison	Houston, TX	Unknown 220 rescued	USCG flood punts and helicopters rescued 220 persons.[75]
08/05-09/05	Hurricane Katrina	New Orleans, southern LA & MS	Hundreds of thousands affected; USCG rescued and evacuated 33,520	USCG responded with 5,290 personnel, 62 aircraft, 30 cutters, 111 small boats. Operations included MRO, oil spill response, law enforcement, and waterway management.[76]
09/24/05	Hurricane Rita	LA and TX	Rescued and evacuated 191	USCG units were still in the area from Hurricane Katrina.[77]

3.4.2 *FLOOD RESPONSE*

Flooding along major river systems is another natural disaster routinely encountered by the USCG. For example, since 1900, major Mississippi River flooding has occurred in 26 different years.[78] Table 5 provides information on major USCG flood response operations since 1980. Most of this flooding has occurred in the Mississippi, Missouri, and Ohio Rivers (in USCG District 8).

In response to floods, the USCG typically mobilizes Disaster Assistance Response Teams (DARTs).[79] These DARTs (formerly known as Disaster Response Units – DRUs) work with other-agency and local responders to search for, rescue, and evacuate stranded individuals in the area affected by the flood. This is usually accomplished using solid-hulled small boats (inflatable boats are easily damaged by submerged obstructions). USCG helicopters have been used from air stations as far away as New Orleans, Traverse City, and Cape Cod to rescue and evacuate stranded individuals.

Responding to floods might also involve pollution-response and waterways-management operations, because flooding often causes oil spills. The key to success in these operations has been contingency planning and training with other agencies and first responders, and close coordination with these agencies and responders during an event.

The worst-case scenario for this type of MRO is a severe flood on a major river system, over hundreds of miles of river, involving simultaneous SAR, evacuation, pollution-response, and waterways-management operations. Reservists are activated, and resources outside the affected Sectors and District are mobilized. The evacuation and rescue of hundreds of individuals are required, with failure potentially resulting in hundreds of fatalities.

Table 5. Natural Disasters - Floods

Date	Incident	Location	Population affected People rescued	Circumstances/Response
01/29/80	San Miguel River Flood	Tijuana, Mexico	Unknown 180 rescued	Two HH-3F helicopters rescued 180 persons in two days.[80]
01/30/82	Calcasieu River Flood	Lake Charles, LA	Unknown	USCG searched for stranded persons and responded to runaway barges.[81]
03/29/84	NJ Flooding	Southern NJ	Unknown 149 evacuated	USCG evacuated 149 persons from Cape May and Atlantic City.[82, 83]
10/08/86	Mississippi and Missouri Flood	St. Louis, MO	Unknown	USCG units evacuated flood victims using helicopters, punts, and trucks. One-hundred-fifty USCG personnel participated. AIRSTAs Traverse City and New Orleans provided aircraft.[84] USCGCs *Sumac* and *Cheyenne* were involved. Small boats and helicopters evacuated stranded victims.[85]
07/93	Upper Mississippi and Missouri Flood	MO and Il	Unknown	USCG personnel assisted in evacuation of flood victims.[86] USCG activated 445 reservists and repositioned/replaced 5,000 buoys and 750 shore aids.[87]
05/02/95	Upper Mississippi and Missouri Flood	NE, IA, MO, Il, and KY	Unknown	USCG closed 366 miles of Missouri River and activated 143 reservists. DRUs were established.[88, 89]
03/19/97	Ohio River Valley Flooding	WV, OH, and KY	USCG assisted 815 20 fatalities	Marine Safety Offices (MSOs) Huntington, Louisville, and Paducah (active duty and reservists) participated. Disaster Response Units formed. Helicopters from AIRSTAs Detroit, New Orleans, and Cape Cod assisted.[90, 91]
04/97	Red River Flooding	Upper Midwest, ND, and MN	90,000 affected USCG rescued 916	USCG responded with 157 personnel. DRUs formed. Helicopters from AIRSTAs Traverse City and New Orleans responded.[92, 93]

3.4.3 EARTHQUAKE RESPONSE

Occasionally, the USCG is involved in the response to a major earthquake in a coastal area. The two notable examples presented in Table 6 are the southern Alaskan earthquake of 1964 and the Loma Prieta earthquake that struck northern California in 1989. As in the case of hurricanes, USCG units might be called upon to rescue or evacuate injured or stranded individuals despite damage to USCG infrastructure. Individuals might be in the water or stranded due to collapsed bridges, and fires following an earthquake might trap individuals on rooftops, requiring vertical evacuation using helicopters. As in the Loma Prieta earthquake, USCG helicopters might be used for medical evacuations (medevacs) of injured persons to local hospitals.

Perhaps the worst-case scenario is a severe earthquake that produces a tsunami (such as in the case of the Alaskan earthquake in 1964). A tsunami can cause vessel casualties, can flood low-lying coastal areas, and can cause serious damage to USCG infrastructure and assets. Fatalities in the hundreds and even thousands might be experienced. In many respects, the aftermath of such an event would resemble the situation after Hurricane Katrina, with persons trapped in structures and possibly washed out to sea. Pollution-response, waterways-management, and law-enforcement activities might need to be undertaken as collateral operations.

Table 6. Natural Disasters - Earthquakes

Date	Incident	Location	Population affected People rescued	Circumstances/Response
03/27/64	Alaskan Earthquake	Southern AK	Thousands affected 125 fatalities	Five USCG cutters dispatched to evacuate remote areas; 360 persons evacuated.[94]
10/17/89	Loma Prieta Earthquake	San Francisco, Northern CA	63 fatalities 3,757 injured 1 USCG fatality	USCG units assisted local agencies in rescue and relief. Greatest number of fatalities (including a USCG member) occurred in collapse of viaduct on Nimitz Freeway in Oakland. USCG helicopters assisted in medevacs. MSO responded to 400,000-gallon gasoline spill. Bridge collapse necessitated re-establishment of ferry service.[95, 96, 97]

3.5 AIR AND GROUND TRANSPORTATION INCIDENTS INVOLVING MARINE RESCUE

In addition to marine-rescue operations arising from maritime accidents, the USCG is occasionally involved in rescue operations arising from air or ground transportation accidents. Seven examples of such incidents are provided in Table 7. In the four aircraft incidents (Air Florida Flight 90 in 1982, World Airways Flight 30H in 1982, U.S. Air Flight 5050 in 1989, and U.S. Air Flight 405 in 1992) airplanes crashed into water in close proximity to an airport, resulting in passengers in the water or trapped inside the aircraft. The train derailment (AMTRAK Sunset Limited in 1993) and two bridge/causeway collapses (Sunshine Skyway Bridge in 1980, and Queen Isabella Causeway in 2001) were initially caused by maritime accidents (vessel allision with a bridge), and resulted in persons in the water or trapped in rail cars or vehicles.

The USCG responded to all incidents except the Air Florida Flight 90 crash. (The USCGC *Capstan* was farther down the Potomac River on another SAR mission when the crash occurred.) USCG boats and cutters responded to the other six incidents; USCG helicopters responded to the AMTRAK derailment and to the Sunshine Skyway Bridge collapse. Complications in the response efforts included ice in the Air Florida Flight 90 incident; and a fire, as well as the remoteness of the accident site, in the AMTRAK derailment. Another complicating issue was the need to rapidly extricate trapped victims from the aircraft, rail cars, and vehicles.

The worst-case scenario for this type of MRO is the crash of a large passenger aircraft in shallow water, with 100 or more survivors in the water or trapped in the aircraft. Many victims might be injured and unconscious, and many might be without flotation devices. To prevent additional fatalities, a rapid, coordinated response that includes first-responders with extrication equipment, dive teams, and emergency-medical personnel, would be required.

Table 7. Other Transportation Incidents involving Marine Rescue

Date	Incident	Location	Cause	Passengers/Fatalities	Circumstances/Response
05/09/80	Sunshine Skyway Bridge collapse	Tampa Bay, FL	Allision by freighter	35 fatalities	*M/V Summit Venture* struck the bridge abutment causing a 1,297-foot section of the center span to collapse. Thirty-five persons in a bus and several cars plunged into Tampa Bay. USCG responded for rescue and recovery.[98, 99]
01/13/82	Air Florida Flight 90	Potomac River, Washington, DC	Snowstorm; icing	79 aboard 74 fatalities	Airplane crashed in Potomac River a short distance from the airport. Passengers trapped in plane; ice hampered rescue. USCGC *Capstan* was downriver on a SAR mission. USCG involved in recovery operation.[100]
01/23/82	World Airways Flight 30H	Logan Airport, Boston, MA	Slid off runway	212 aboard 2 fatalities 30 injuries	Aircraft skidded off slick runway into Boston Harbor and broke open. USCG responded in shallow water with local authorities. Two bodies were never recovered.[101]
09/21/89	U.S. Air Flight 5050	La Guardia Airport, NYC	Aborted takeoff	63 aboard 61 rescued	USCG responded. Survivors trapped in fuselage and under pier were extricated; others were rescued from water.[102]
03/23/92	U.S. Air Flight 405	La Guardia Airport, NYC	Crash on takeoff	51 aboard 23 fatalities 28 injuries	Plane crashed on takeoff and slid into Flushing Bay. Passengers trapped in crushed fuselage. USCG assisted local first responders in rescue.[103]
09/22/93	AMTRAK Sunset Limited derailment	Rail bridge on bayou near Mobile, AL	Barge pushed into and damaged bridge	220 aboard 47 fatalities 103 injuries	Train derailed into bayou, fuel tanks ruptured, and train caught fire. Many passengers trapped in cars. Darkness and remoteness of site hampered rescue. USCG responded with 8 helicopters and 6 boats.[104, 105]
09/15/01	Queen Isabella Causeway collapse	South Padre Island, TX	Allision by barge tow	18 car passengers 5 fatalities	Ten cars in the water. Four USCG small boats responded, rescuing 13. USCGC *Mallet* assisted in recovery effort.[106, 107]

3.6 REFUGEE RESCUE/INTERDICTION

This MRO involves a large number of individuals aboard one or more vessels approaching U.S. shores to claim political asylum or to illegally enter the country. The vessels that are transporting these individuals are typically overloaded, which might threaten vessel stability, and lifesaving equipment is inadequate. In addition, there is undoubtedly no abandon-ship procedure in place. Thus, as a rescuing/interdicting vessel approaches, passengers might panic and move to one side of the vessel, capsizing it, or they might jump into the water in an attempt to swim to the approaching vessel. Both of these actions have resulted in fatalities in the past.

As indicated in Table 8, a number of these types of MROs have occurred, beginning with the Mariel Boatlift in 1980, during which an estimated 125,000 individuals in 5,000 vessels crossed the Florida Straits between Cuba and South Florida, a distance of 120 miles. Many of the vessels were overcrowded and unseaworthy, and supervising the exodus required a 3-month commitment of a majority of resources in the Seventh USCG District (including 600 reservists). Resources were also required from adjacent USCG Districts and from the U.S. Navy in order to handle the situation. Although the majority of the refugees were brought to safety, reports of bodies in the Florida Straits clearly indicated that some fatalities resulted.

A similar situation arose in the early 1990s when refugees from Haiti attempted to transit the Windward Passage, because of political turmoil and poverty in Haiti. In numerous incidents, USCG cutters successfully interdicted or rescued refugees and repatriated them to Haiti; several of the incidents are outlined in Table 8. While most of these operations were successful in preventing fatalities, some fatalities occurred when the Haitian vessels sank or capsized before they could be reached, or during a rescue operation. During the height of the Haitian exodus (October 1991 through November 1992), a flotilla of over 27 USCG cutters rescued 35,000 Haitian migrants from hundreds of overcrowded or unseaworthy vessels.

More recently, the USCG has interdicted vessels approaching the United States or Latin America attempting to smuggle illegal Chinese immigrants into the country. During the period April to December 1999, the USCG intercepted seven vessels carrying 913 migrants from the People's Republic of China. These migrants were turned over to the U.S. Immigration and Naturalization Service in Tinian Island, Midway Island, and Guatemala. Two specific incidents are listed in Table 8. In the incident involving the *M/V Wing Fung Lung* on December 6, 1999, panicked migrants jumped into the water when it appeared the vessel was being scuttled. Luckily all the migrants were rescued.

The worst-case scenario for this type of MRO is probably the deliberate or accidental sinking of a vessel carrying a large number of refugees (up to 500) during a rescue/interdiction operation. Large numbers of people could enter the water without life preservers, requiring rapid lifesaving measures (providing flotation devices) and retrieval by the rescuing ship. Fatalities could number into the hundreds. **Note**: If a vessel sinks without a rescue vessel nearby, the scenario becomes the same as that of a cruise-ship or ferry sinking.

Table 8. Refugee Rescue/Interdiction

Date	Incident	Location	Cause	Passengers/Fatalities	Unique Circumstances
04/80 to 06/80	Mariel Boatlift Cuban refugee exodus	Florida Straits	Political action	125,000 in 5,000 boats. Assistance provided to 1,292 refugee boats.[108] Most reached United States safely, but there were an unknown number of fatalities	U.S. response included USCG, Navy, and Immigration. Operations included rescue, vessel escort, and law enforcement. Operation required all USCG District 7 resources. Six hundred reservists were activated.[109] Operation involved 18 USCG cutters, 7 Navy vessels, 16 USCG aircraft, and 1,000 USCG and Navy personnel.[110]
10/28/91	Refugee exodus from Haiti	Windward Passage	Political action: overthrow of president	Tens of thousands 40,000 rescued in one year	Possibly largest SAR operation in USCG history. USCG rescued 6,300 in 30 days. Seventy-five USCG units participated.[111]
06/19/92	*M/V Lucky No. 1*	Pacific Ocean	Illegal immigration	Unknown	Third Chinese immigrant vessel seized in 6 months.[112]
01/27/93	*M/V East Wood*	Marshall Islands	Hijacking	527 refugees 10 crew	USCGC *Rush* investigated and found Chinese nationals who were repatriated to China.[113]
06/06/93	*M/V Golden Venture*	Off Long Island, NY	Illegal immigration	289 refugees 8 fatalities	Refugees jumped in water in attempt to reach shore; 8 died.[114]
07/94	Operation Able Manner	Windward Passage	Political unrest	531 refugees	Refugees rescued from grossly overloaded sailboats and repatriated.[115]
07/94	Haitian freighter	Off Haiti	Political unrest	516 refugees	USCGCs *Northland* and *Decisive* intercepted freighter. A total of 516 were evacuated and repatriated.[116]
06/95	*M/V Fang Ming*	600 miles south of San Diego, CA	Illegal immigration	95 persons, 11 crew	USCGCs *Tybee* and *Long Island* involved.[117]
11/26/96	Haitian freighter	Off Haiti	Political unrest	581 refugees	Vessel spotted by USCG HC-130. Several USCG cutters responded and evacuated refugees.[118]
08/27/98	*F/V Chih Yung*	Mexico		170 illegal immigrants	USCGC *Munro* interdicted vessel.[119]
12/06/99	*F/V Wing Fung Lung*	Off the coast of Guatemala		250 Chinese immigrants	USCGC *Munro* interdicted vessel. Migrants jumped into water and were pulled to safety. Migrants onboard vessel became rebellious and a threat to USCG crew members. An attempt to scuttle the vessel was thwarted.[120]
02/04	13 Haitian boats intercepted	Windward Passage	Political unrest	531 refugees	USCGCs *Valiant* and *Nantucket* repatriated refugees.[121]

3.7 MISCELLANEOUS INCIDENTS INVOLVING MARINE RESCUE AND EVACUATION

In addition to the incidents described above, the USCG might be asked to respond to other incidents that occur on shore, on the waterfront, and in the USCG's area of operation, if rescue and evacuation are required. Several examples are presented in Table 9. Two of these involved the rescue of individuals from ice floes in the Great Lakes; two involved damage to and/or collapse of waterfront buildings; one involved a hotel fire; and one involved the 9/11 terrorist attack on the World Trade Center.

The USCG responded to all of these incidents, providing rescue, recovery, and/or evacuation services. Most cases involved close cooperation between USCG and local first-response agencies. The ice rescues were accomplished using small boats, ice skiffs, and a police helicopter. For the other incidents, the USCG provided either waterside access to the scene via cutters and small boats, or vertical evacuation using helicopters. The response to the attacks on the World Trade Center was unique in that it required supervising the evacuation of hundreds of thousands of individuals from lower Manhattan, while securing the port against additional terrorist attacks.

The worst-case scenario for this type of MRO is probably an accidental or deliberate fire and explosion at a waterfront facility, requiring the rescue of individuals who might have been thrown or have jumped into the water, along with the evacuation of a large number of individuals from the surrounding area. Potential fatalities might exceed 100. A rapid response coordinated with local first-responders would be required for success.

Table 9. Miscellaneous Incidents involving USCG Rescue and Evacuation

Date	Incident	Location	Cause	Population affected Fatalities/Rescues	Circumstances/Response
02/24/64	Ice rescue	Camp Perry, OH St. Clair, MI	Ice floe adrift	30 rescued	Rescued by USCG ice skiff and police helicopter.[122]
12/31/86	Dupont Plaza Hotel Fire	San Juan, PR	Fire: arson	98 fatalities 140 injuries	USCG HH-65 and Navy helicopters evacuated individuals from the roof.[123, 124, 125]
12/14/96	Riverwalk Mall	New Orleans, LA	Allision by vessel	0 fatalities 58 injured, 4 seriously	The *M/V Bright Field,* after losing power and steering control, collided with the Riverwalk Mall, causing extensive damage. The vessel narrowly missed the casino ship *M/V Queen of New Orleans*.[126]
12/29/98	Ice rescue on Lake St. Clair	Lake St. Clair, MI	Ice floe adrift	17 people involved, all rescued	Ice fishing party trapped on drifting ice floe during sudden storm. USCG and local responders rescued party using small boats and ice skiffs.[127]
05/19/2000	Pier collapse	Delaware River, Philadelphia, PA	Structural failure	3 fatalities 37 injuries	A pier collapsed on the Delaware River throwing 40 people in a nightclub on the pier into the water. All but three individuals were rescued and treated. USCG participated in search and recovery following the incident.[128, 129]
09/11/01	World Trade Center attack	Manhattan, NY	Terrorist action	Potentially 1 million affected	Tens of thousands evacuated from lower Manhattan. Several USCG cutters aided in evacuation and traffic management. USCG secured waterways in vicinity.[130, 131]

4 MRO WORKSHOP USING THE RBDM PROCESS

This section describes the processes used to identify and rank mass-rescue situations by level of risk, assess the USCG's ability to mitigate the risk, identify areas of concern that could hamper a successful response, and to rank situations for potential USCG investment. To accomplish these processes, the USCG R&DC hosted a one-day workshop on MROs. Participants included city and state emergency-management officials and first responders, as well as planning and response officials from the aviation and port communities. USCG participants with expertise in SAR and passenger-vessel safety represented Districts 5, 7, 8, 13, and 17; the Office of Search and Rescue, Mass Rescue Program; and the R&DC. ABS Consulting facilitated the risk-based decision-making prioritization of MRO scenarios.

The risk ranking was accomplished with the aid of a relative-ranking/risk-indexing tool developed to support RBDM. The primary output of the workshop was a completed relative-ranking/risk-indexing matrix and score sheet, with documentation on how the various risk values were assigned. In addition, policy and technology areas of concern that might lead to an unsuccessful response were noted. The processes and results are described in the following sections.

4.1 SCENARIO DEVELOPMENT

Workshop participants considered scenarios reflecting the breadth of mass-rescue situations (as defined by the IMO) that the USCG has responded to in the past or might be requested to respond to in the future as identified in the historical review. This approach engendered a discussion on how many people had to be in distress in order to constitute an MRO. In the case of a small-boat station, a situation with 10 people in distress could become an MRO. Thus, the number of people required to be in distress to make a situation an MRO depends on the resources of the local rescue organizations.

Participants discussed examples of past MROs and developed a list of scenarios and associated characteristics and constraints (Table 10). During the analysis process, it was decided that scenario A (Large vessel or offshore rig sinks; passengers and crew must be located and rescued) should be split into A1 (vessels) and A2 (offshore rigs), because vessels and offshore rigs have different mass-rescue characteristics (populations and lifesaving resources). It was also decided that scenario B (Major casualty aboard vessel requires evacuation) should be split into B1 (larger cruise ships) and B2 (smaller domestic passenger vessels), because cruise ships have different requirements for lifesaving equipment than do domestic small passenger vessels.

In addition to rescue, related response actions could include the following:

- Hazard mitigation
- Damage-control and salvage operations
- Pollution control
- Complex traffic management (marine, aviation, vehicle, etc.)
- Large-scale logistics
- ICS setup

- Communications
- Medical and coroner functions
- Accident/incident investigation
- Law-enforcement actions
- Customs and immigration activities
- Victim/survivor/rescuer accountability
- Intense interest/interaction with the media and public (including with the relatives of victims)
- Assistance to families and survivors

The importance of preplanning was stressed, particularly with respect to communications and resources involving multiple agencies and organizations.

Table 10. Summary of MRO Scenarios and their Characteristics

SCENARIO	CHARACTERISTICS	CHALLENGES AND CONSTRAINTS
A1 Large vessel (for example, cruise ship) sinks, passengers and crew must be located and rescued	• Large number of individuals might be in lifeboats/rafts and/or in the water • Lifeboats might not be deployed	• The population of a cruise ship or gaming vessel might include many elderly people • Events can occur a significant distance offshore • Remote areas are an issue – for example, in the recent "Semester at Sea" incident, the ship was outside of normal shipping lanes, a long way from potential rescuers[132] • Cold water could cause hypothermia • Boats and people might disperse from initial location requiring extensive SAR effort • The involvement of Good Samaritans in a rescue effort requires coordination • The presence of hazardous materials (HAZMAT) due to a spill of a vessel's fuel is possible The focus has been on getting people over the rail rather than on what happens when they get there. How do you get them out of the rafts or out of the water?
A2 Rig sinks; crew must be located and rescued	• Large number of individuals might be in lifeboats/rafts and/or in the water • Lifeboats might not be deployed	• Rigs can be located a significant distance offshore • Rigs in areas where the USCG has rescue responsibility can be at a long distance from USCG resource assets. Deepwater developments in the Gulf of Mexico will make this issue worse. • Cold water could cause hypothermia • Boats and people might disperse from initial location requiring extensive SAR effort • The involvement of Good Samaritans in a rescue effort requires coordination • The presence of HAZMAT due to a spill from rig production or inventory is possible *Differences from scenario A1:* • Rig population is smaller • Rigs would normally be staffed by personnel in relatively good physical condition and trained for emergencies • Rigs are equipped for 100% lifesaving (boats/rafts), and the industry places a lot of emphasis on not depending on USCG assets (for example, use of offshore supply vessels and other boats supporting the rig to rescue crew)[133]

Table 10 (cont'd). **Summary of MRO Scenarios and their Characteristics**

SCENARIO	CHARACTERISTICS	CHALLENGES AND CONSTRAINTS
B1 Major casualty aboard cruise ship requires evacuation	• Large number of people might be onboard, in lifeboats/rafts, and/or in the water • Crew might remain aboard but need assistance dealing with casualty • Location is known but might be far offshore	*Example*: Fire severe enough to require evacuation • The population of a cruise ship might include many elderly people • People might be in the water, although cruise vessels should have adequate lifeboats and rafts • People might be trapped inside the vessel
B2 Domestic passenger vessel requires evacuation	• Large number of people might be onboard, in lifeboats/rafts, and/or in the water • Crew might remain aboard but need assistance dealing with casualty • Not as likely as cruise vessel to be a long way from shore	• The population of a gaming vessel might include many elderly people • People might be in the water (Subchapter K boats generally have no lifeboats; lifejackets might be the only lifesaving equipment available). How do you get survivors out of the water when there are no rafts on the vessel? • People might be trapped inside the vessel • Location might be inaccessible (In the western rivers, a smaller domestic passenger vessel could go up onto a bank at a location remote from road access in an area with few resources. The scenario could involve a collision with a chemical or oil barge.)
C Airliner crash requiring passenger extrication and water rescue	• Large number of people involved • Crash might occur in shallow water	• Some individuals might be trapped in plane • Shallow water environment might complicate access (availability of appropriate resources for shallow water was cited as a big issue) • Might be far from USCG assets • Cold water and HAZMAT might be present • While concern was expressed that evacuation slides/rafts on large new airplanes might not have sufficient capacity for all passengers, such capacity is currently required.[134, 135] • Degree of airport preparedness, organization, and resources varies.
D Natural disaster requiring air, land, sea rescue	• USCG not primary response agency, other agencies involved • Large number of people requiring rescue might be dispersed over wide area • Shallow-water SAR involved	• Coordination is key, and it is most challenging; focus on ICS and National Incident Management System (NIMS) • Support has to be preprogrammed to come from outside • First responders might also be victims, and planners with the most knowledge might be unavailable • Not necessarily near USCG assets • USCG infrastructure might be disabled • There might be federal mandates for pet recovery

Table 10 (cont'd). Summary of MRO Scenarios and their Characteristics

SCENARIO	CHARACTERISTICS	CHALLENGES AND CONSTRAINTS
E Rescue and interdiction of large number of refugees/illegal immigrants	• Overall operation is not primarily mass rescue; assumed that some rescues are required as part of interdiction activity • Large number of individuals might be in water or in multiple disabled boats	• Language barrier might exist • Individuals might be uncooperative (might not want to be rescued) • Political considerations might be an issue • Might need to rescue but restrict access to shore • Need to screen individuals for security risk
F Waterborne evacuation necessitated by large-scale terrorist action, industrial accident, natural disaster, or nuclear/ biological incident	• Operation is less rescue and more evacuation; assumed some people not evacuated would suffer fatalities • USCG might act as coordinator vs. primary evacuator	• Could include vertical rescue (for example, Dupont Plaza Hotel fire in San Juan, PR) • Infrastructure to ensure coordination is key • USCG might have to deal with cause of evacuation as well as evacuation
G Rescue of people from collapsed or burning waterfront building or facility	• Waterside rescue is easiest or required • Generally not a USCG role, but USCG vessels and aircraft might be involved	*Example:* the collapse on the Delaware River of an industrial pier that contained a night club; people were thrown into the water *Example:* the helicopter rescue at the Dupont Plaza Hotel in Puerto Rico • Preplanning is key, and plans are useless unless they are exercised. Interoperability of communications is required. Types of resources available need to be known. • People might be trapped in rubble or trapped on rooftop
H Rescue of individuals stranded on ice floe or on a ship beset in the ice	• Icebreaking or ice access required	• Possibly remote location (high Arctic or Antarctic) (The Arctic is quickly becoming international, and aircraft use polar routes. A forced landing on ice is a possibility.) • Exposure is a concern • Might have time to drop supplies *Examples*: ice fishing party stranded on ice floe in District 9, ferry trapped in ice in District 1
I Rescue of individuals necessitated by bridge collapse or train derailment	• Large number of people might be involved, many with injuries	• Extrication from vehicles and rail cars might be required • Vehicles or rail cars might be under water • Environmental considerations might include snakes and alligators

Table 10 (cont'd). Summary of MRO Scenarios and their Characteristics

SCENARIO	CHARACTERISTICS	CHALLENGES AND CONSTRAINTS
J Rescue of large number of people from flooded (or flooding) tunnel or other need for rescue	• Typically not a USCG role • Scenario includes any below-grade rescues (not just tunnels)	• Might involve confined space • Might require moving equipment below grade • Might require access through tunnel itself via small craft • Might require waterborne evacuation of individuals via tunnel ventilation system • Communications are degraded
K Small MRO (above local capability)	• Event is large enough to overwhelm local assets, but might be as few as 5 or 8 persons to rescue • Event can happen anywhere there are maritime activities (for example, recreational boating)	• Locating a small vessel (search) can be the initial challenge • Capability to rescue varies by location

4.2 RBDM METHODOLOGY

The R&DC project team considered various tools for measuring risk: a causal factors analysis, an event tree, and relative ranking/risk indexing. For the results desired, and the scoping level involved, relative ranking/risk indexing was selected as the most appropriate tool.

Workshop participants ranked the scenarios using historical information and their knowledge and intuition of current MRO situations and USCG preparedness to deal with these situations. Participants needed to determine what could go wrong, its likelihood, and the potential impacts of USCG response efforts in a reasonable worst-case situation.

Steps Performed in the Risk Review

Using the scenarios in Table 10, the participants performed the following steps. The outcome of each step is documented in the results (Section 4.3).

Step 1: Assigned a frequency category (Figure 1) to the scenario that reflected the likelihood such a scenario would occur in the USCG's area of responsibility.

Frequency Category	Description
High	More often than once per year
Medium	Once per year to once in 10 years
Low	Once in 10 years to once in 100 years
Very Low	Less than 1 event in 100 years

Figure 1. Frequency Categories

Step 2: Assigned a consequence category (Figure 2) to the scenario that reflected the expected level of fatalities if an effective external rescue by USCG or other available assets did not occur.

Consequence Category	Description
Low	50 to 150 potential fatalities
Medium	More than 150 to 1,500 potential fatalities
High	More than 1,500 potential fatalities

Figure 2. Consequence Categories

Step 3: Assigned a risk ranking to the scenario, using the indices (1 to 10) defined in Figure 3. These indices reflect an aversion to high-consequence events; that is, at equivalent risk levels, higher-consequence events generally receive a higher risk index.

Frequency			Consequence (Potential Fatalities If Not Rescued)		
Time between Events	**Frequency (events per year)**	**Frequency Category**	**Low (50-150)**	**Medium (>150-1500)**	**High (> 1500)**
Less than a year	More than 1	High	**7**	**10**	**10**
Once per year to once in 10 years	0.1 to 1	Medium	**4**	**8**	**10**
Once in 10 years to once in 100 years	0.01 to 0.1	Low	**2**	**5**	**9**
Less than once in 100 years	<0.01	Very Low	**1**	**3**	**6**

Figure 3. Mass Rescue Risk Index

Step 4: Assigned a rescue index (Figure 4) to each scenario, reflecting the likelihood an effective rescue would be mounted. The rescue could be performed by the USCG, or by a combination of USCG assets and other local agencies, Department of Defense (DoD) assets, and Good Samaritan resources.

Rescue Index	Likelihood of Achieving an Effective Rescue
10	Less than 10%
9	10 to 20%
8	20 to 30%
7	30 to 40%
6	40 to 50%
5	50 to 60%
4	60 to 70%
3	70 to 80%
2	80 to 90%
1	> 90%

Figure 4. Rescue Likelihood Categories

Step 5: Placed each scenario into the risk/rescue matrix (Section 4.3.2). This matrix reflects a combination of the scenario risk and the rescue-likelihood assignments made by the workshop participants.

Step 6: Assigned a sequential priority ranking for each scenario on the basis of the overall information discussed in the workshop. This information includes estimated risk, rescue likelihood, and the other factors reflected in Table 10.

The priority ranking is the preliminary input toward identifying scenarios the USCG R&DC should examine for potential mass-rescue research efforts.

4.3 RBDM PROCESS RESULTS

For each of the MRO scenarios considered by workshop participants, Table 11 shows the value assigned for frequency (based on the definitions in Figure 1), and for consequence (based on the definitions in Figure 2). It also shows the resulting risk index (derived from Figure 3), and the assigned rescue index (based on the definitions in Figure 4).

Table 11. Scenario Frequency, Consequence, Risk, and Likelihood of Rescue Summary

Scenario		Frequency	Consequence	Risk Index	Rescue Index
A1	Large vessel sinks, passengers and crew must be located and rescued	L	H	9	8
A2	Rig sinks; crew must be located and rescued	M to L	L	2 to 4	3
B1	Major casualty aboard cruise ship requires evacuation	M	M	8	3
B2	Domestic passenger vessel requires evacuation	M	M	8	5 to 6
C	Airliner crash requiring passenger extrication and water rescue	M	L to M	4 to 8	5
D	Natural disaster requiring air, land, sea rescue	M to H	M	8 to 10	2
E	Rescue and interdiction of large number of refugees/illegal immigrants	L to M	M	5 to 8	3 to 4
F	Waterborne evacuation necessitated by large-scale terrorist action, industrial accident, natural disaster, or nuclear/biological incident	L	L to M	2 to 5	2
G	Rescue of people from collapsed or burning waterfront building or facility	L	M	5	5 to 6
H	Rescue of individuals stranded on ice floe or on a ship beset in the ice	L	L	2	2 to 3
I	Rescue of individuals necessitated by bridge collapse or train derailment	M	L	4	6 to 7
J	Rescue of large number of people from flooded (or flooding) tunnel or other need for rescue	L	L	2	10
K	Small MRO (above local capability)	H	L (very low)	7	1 to 2

The discussions that led to the assignment of the values in Table 11 are outlined below.

4.3.1 FACTORS CONSIDERED AND ASSUMPTIONS MADE DURING THE RBDM PROCESS

Defining 'an effective rescue' generated much discussion. The need for an organization-wide definition of "best response" for SAR, and the Commandant's measurement of SAR success (93 percent of personnel rescued), were mentioned; however, it was decided that defining an effective response for MROs was another USCG Headquarters (HQ)/R&DC effort unto itself. In the interest of time, the workshop participants decided not to precisely define effective rescue. In making assessments, team members used their own understanding of what constitutes ‘an effective rescue’.

During the RBDM risk-ranking process, the workshop participants examined each MRO scenario at length, discussing the various factors that might affect frequency, consequences, and the potential for success in rescue operations, and making assumptions where necessary to move the process forward. These discussions are captured in some detail below. They are important in that they reflect the collective experience and insight of the group for each scenario, and are perhaps more significant that the numerical risk-ranking values that were produced.

A1 – Large vessel sinks; passengers and crew must be located and rescued. The frequency for this scenario would depend on the weather and on the level of activity (expected to increase). For cruise vessels, the frequency was judged to be relatively low (perhaps once in 100 years).

Consequences would depend on the weather and the water temperature (considered to be cold-weather conditions north of Cape Hatteras), the size of the cruise ship, and its remoteness: adventure cruises, for example. The incident itself might cause most of the casualties. Depending on the type of incident that causes the vessel to sink, there might be insufficient time to launch lifeboats or to don lifejackets. The consequence level was judged to be high, more than 1,500 potential fatalities if there is no rescue, due to the number of people involved and the potential age of the population. Also, while the passengers might be able to get into lifeboats or rafts, the problem of rescuing them from the rafts remains. Planned mutual aid from another ship is a mitigating factor in some areas; however, if the rescue procedures have not been practiced, its effectiveness might be questionable.

A rescue index of 8 was selected, representing a 20% to 30% chance of achieving an effective rescue, on the assumption that one in five rescues would be effective.

A2 – Rig sinks; crew must be located and rescued. The frequency of this scenario would depend on the weather, the level of activity, new designs, and the placement of rigs in deeper water. A move toward less dependency on foreign oil, and the new oil deposit discoveries in the Gulf of Mexico, indicate that the level of activity will increase. Also, other countries are drilling offshore right up to the U.S. EEZ (exclusive economic zone). While rigs off the U.S. coast represent a small part of the world’s rigs, the worldwide experience indicates the potential for incidents. The frequency was estimated at once in 10 years, which is the dividing line between medium and low frequency.

Consequences would depend on the weather, the water temperature, and the distance from shore. For offshore rigs, the consequences were estimated to be low (50 to 150 fatalities if there is no rescue) due to the smaller number of people present, their relatively young age, and the training they receive. The likelihood of achieving an effective rescue was estimated to be 70% to 80%, which is represented in Table 11 by a rescue index of 3. Getting rescue resources on scene in deep-water drilling locations, however, remains a problem.

B1 - Major casualty aboard cruise ship requires evacuation. The difference between this scenario and scenario A1 (sinking vessel) is the additional time available to effect a rescue. Therefore, the likelihood of getting passengers and crew into rafts is higher than for a sinking vessel. Additional problems arise, however, if the cruise ship is far from SAR assets and from shipping lanes. Experience in these types of situations has been good, but luck can't be discounted.

Frequency of occurrence was estimated to be once in 10 years (medium), with hundreds of fatalities if there is no rescue (medium consequence). Effective rescue should occur 70% to 80% of the time (a rescue index of 3).

B2 – Domestic passenger vessel requires evacuation. Domestic passenger vessels (gaming boats, ferries, etc.) have less training for passengers than do cruise vessels (verbal discussion versus practicing donning lifejackets). The vessels might be minimally crewed and equipped, and the crew might be less experienced and have less training than cruise-ship crews have. Areas of operation tend not to be as remote, although remote areas on western rivers were cited previously in the scenario development. Lack of mutual aid in areas where other vessels are not available would be a problem.

For the domestic passenger vessels, a mishap of this type is expected to occur with medium frequency (once per year to once in 10 years), with medium consequences (150 to 1,500 fatalities if there is no rescue), resulting in a risk index of 8. The rescue index would be 5 to 6, representing a 40% to 60% chance of achieving an effective rescue.

C – Airliner crash requiring passenger extrication and water rescue. Frequency can be annually for planes with six to eight people, but for larger planes it is more likely to be once every five to ten years. Thus, the frequency category would be medium, and the consequence would be hundreds of fatalities if there is no rescue (the low end of medium). Rescue is highly location dependent. Some airports are equipped and have plans in place to call on the collective assets of the community; other airports are far from assets. If a plane goes off a runway into shallow water, access might be difficult.

D – Natural disaster requiring air, land, sea rescue. These incidents occur annually (flooding in Houston has occurred twice in the past five years), and will increase in the future because cities are close to the water, are overbuilt, and have inadequate provisions for flood control, particularly in older sections. There is a danger that the experience of Hurricane Katrina will cause all planning for natural disasters (an earthquake, for example) to be done with a Katrina mindset (in other words, the workshop members agreed that the USCG would not necessarily be the primary response agency).

The frequency was estimated to be medium to high, and the consequences with no rescue to be medium, giving a risk index of 8 to 10. A rescue index of 2, representing an 80% to 90% likelihood of achieving an effective rescue, was selected because, despite the fact that the natural disasters are all different, rescues historically have been rather effective.

E – Rescue and interdiction of large number of refugees/illegal immigrants. The frequency of large-scale migrations is low to medium, but the potential consequences were initially judged to be high, due to the number of people involved. There is a lack of fatality data: the numbers interdicted are known, but the numbers who avoid interdiction or are lost at sea are not known. Interdiction occurs continually, while rescues occur only periodically. When the consequence estimate was applied only to *rescues* occurring during interdiction, not to interdictions, it was reduced to medium. It was felt that the historical experience is low consequence, but that the potential is for medium consequence. The rescue index range selected was 3 to 4, representing a 60% to 80% possibility of achieving an effective rescue.

Throwing lifejackets to a vessel in trouble can have a paradoxical effect: Passengers rushing to one side of the boat can threaten its stability. The same problem is likely when using life rafts.

Other issues, such as the need to deal with immigration and customs controls, might arise in this scenario. The types of vessels might vary from commercial vessels to inner tubes and rafts, depending on the country of origin of the migrants.

F – Waterborne evacuation necessitated by large-scale terrorist action, industrial accident, natural disaster, or nuclear/biological incident. This scenario was determined to be an outlier, because it primarily involves evacuation rather than rescue. Interagency coordination would be 90% of the issue, and success would depend on exercising and maintaining connectivity of the organizations.

The frequency of this type of event was judged to be in the upper range of the low category, while the consequences were judged be low to medium, giving a risk index of 2 to 5. The rescue index was difficult to assess, because the actual incident might not be a USCG responsibility; however, if there were a request or a need, the USCG would help. The USCG could become task-force commander of boats, as in the World Trade Center tragedy, where USCG and Good Samaritans evacuated a large number of people from lower Manhattan by boat. Additionally, in the case of a hazardous environment (chemical, biological, radiological, nuclear, or explosive), USCG personnel and Good Samaritans without protective gear would not be sent near the incident. The decision in the workshop was to judge the rescue index for getting people out of an area that was not a hot spot but that could endanger the potential evacuees if they stayed. The likelihood of achieving an effective rescue/evacuation in this situation was estimated as 80% to 90%.

G – Rescue of people from collapsed or burning waterfront building or facility. When waterfront incidents occur, the USCG might have the only resources with the water-rescue capability needed. Helicopters have been used for vertical extrication from burning buildings, and USCG assets have been used to rescue people from the water following a pier collapse. This type of incident was estimated to occur once in ten years or less (low frequency) with medium consequences (150 to 1,500 fatalities possible if there is no rescue). The rescue index was selected as 5 to 6, representing a 40% to 60% chance of achieving an effective rescue.

H – Rescue of individuals stranded on an ice floe or on a ship beset in ice. While this incident occurs primarily in District 9, other occurrences were noted. After the Air Florida Flight 90 incident, Reagan National Airport bought airboats that can navigate in ice; however, when equipment is purchased in response to a specific event, there is a danger that it will not be maintained. Technology, equipment, and training are available for dealing with these scenarios, but problems arise when local capability is overwhelmed. Both frequency and consequence were estimated to be low, with a likelihood of effective rescue of 70% to 90% (a rescue index of 2 to 3).

I – Rescue of individuals necessitated by a bridge collapse or train derailment. Frequency of this type of incident was estimated to be medium (once in 10 years or less), while the consequences would likely be low (50 to 150 people). People might be trapped in cars (for example, the AMTRAK Sunset Limited train wreck in Alabama), which would make rescue difficult, perhaps an index of 6 to 7, representing a 30% to 50% possibility of effective rescue.

J - Rescue of large number of people from a flooded (or flooding) tunnel or other need for rescue. In discussing this type of incident, participants determined that it would most likely not be a USCG responsibility (although the USCG would respond if requested). Also, this scenario would probably result in a recovery effort rather than in a rescue effort. The frequency and consequence were assessed to be low, and the possibility of an effective rescue was assessed to be less than 10% (a rescue index of 10).

K – A small MRO (above local capability). This scenario occurs with high frequency, annually in some Sectors. Local resources being overwhelmed, versus a large number of people being at risk, is what makes this an MRO. Thus, the consequences might be very low. Rescue results historically are good, and the rescue index was determined to be 1 to 2, representing an 80% to greater than a 90% possibility of effective rescue.

4.3.2 Relative Ranking of the MRO Scenarios in the RBDM Process

Based on the discussions described above, and on the index values selected for overall risk and likelihood of rescue, the various scenarios can be grouped and graphically presented to portray the relative severity of each. The values assigned to each scenario for frequency and consequence (Table 11) determine where the scenario appears in the risk matrix shown in Figure 5.

	Consequence Category (Potential fatalities if not rescued)		
Frequency Category	**Low**	**Medium**	**High**
High	K	D	
Medium	A2, C, I	B1, B2, C, D, E	
Low	A2, F, H, J	E, F, G	A1

Figure 5. Risk Matrix

Figure 5 shows the scenarios from Table 11 in a traditional risk matrix, with each scenario plotted by its frequency-consequence assignment. Some scenario letters appear in more than one box, because the team assigned more than one potential frequency to these scenarios.

Note: Figure 5 was not used during the workshop; it was constructed in a subsequent analysis by the project team.

An alternative plotting scheme for the risk-index and rescue-index values from Table 11, for each scenario, produces the risk-rescue diagram shown in Figure 6.

MASS RESCUE RISK INDEX		1	2	3	4	5	6	7	8	9	10
High Risk	10		D								
	9		D						A1		
	8		D	B1, E	E	B2, C	B2				
	7	K	K	E	E	C					
	6			E	E	C					
	5		F	E	E	C, G	G				
	4		F	A2		C	I	I			
	3		F	A2							
	2		F, H	A2, H							J
Low Risk	1										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
		High									**Low**
		RESCUE INDEX									

Figure 6. Risk-Rescue Diagram

4.3.3 Discussion of RBDM Risk-Ranking Results

In Figure 6, the events with the highest risk, and the lowest likelihood of rescue, appear in the upper right corner. Closest to this location is scenario A1 (large vessel sinks): Large numbers of people and limited time to rescue them, coupled with the frequency, yielded a risk index of 9, while the likelihood of effective rescue was judged to be low. Participants agreed that this scenario was the most important for rescue. After scenario A1 on Figure 6, scenario B2 (passenger-vessel casualty) was assessed as having the next highest priority.

In contrast, scenarios with the lowest risk, and the greatest likelihood of rescue, appear in the lower left corner. Scenarios H (ice rescue), F (waterborne evacuation), and A2 (offshore-rig casualty) are located closest to this corner. Scenario H had low numbers of people involved, and limited areas with exposure. Scenario F (waterborne evacuation) was considered more likely to involve an evacuation versus a rescue operation. Although the frequency of scenario A2 is expected to rise, it involves a well-trained and well-equipped crew.

Scenarios D (natural disaster) and E (refugees/illegal immigrant interdiction) are high risk, but rescue efforts are generally effective. In scenario B1 (cruise-ship casualty), rescue is likely to be effective, because the passengers generally have some ability to wait until help arrives. Scenario C (aircraft crash) generally has lower consequences than does a passenger-vessel casualty, and rescue effectiveness is similar to scenario G (waterfront facility). For scenario I (train derailment), immediate rescue from the train or from the water by first responders is not likely to be highly effective. (For example, in the case of the Sunset Limited, first responders had difficulty determining where the derailment had occurred and difficulty reaching the remote area. Passengers rescued each other from the train; first responders then removed the passengers from the scene.) Rescue is even less likely for scenario J (tunnel/below grade evacuation/rescue). Scenario K (small MRO) has the highest frequency but a fairly low consequence. Rescue is estimated to be 80% to 90% effective, even if initial response capabilities are overwhelmed.

4.3.4 Priority Ranking of Scenarios Based on Return of USCG Investment

Following the risk ranking described above, workshop participants considered the question: How would you apportion your R&D dollars if you had X dollars to spend to achieve maximum effectiveness? This exercise was somewhat different from the risk-ranking exercise, in that it involved subjective judgment on how amenable the problems encountered in each scenario were to technological solutions. Although the higher payoff scenarios could be expected to generally correspond to the risk rankings, the relative priority might not be the same.

Participants arrived at the prioritized list shown in Table 12. Participants thought scenario B2 (domestic passenger vessel) offered the biggest payoff. Solutions for addressing scenario B2 might help somewhat in addressing scenario A1 (large passenger vessel) and scenario E (refugees/illegal immigrants) as well. The consensus was that the priority for spending money should be in getting people out of the water, or in evacuating them from a vessel before it had to be abandoned.

Table 12. Scenario Ranking for USCG Investment

#	Scenario	Ranking
B2	Domestic passenger vessel requires evacuation	1 (tie)
A1	Large vessel sinks, passengers and crew must be located and rescued	1 (tie)
D	Natural disaster requiring air, land, sea rescue	3
B1	Major casualty aboard cruise ship requires evacuation	4 (tie)
E	Rescue and interdiction of large number of refugees/illegal immigrants	4 (tie)
C	Airliner crash requiring passenger extrication and water rescue	6
G	Rescue of people from collapsed or burning waterfront building or facility	7
I	Rescue of individuals necessitated by bridge collapse or train derailment	8 (tie)
K	Small MRO (above local capability)	8 (tie)
A2	Rig sinks; crew must be located and rescued	10
F	Waterborne evacuation necessitated by large-scale terrorist action, industrial accident, natural disaster, or nuclear/biological incident	11
H	Rescue of individuals stranded on ice floe or on a ship beset in the ice	12
J	Rescue of large number of people from flooded (or flooding) tunnel or other need for rescue	13

4.3.5 Issues and Needs Identified in the MRO Workshop

During the MRO workshop discussions, the participants identified various issues and needs regarding the problems associated with MROs, and the USCG's ability to respond to MROs. These issues and needs, which reflected the general knowledge and experience of the participants, were not researched prior to the workshop or verified following it; therefore, they are presented here simply as areas of concern potentially warranting further consideration. They can be categorized as either policy related (involving regulatory requirements, procedures, and resource levels) or technology based (involving the availability and effectiveness of equipment and systems).

POLICY-BASED ISSUES AND NEEDS

Domestic Small Passenger Vessels

- Current lifesaving-equipment regulations are inadequate for domestic small passenger vessels. Vessels in this class are not required to have life rafts/lifeboats that would enable people to abandon ship without entering the water. In addition, depending on the type of vessel, number of passengers, and operating environment, certain domestic small passenger vessels might have less than 100% life-saving capacity. (Lifesaving-equipment requirements for these vessels are specified in 46 CFR Subchapters K and T.)
- Training for domestic small passenger vessels needs to be upgraded. Toward this end, industry needs to be educated concerning the advantages of training their crews. These needs are particularly true for crews on Subchapter K vessels.
- In District 13, domestic passenger vessels operating in breaking-bar conditions are not required to ensure that passengers wear personal flotation devices (PFDs). Wearing PFDs should be required by regulation. The situation was likened to airlines requiring passengers to wear seatbelts during takeoffs and landings.
- It might be assumed that a domestic passenger vessel in a river or near shore could run up onto a bank or shore and thereby avoid the need to abandon ship. This assumption ignores those situations that could prevent the vessel from reaching shallow water (for example, collision in the channel). This situation, which could result in people in the water, needs to be considered in MRO contingency planning for domestic vessels.

Offshore MROs

- For casualties involving large numbers of persons offshore, there is a need to provide a stable environment away from a vessel or oil rig until augmented rescue assets can arrive. An example given was using stockpiled air-deployable rafts that activate hydrostatically. For refugee/migrant rescue, easily deployable rafts are desirable; however, distributing these to USCG rescue assets could be a problem. It would be expensive to have them on all cutters in the region, and the service life is five years. Even when rafts are procured, there have been problems obtaining funds for maintenance and replacement. If rafts are put on HH-65 helicopters, which can carry two of them, other equipment might need to be removed. Also, their use could cause a refugee vessel to capsize, if all the occupants of the vessel aggregated on one side.

Offshore Rigs

- Planning for deepwater MROs on offshore rigs might require additional regulation, access to the offshore supply vessel (OSV) fleet, and coordination with individual rig operators.[136] Lifesaving equipment required on offshore rigs is specified in 33 CFR Part 144. The requirement for rig-evacuation plans is specified in 33 CFR 146. Workshop participants indicated that the offshore oil industry strives to be proactive in planning for rig evacuation and has resources to provide for crew safety. However, if industry resources are inadequate, the USCG would undoubtedly be called upon to render assistance.

Small MROs

- For the small MRO scenario, the needs are location-specific. Continued planning, coordination, and exercises would be needed.

Contingency Planning and Exercises

- Workshop participants recognized the value of contingency planning and exercises consistent with the guidance in the IMO Guidelines and the CGADD. Follow-up discussions with SAR Program and Passenger Vessel Safety Specialist (PVSS) personnel at the District and Sector level, after the workshop, indicate that MRO exercises have already been conducted. Conversations with personnel in District 1[137, 138] indicate that rescue drills and tabletop exercises in District 1 are focusing on ferry and tour-boat casualties (scenarios B2 and A1). Conversations with the PVSS coordinator in District 5[139] indicate that a recent tabletop exercise (Little Creek Exercise) focused on a gaming-vessel casualty (scenario B2). Participants at the workshop indicated that additional MRO drills are already planned for Boston, Oregon, and Puget Sound.
- Workshop participants expressed concern that the ownership and funding of exercises need to be clarified. (Does District, Area, or USCG HQ have the lead role?)
- Exercises must include the widest range of industry (for example cruise lines and ferry companies) and other agency participation. This will ensure enhanced preparedness, buy-in, and awareness of potential issues, e.g., communications interoperability.

Regulations

- In areas without response capability, survival equipment should be required rather than left to the judgment of the vessel operator. For example, small deep-sea fishing vessels that venture a significant distance offshore should be required to carry immersion suits (or some form of thermal protective aids) in addition to PFDs.
- The approach in implementing additional regulations is to reduce operator cost while increasing survivability. There has to be a give-and-take that makes it profitable to improve safety as well as improve the ability to rescue passengers (savings to operator in insurance costs, for example).
- Emergency position-indicating radio beacons (EPIRBs) or other types of tracking device – Automatic Identification System (AIS), for example, or Search and Rescue Transponders (SARTs) – are needed to track survival craft (lifeboats and rafts) that drift from the casualty site.

TECHNOLOGY-BASED NEEDS

- An improved deployable buoyant apparatus is needed that can be quickly deployed to and used by persons in the water who might not have flotation.
- Vessels need a better way to retrieve individuals or survival craft (life rafts or lifeboats) from the water. Because of the high freeboard on some vessels, it might be difficult for

persons in the water to climb up a Jacob's ladder, cargo net, or other device hung from the side. This need was mentioned in IMO Radiocommunications and Search and Rescue (COMSAR) Circular 31.

- There is a need to provide a deployable evacuation and rescue device for augmenting onboard equipment (when this is inadequate or unusable), as well as for supplying an evacuation and rescue means where none currently exists. Such a device must facilitate the actual rescue of people from the water.
- Extrication devices are needed to remove individuals trapped in the hull of a capsized or partially submerged vessel (an aquatic Jaws of Life). Complicating issues such as explosive vapors in the hull, heat from the device, and causing the vessel to sink in attempting to gain access need to be considered. Similar technology is used to cut into the holds of capsized oil tankers in order to pump them out. The technology is available, but people would need to be trained.
- Consideration should also be given to an inflation device (like an air bag) to add flotation to a capsized vessel. These devices would be used, not to salvage the vessel, but to facilitate the rescue of people trapped in the hull.

Table 13 correlates issues and needs cited by participants with the MRO scenarios considered in the workshop.

Table 13. Workshop Issues and Needs Correlated with MRO Scenarios

		Policy Issues/Needs											Technology Issues/Needs				
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
	Scenario	Improve survival regs. for domestic pax* vessels	Upgrade industry training for domestic small pax vessels	Require PFDs for dom. pax vsls. going through surf	Realize that grounding might not work (dom pax vsl)	Provide stable environment for evacuees far from shore	Improve planning for deep-water ops on offshore rigs	Improve planning, coord., etc., for small MRO scenario	Emphasize contingency planning and exercises	Consider regulations where assets are unavailable	Reduce operator cost while increasing survivability	Provide tracking capability for survival craft	Improve deployable buoyant apparatus	Improve methods for vsls to retrieve persons in water	Provide a deployable evacuation & rescue device	Obtain extrication capability	Consider flotation for rescues from capsized vsls
A1	Large vessel sinks, passengers and crew must be located and rescued					X			X		X	X	X	X	X		
A2	Rig sinks; crew must be located and rescued					X	X		X	X	X	X	X	X	X		
B1	Major casualty aboard cruise ship requires evacuation					X			X		X	X	X	X	X		
B2	Domestic passenger vessel requires evacuation	X	X	X	X				X	X	X		X		X		
C	Airplane crash requiring passenger extrication and water rescue								X		X		X			X	X
D	Natural disaster requiring air, land, sea rescue								X				X			X	X
E	Rescue and interdiction of large number of refugees/illegal immigrants					X			X		X	X	X	X	X		
F	Waterborne evacuation necessitated by large-scale terrorist action, industrial accident, natural disaster, or nuclear/biological incident								X								
G	Rescue of people from collapsed or burning waterfront building or facility								X								
H	Rescue of individuals stranded on ice floe or on a ship beset in the ice								X								
I	Rescue of individuals necessitated by bridge collapse or train derailment								X				X			X	
J	Rescue of large number of people from flooded (or flooding) tunnel or other need for rescue								X								
K	Small MRO (above local capability)							X	X						X		

* pax = passenger(s)

5 STUDY FINDINGS AND RECOMMENDATIONS

The purpose of this scoping study was to identify the MRO scenarios likely to affect USCG SAR operations into the future, and to provide a high-level overview of the risks and challenges involved in each scenario. From the standpoint of the Coast Guard R&DC, the objective of this study was to identify needs and areas of concern and recommend further initiatives to address them. (The intent was not to define specific programmatic changes or technology-development projects to address specific MRO issues or needs.) The follow-on policy and technology initiatives recommended in this section are based on the MRO historical review and the MRO workshop.

5.1 POLICY INITIATIVES

The following organizational and procedural initiatives pertain to programs supporting the Maritime Safety mission.

- ***Finding:*** Workshop participants expressed concern regarding the MRO preparedness of domestic small passenger vessels (46 CFR Subchapter K, and 46 CFR Subchapter T vessels), specifically in terms of proportionate numbers of trained crew, passenger access to safety briefings, and adequacy of lifesaving equipment. Domestic small passenger vessels are unique in that the requirements regarding lifesaving equipment differ on the basis of the number of passengers carried (Subchapter K: 151 passengers or more; Subchapter T: fewer than 151 passengers), and the distance from shore at which they operate. Although all vessels are required to have PFDs aboard for 100 percent of their passengers, the type and number of survival craft required differs on the basis of operating environment and vessel construction. (Larger passenger vessels over 100 tons operating on international voyages, and subject to SOLAS requirements, fall under 46 CFR Subchapter H, and have stricter requirements for lifesaving equipment.) The participants at the MRO workshop considered incidents involving small and non-SOLAS vessels to be high-risk scenarios, because limited equipment, and a lack of a sufficient number of trained crewmembers, might complicate a vessel evacuation. This concern was consistent with the significant loss of life in recent ferry sinkings in other countries.

  Recommendation: The adequacy of lifesaving procedures, number of trained crew, and equipment for domestic small passenger vessels should be further investigated, in consultation with industry, to determine if improvements in preparedness are needed.

- ***Finding:*** Incidents involving the sinking or evacuation of vessels have occurred in remote areas, particularly in Alaskan waters (for example, *M/V Prinsendam* and *M/V Selendang Ayu*). In the event of a major cruise-ship or other vessel incident far from shore, a crucial component of the response would be the ability to provide on-scene command and control prior to the arrival of USCG cutters or Automated Mutual Assistance Vessel Rescue (AMVER) vessels, which could take several hours.

  Recommendation: The capability to provide on-scene command and control prior to the arrival of USCG cutters or AMVER vessels should be investigated in more detail, and should be considered in MRO planning and exercises.

- ***Finding:*** Although larger passenger vessels (and other large commercial vessels) have adequate lifesaving equipment on board, they might not be able to deploy their lifesaving equipment when they are unstable (listing) or sinking rapidly. This concern was raised during the MRO workshop, and proved particularly problematic in the case of vessels listing (as with the *M/V Cougar Ace*). Also, backup lifesaving equipment might be needed for cases when large passenger vessels must be abandoned in remote locations prior to USCG or AMVER rescue vessels being able to reach them.

Recommendation: Although the USCG has adequate capability to provide resources for sinking incidents involving freighters, tankers, or fishing vessels, the U.S. Coast Guard's current capability to provide high-capacity, rapidly deployable survival platforms should be assessed. This assessment should consider the type and number of platforms available, the logistics of transporting them, and the overall capability to provide the assets on scene in remote areas (for example, in mid-ocean, or in Alaskan waters). In addition, the need for tracking and direct communications capabilities (EPIRBs and SARTs) aboard life rafts should be investigated.

- ***Finding:*** Oil-rig disasters are infrequent in U.S. jurisdiction, and a rig incident was considered a low-risk scenario by workshop participants; however, the increase in oil exploration and production activities farther offshore makes oil-rig rescue in the event of a disaster more challenging.

  Recommendation: The contingency plans and response capabilities of the offshore oil industry should be assessed to determine the level of USCG assistance that might be required in the event of an oil-rig incident far offshore. Discussions with the offshore oil industry, as well as coordinated planning, are required to ensure an adequate response to future oil-rig accidents.

- ***Finding:*** Several scenarios, particularly those dealing with non-maritime transportation modes and situations, indicate a need for close coordination and interoperability with other organizations that deal with rescue and evacuation. Advance contingency planning and joint exercises serve to develop this close coordination and interoperability. In addition, including affected industry components in planning and training activities is important. The need for and the approach to planning and conducting exercises are reflected in the IMO Guidelines, as well as in the CGADD to the NSS. These planning and exercise activities are already underway in a number of USCG Districts and Sectors, as reflected in several exercise plans presented by attendees at the MRO workshop, and in follow-up discussions with SAR program personnel and PVSS program personnel.

  Recommendation: The USCG should integrate the identified scenarios into its exercise program at the District, Sector, and unit level. Vessel and airport operators, first responders, and other local stakeholders should be included in both command center and field exercises to ensure coordination and communication interoperability. The results of these exercises should be widely disseminated within the USCG and transportation/shipping/response communities (via, for example, the Coast Guard Standard After-Action Information Lessons Learned System) in order to pass along lessons learned and highlight specific issues and user needs.

- ***Finding:*** Several of the incidents identified in the historical review (for example, airplane crashes at La Guardia and Logan airports, and the AMTRAK Sunset Limited derailment) have involved injured victims trapped in an airplane fuselage, rail car, or vehicle.

Rescuing victims trapped in submerged or partially submerged aircraft, rail cars, or vehicles requires the proper extrication equipment and training.

Recommendation: Although the USCG focuses primarily on vessel casualties, situations involving air and ground transportation casualties should be included in USCG MRO planning and exercises. The USCG should investigate these scenarios further toward identifying the types of devices and procedures required to safely extricate victims from a plane, rail car, or vehicle. The USCG should determine whether this scenario could be adequately addressed by local first responders transported to the scene, or whether an inherent USCG capability (training and equipment) would be needed.

5.2 TECHNOLOGY INITIATIVES

The technology initiatives recommended in this section involve ascertaining current USCG capabilities, and analyzing existing and potential alternatives or solutions:

- ***Finding:*** The most challenging MRO situation is a rapid abandonment of a large passenger vessel or oil platform far from rescue assets, resulting in a large number of individuals being adrift in lifeboats or in the water (with or without PFDs and/or survival suits). Several of the scenarios ranked as high risk involve this type of casualty, and a number of the issues and needs identified by MRO workshop participants relate to this scenario. In this situation, heavy seas and cold temperatures would make rescue unlikely unless immediate assistance to survivors could be provided.

  Recommendation: The USCG should investigate the availability and adequacy of possible methods for preventing large numbers of people adrift in open water from drowning, developing hypothermia, or dispersing before rescuers can arrive. (One method would involve air-dropping survival platforms and PFDs as an interim measure.) A technology assessment should be conducted to identify innovative devices that focus on ease of deployment, level of protection, ease of entry from a vessel and the water, tracking mechanisms, and ease with which a rescue vessel or aircraft could retrieve evacuees.

- ***Findings:*** As indicated by the historical review and workshop discussions, many rescues, particularly those involving abandoned passenger or refugee vessels, would entail having to retrieve large numbers of people who are injured or who are suffering from hypothermia. Mechanisms currently used for boarding ships, such as Jacob's ladders and cargo nets, would be of only limited use in this regard.

  Recommendation: The USCG should investigate methods and devices for retrieving people who have abandoned ship, including large numbers of people who are impaired. A technology assessment should be conducted to identify innovative equipment and procedures for quickly retrieving incapacitated victims to a rescue vessel or aircraft. Ideally, quickly retrieving incapacitated victims would be accomplished without placing rescue swimmers into the water.

- ***Findings:*** The historical review and the MRO workshop indicated that evacuating large numbers of passengers from a cruise ship or ferry is a scenario of major concern (Scenario B2 received the highest risk ranking). Evacuating large numbers of passengers (including children, the elderly, and individuals not trained in such operations) might pose an even greater risk than the incident requiring the evacuation. Also, transferring individuals from a stricken vessel to a rescue vessel by helicopter can be time consuming and hazardous in bad weather.

Recommendation: The USCG should investigate methods and devices for quickly evacuating large numbers of people from a disabled vessel to a rescue vessel without using small boats or helicopters. A technology assessment should be conducted to identify innovative equipment that would allow deck-to-deck transfers of individuals while protecting them from the environment.

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