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Final Report

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16. Abstract (MAXIMUM 200 WORDS)

Since 2006, the U.S. Coast Guard (CG) Research and Development (R&D) Center (RDC) has worked with the CG Search and Rescue (SAR) program and the network of district Passenger Vessel Safety Specialists (PVSS) to address potential shortcomings in mass rescue operations. In 2007, the RDC completed a Mass Rescue Operations Scoping Study (MROSS) that identified the largest potential response gaps were associated with CG response to significant numbers of survivors from a passenger vessel casualty. The recommendation from that study was to develop equipment or techniques to effect rapid evacuation and rescue of multiple survivors.

This project built on the MROSS by validating the most likely mass rescue incident scenarios based on incidents since 2003, examining response activities (including response gaps), and defining functional requirements of potential response interventions. The project also conducted extensive market research, including a published Request for Information (RFI) and liaison with industry, and determined the potential availability of intervention equipment. The project then revalidated intervention requirements. This report presents the background methodology and results, and lists conclusions and recommendations.

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EXECUTIVE SUMMARY

The Research and Development (R&D) Center (RDC) has been working with the Coast Guard (CG) Search and Rescue (SAR) program and the network of district Passenger Vessel Safety Specialists (PVSS) since 2006 to address potential shortcomings in mass rescue operations. In 2007, the RDC completed a Mass Rescue Operations Scoping Study (MROSS) that identified the largest potential response gaps were associated with CG response to significant numbers of survivors from a passenger vessel casualty. The recommendation from that study was to develop equipment or techniques to effect rapid evacuation and rescue of multiple survivors.

The current project built on the MROSS by validating the most likely mass rescue incident scenarios, examining response activities (including response gaps), and defining functional requirements of potential response interventions. Project personnel also conducted extensive market research, including a Request for Information (RFI) and liaison with industry and other response agencies, and determined the potential availability of intervention equipment. The project team then validated intervention requirements and compared the functional requirements to rescue device characteristics. This report presents the findings and recommendations.

Before validating mass rescue scenarios, the project team reviewed actual mass rescue incident records since 2003, and developed a scenario-response matrix with information about each incident, the number of persons affected, the number of persons rescued (as well as what they were rescued from), rescue resources, rescue activity, degree of success, and rescue gaps/successes, as best determined from the recorded information and interpreted by the project team.

The RDC provided this "Mass Rescue Incident and Response Scenario Matrix" as part of a read-ahead for a Mass Rescue Response Scenario Validation workshop. The project invited a significant cross-section of CG district incident management and PVSS representatives to participate. Workshop participants reviewed the incidents to identify rescue successes and gaps, and then to rank scenario and intervention gaps in order of probability and consequence. From this, workshop participants developed intervention needs and/or functional requirements to address the intervention gaps.

Concurrent work included categorizing and evaluating responses to the RFI. The project team screened the responses for applicability to the functional requirements and developed a Mass Rescue Intervention Data and Equipment Listing. The team also investigated additional sources of rescue-related equipment or devices based on available information, web-search, or other input. In most cases, the equipment description and information provided by the vendors did not address all the functional requirements developed and validated by the workshop participants.

Project personnel also investigated rescue equipment, devices, and procedures in use or being developed by rescue services outside the U.S. This report contains a summary of information presented at the International Maritime Rescue Federation's June 2010 Conference on Mass Rescue at Sea, and observations from a demonstration by the Toronto, ON Police Marine Unit in July 2010. Developments outside the U.S. show that there is a range of possible rescue techniques and devices that warrant attention and review here.

In the development of procedures and devices for maritime mass rescue interventions, there is no "magic bullet." One specific device or procedure will not fit all maritime mass rescue needs. Functional requirements often compete with one another. As an example, a device of weight and size that allows it to be successful deployed from a light helicopter or relatively-small vessel might not have the ability to provide anything but short-term refuge from immersion for a relatively small number of victims. However, the lack of a single solution does not preclude prioritizing requirements for a few generalized applications, and then selecting a combination of devices that provide a "best-fit" for those applications, from available technology.

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

AGL	Above ground level
AMVER	Automated Mutual Assistance Vessel Rescue
AOR	Area of Responsibility
ARK	Aerial Rescue Kit
CG	U.S. Coast Guard
CG-534	CG Office of Search and Rescue
CG-711	CG Office of Aviation Forces
CG-SAILS	CG Standard After-Action Information Lessons Learned System
DHS	Department of Homeland Security
F/V	Fishing vessel
FY	Fiscal year
HARK	Helicopter Aerial Rescue Kit
IBA	Inflatable buoyant apparatus
IMO	International Maritime Organization
IMRF	International Maritime Rescue Federation
LB	Lifeboat
LR	Life Raft
LSA	Liferaft Systems Australia
M/V	Motor vessel
MES	Marine Evacuation System
MISLE	Marine Information for Safety and Law Enforcement
MMRI	Maritime Mass Rescue Intervention
MOR	Means of rescue
MRO	Mass Rescue Operation
MROSS	Mass Rescue Operations Scoping Study
MSAM	Major Systems Acquisition Manual
MTBO	Mean time between overhaul
NTSB	National Transportation Safety Board
ORIL	Open Reversible Inflatable Liferaft
ORL	Open Reversible Liferaft
P/V	Passenger vessel
PAX	Passenger(s)
PC	Pleasure craft
PIW	Person in water
POB	Persons on board
PVSS	Passenger Vessel Safety Specialist
R&D	Research and Development
RDC	Research and Development Center
RFI	Request for Information
RIB	Rigid Inflatable Boat
Ro-Pax	Combination vehicle and passenger vessel

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS (Continued)

Ro-Ro	Roll on, roll off
S&T	Science and Technology
SAR	Search and Rescue
SART	Search and Rescue Transponder
SKAD	Survival Kit Air Droppable
SOLAS	Safety of Life at Sea
SSRS	Swedish Sea Rescue Service
U.S.	United States
USCG	United States Coast Guard
WMEC	Medium Endurance Coast Guard Cutter

1 INTRODUCTION

1.1 Background

In a June 2009 memo, the Office of Search and Rescue (CG-534) documented the need for Research and Development (R&D) support of the Search and Rescue (SAR) program. CG-534 listed mass rescue operations as a high priority item.

Since 2006, the R&D Center (RDC) has worked with the SAR program and the district Passenger Vessel Safety Specialists (PVSS) to address potential shortcomings in mass rescue operations (MRO). In 2007, the RDC completed a Mass Rescue Operations Scoping Study (MROSS). Table 1 shows the resulting risk-based ranking of mass rescue incident scenarios. The study identified the largest potential response gaps were associated with Coast Guard (CG) response to significant numbers of survivors from a passenger vessel casualty. Though the apparent emphasis can be seen with regard to cruise ships with upwards of thousands of passengers, the most-likely scenario concerned response to near-shore or coastal passenger vessels, not subject to Safety of Life at Sea (SOLAS) requirements for lifesaving apparatus. The recommendation from this study was to develop equipment or techniques to effect rapid evacuation and rescue of multiple survivors.

Table 1. Risk-based ranking of mass rescue incident scenarios from MROSS.

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

In 2007 the RDC led an effort under the Department of Homeland Security (DHS) Science and Technology (S&T) Rapid Technology Assessment Program to investigate and develop an air-deployable Mass Evacuation and Rescue Device to handle upwards of 100 survivors. This effort was not funded due to potential technical risk, and an apparent lack of a sense of urgency and need.

In 2008, the RDC received a project ideation for a "multiple-person hoisting/cargo transport device." Though this ideation was field-generated by a CG rescue helicopter pilot and aviation engineer, and offered an approach to expedite multiple-person hoists in view of a then-recent Class A aviation mishap involving hoist operations, CG-534 and the Office of Aviation Forces (CG-711) did not support further investigation. CG-711 representatives advised the RDC they had previously evaluated the device (called a "Heli-Basket") in 2007 and found "it did not meet mission requirements."

Since then, input to CG-534 from the PVSS community (who also play a role in their district mass rescue organizations) resulted in CG-534 requesting RDC to "research the availability of and develop the technologies to permit outside intervention (by rescue forces or third parties) in mass rescue operations, including rescue of persons from large passenger vessels or multiple persons in the water."

1.2 Purpose/Objective

The CG R&D Program supports the following SAR Program objectives from the fiscal year (FY) 2010-2015 SAR Mission Performance Plan:

- Objective 1.8 – Coordinate the Development of a Coast Guard Mass Rescue Program.
- Objective 1.9 – Support an Inclusive Requirements Development Process.

In a June 2009 memorandum, CG-534 noted: there are no readily available "interventions" for use by rescuers or good Samaritans in mass rescue incidents. In response, the RDC developed this project on Maritime Mass Rescue Interventions (MMRI) with the following objectives:

- **Research the availability of devices and technologies** to permit outside intervention in maritime mass rescue operations including rescue of persons from large passenger vessels or multiple persons in water (from June 2009 CG-534 memo).
- **Develop functional requirements** that can be used in the acquisition or procurement process for such interventions, or that can be used by other potential response organizations (from 2010-2015 SAR Mission Performance Plan).

1.3 Project Methodology

The project team built on the MROSS by validating the most likely mass rescue incident scenarios, examining response activities (including response gaps), and defining functional requirements of potential response interventions. To validate the mass rescue scenarios, project personnel reviewed incident records and developed a "scenario-response matrix" with information about the incident, persons affected, persons rescued, rescue resources, rescue activity, degree of success, and rescue gaps/successes, as determined from the recorded information. The RDC provided this matrix as read-ahead for a workshop that included a cross-section of CG district incident management and PVSS representatives. Workshop participants reviewed the incidents to identify rescue successes and gaps, and ranked the gaps in order of probability and consequence. Participants developed intervention needs and/or functional requirements to address the gaps.

Project personnel also conducted extensive market research, including issuing a Request for Information (RFI) to assess technologies for outside intervention in maritime mass-rescue incidents, and liaising with industry and response agencies. They determined the potential availability of intervention equipment, categorizing and evaluating RFI responses. The project team screened responses for applicability to functional requirements and developed a Mass Rescue Intervention Data and Equipment Listing. The team also investigated additional sources of rescue-related equipment or devices based on available information, web-search, or other input. They then revalidated intervention requirements.

Project personnel also investigated rescue equipment, devices and procedures in use or being developed by rescue services outside the US, including information presented at the International Maritime Rescue Federation's June 2010 Conference on Mass Rescue at Sea, and a demonstration by the Toronto, ON Police Marine Unit in July 2010.

2 MASS RESCUE INCIDENT SCENARIOS AND INTERVENTION NEEDS

2.1 Scenario-Response Matrix

In order to best align the R&D project to field realities and needs, the RDC team developed a Mass Rescue Incident and Response Scenario Matrix that used a variety of sources to identify and assess details from selected rescue incidents that had occurred since 2003 (the timeframe that followed the end of the MROSS data gathering process). Though many of the incidents chosen do not fit a rigorous definition of a "mass rescue incident" (e.g., exceeding available resources), the project team decided to include those where a "significant" number of people were affected (usually greater than 10), the incident was of a unique nature that indicated potential rescue shortfalls/successes, or one that received a high degree of response, investigative, or media attention. Data sources included:

- National Transportation Safety Board (NTSB) Reports.
- CG Marine Information for Safety and Law Enforcement (MISLE) database.
- CG Standard After-Action Information Lessons Learned System (CG-SAILS).
- CG Marine Safety Reports.
- Transportation Safety Board of Canada.
- United Kingdom Marine Accident Investigation Branch.
- Liberian Bureau of Maritime Affairs.

The scenario-response matrix contains information about the incident, the number of persons affected, the number of persons rescued (as well as what they were rescued from), rescue resources, rescue activity, degree of success, and rescue gaps/successes. There are 29 incidents in the matrix, 21 from the U.S. and 8 from foreign countries. An abbreviated form of the matrix is shown in Table 2 (the matrix with all 29 cases is included as Appendix A). The full citations for the incidents covered in this study, including MISLE case numbers (where applicable), can be found in the Reference Section.

Incidents were counted as U.S. if they involved U.S. CG (or U.S. commercial vessel) response. According to the International Maritime Organization (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 more important attributes of MROs from the IMO Guidelines include:

- The incident involves the need for immediate assistance to large numbers of persons in distress such that capabilities normally available to SAR authorities are inadequate.
- 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.

Table 2. Abbreviated scenario-response matrix.

Incident					Pers affected			Pers Rescued				Rescue Resources					
Vessel Type	Date	Incident Type	Name	Incident Location	Pax	Crew	Other	Source	PIW	LB Raft	Other	Gov Vsl	Other Vsl	GOV AC	Other AC	Rescue Activity	Rescue Gaps/Success
Large PV	5/14/07	Ground-ing	*Empress of the North*	Lynn Canal, SE AK	206	75		252			29	2	4			CG evacd 131; comml vsls evacd others; 29 remained on board	Evacuees either walked directly into the rescuing vsls or used the gangways
Small PV	3/6/04	Capsize	*Lady D*	Baltimore, MD	23	2		?	25			3	10 +	1		LCM-8 evacd or recovered 22 pers	Passenger inability to escape from overturned boat – assisted by LCM-8
Small PV	9/18/05	Fire	*Miners Castle*	Munsing, MI	73	3		73			3		1			73 pax evacuated by tug. Crew remained on board	
Commuter Ferry	6/12/06	Fire	*M/V Massachu-setts*	Boston Harbor, MA	65	4		69				1	6			*Laura* evacd 65 pax., CG evacd 4 crew	
Passenger Ferry	5/10/04	Ground-ing Sinking	*LeConte*	Cozian Reef, Sitka, AK	86	23		2		99	8	7	5	5	2	CG medevacd 2; Comml Vsls evacd 99 from rafts	
Charter FV	6/14/03	Capsize	*Taki-Tooo*	Tillamook Bay Inlet, OR	17	2			19			3		2		MLB recovered 1 victim (died later), FW recovered 2 bodies, Survivors swam or were washed ashore	MLB unable to approach PV (too dangerous)
52 ft PC	12/14/08	Ground-ing	*Giant Feet*	Near Candlestick Park, SF, CA	25	1		26				3	3	1		CG RW dropped 20-man LR & RS. mult FD sm boats xferred all POB in groups	CG boats unable to get close to vsl. POB removed in small groups.
Fish Proc Vsl	2/26/08	Fire	*F/V Pacific Glacier*	135 nm NE of Dutch Harbor		106	15	90				1	11	4		4 good Sam vsls evacd 90 crew. 31 pers remained on vsl	
Fish Proc Vsl	3/23/08	Sinking	*F/V Alaska Ranger*	Bering Sea		47			25	22		1	1	3		*Alaska Warrior* rescued 22 pers in rafts, 21 PIW rescue by CG helo	PIW had difficulty reaching life rafts; cold water
Fishing Vessel	2/8/10	Fire	*F/V Hou Chun 11*	50 nm N of Kingman Reef		28				28		1		2	1	WMEC 282 boats rescued crew fm 2 LRs w/ vectoring assistance fm C-130	Multiple tranfers of recued personnel. Sister ship too far away to assist.
Migrant vessel	5/13/09	Capsize	[unknown]	14 nm offshore Lake Worth, FL	28				28			3	3	3		*Semia* rescued 3 pers fm water, then notified CG of 30 others. CG & local assets rescued/recovered	

Table 3 lists the vessel types included in the matrix and number of persons involved by vessel type. Figures 1 and 2 show the number of people rescued by various rescue assets, and whether they were rescued directly from the source, out of the water (PIW – person in water), or from a life raft/boat. Figure 1 contains only the U.S. incidents and Figure 2 contains the data from all 29 incidents.

Lessons learned for the case studies were not always readily apparent, particularly details of the actual rescue activity and equipment. As is apparent from Figures 1 and 2, the majority of people were rescued by commercial vessels, commonly known as "good Samaritans."

Table 3. Number of persons involved by vessel type.

	Number of Passengers and Crew on Vessel				
Vessel Type	>100	50 to 100	25 to 49	10 to 24	<10
52 ft pleasure craft (PC)			1		
Bulk carrier			1	1	
Car carrier				1	
Charter fishing vessel (F/V) (Subchapter T)				1	
Chemical Tanker			1		
Commuter Ferry (Subchapter K)		1			
Construction Barge					1
Container ship			1		
Fish Processing Vessel	1		1		
Fishing Vessel			1		
Kayakers			1		
Large passenger vessel (P/V)	1				
Large P/V (Subchapter H)	1				
Medium Airliner A320	1				
Migrant vessel	1		1		
Passenger & vehicle ferry	1				
Passenger Ferry	1				
Ro-ro cargo vessel				1	
Sail training vessel			1		
Small fishing vessel				2	
Small P/V	1	1		1	
Small P/V (Subchapter T)			1		
Stranding on ice floe	1				
Sum of Count	**9**	**2**	**10**	**7**	**1**

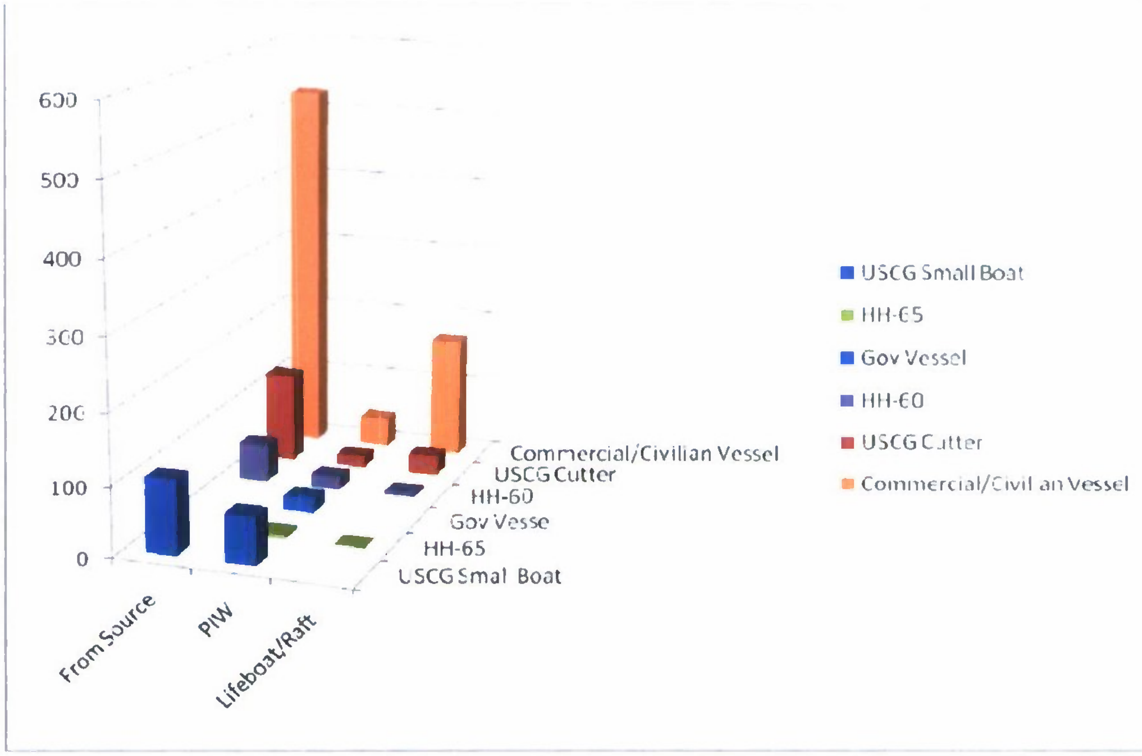

Figure 1. Number of people rescued by resource type for U.S. incidents.

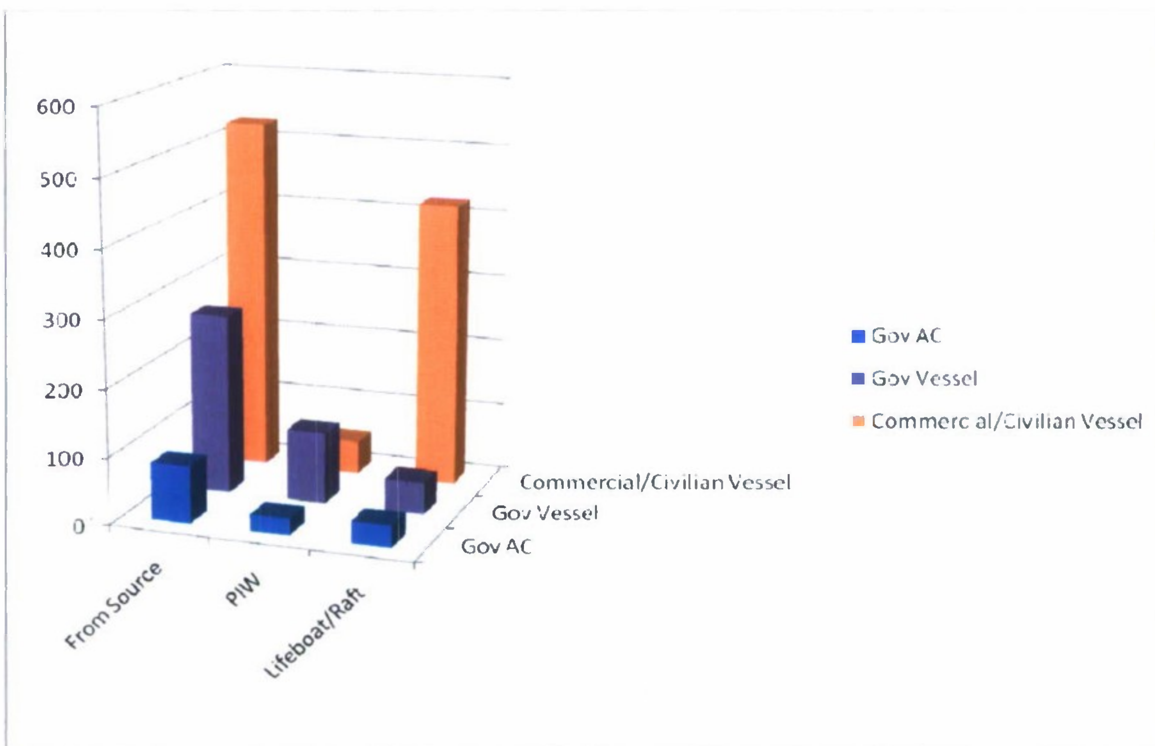

Figure 2. Number of people rescued by resource type for all incidents.

2.2 Scenario-Response Validation

To validate the nature of the incidents and response gaps identified in the scenario-response matrix, RDC conducted a Mass Rescue Response Scenario Validation workshop in May 2010. The project team invited a significant cross-section of CG district incident management and PVSS representatives to participate. Workshop participants reviewed the incidents to identify rescue successes and gaps, and then ranked scenario and intervention gaps in order of probability and consequence. From this, workshop participants developed intervention needs and/or functional requirements to address the intervention gaps.

Workshop participants discussed the definition of "Mass Rescue Operation" to determine whether or not a particular incident should be included on the list. Though not limited to the specific IMO definition, participants agreed the following factors should be considered for including an incident for the purposes of this project:

- Number of people involved.
- Location (range to resources); distance off shore.
- Water and air temperature.
- Weather, sea state.
- Other hazards (e.g., oil or chemicals).
- Number of resources available/responding.
- Shore infrastructure capability.

Workshop participants agreed the incidents included in the matrix fit their definition of MRO. There are a number of what might be considered MRO incidents that were not included in the matrix for a variety of reasons:

- The matrix does not include all migrant vessel incidents. The CG often records these incidents as Migrant Operations rather than SAR. This particular aspect may require additional, subsequent attention.
- Natural disaster response was not included in the matrix. As seen in SAR program reports, natural disaster response skews the data, and makes it extremely difficult to balance the remainder of the incidents against the sheer numbers associated with an event such as Hurricane Katrina. In general, from MISLE review, response is often captured as individual sorties, but in aggregate, would count as an MRO.

2.3 Incident Response Gap (and Success) Identification

Workshop participants also reviewed the incidents to validate specific rescue successes and gaps. Selected results are shown in Table 4. In particular cases, participants voiced the sentiment that the successful outcome to an incident was a result of solid, preventive measures, either mandatory or voluntary. The participants felt strongly that these successes be identified. In Table 4, these preventive successes (or gaps) are shaded. The incidents are listed in chronological order of occurrence.

Table 4. Incident successes and gaps.

Incident	Successes	Gaps
Charter F/V *Taki-Tooo* Tillamook Bay Inlet, OR [Capsize, June 2003]		Small/uninspected passenger vessel operator did not heed CG advisory.
M/V *Bow Mariner* Off coast of Virginia [Explosion, February 2004]		The people were too injured or cold to climb into a raft.
P/V *Lady D* Northwest Harbor, Baltimore, MD [Capsize, March 2004]	Navy used bow ramp on the landing craft to lift the ferry and help extract trapped personnel - important in rescuing people from under capsized vessel	
P/V *LeConte* Cozian Reef, Sitka, AK [Grounding, May 2004]	Timeliness getting "good Samaritans" on scene. Car ramp used to get people off boats.	Passenger accountability problem - some passengers got on a fishing boat and left scene. Significant communications problems. Casualty occurred in area with no nearby CG resources, i.e., 70 mile gap between CG station AORs
M/V Selendang Ayu Bering Sea [Grounding, December 2004]		Lack of multiple-person, helicopter hoist capability (Though this was questioned since Master did not accept crew evacuation until in-extremis
P/V Miners Castle IVO Munsing, MI [Fire, September 2005]	Deployed own vessel Inflatable Buoyant Apparatus (never used as sister ship came alongside and allowed passengers to walk off.	
P/V Queen of the North Gil Island, Wright Sound, BC [Grounding & sinking, March 2006]		Accurate manifest was not available resulting in 2 passengers left behind - later found dead
M/V Cougar Ace 230 nm South of Adak, AK [Taking on water, July 2006]	Weather was good; multiple helicopter availability rescued all crew.	Crew couldn't get to life raft because of list of vessel.
M/V *Massachusetts* Boston Harbor, MA [Fire, June 2006]	Though not required to have fire suppression system, vessel did, and fire was contained to the engine room	
P/V *Empress of the North* Lynn Canal, SE AK [Grounding, May 2007]		Unknown max capacity for cutters - people-weight-etc. Personnel transfer from casualty to patrol boat to M/V *Columbia*
M/V *Hai Tong 7* 375 nm NW of Guam [Capsize, July 2007]	Effectiveness of Automated Mutual Assistance Vessel Rescue (AMVER) system	Problematic manifest tracking. Due bad weather, "good Sam" lifeboat use n/a.
P/V Explorer Antarctica [Sinking, November 2007]	Master decision to abandon ship early enough to get everyone successfully into lifeboats or RIBs.	Crew did not inform passengers of lifeboat survival equipment.
F/V Pacific Glacier 135 nm NE of Dutch Harbor, AK [Fire, February 2008]	Four "good Sams" on scene evacuated personnel	
F/V Alaska Ranger Bering Sea, AK [Sinking, March 2008]	Multiple people in water had time to don survival suits	PIW difficulty reaching life rafts; cold water; Crew accountability–fish master not on manifest

Table 4. Incident successes and gaps (Continued).

Incident	Successes	Gaps
P/V *Queen of the West* Columbia River, OR [Fire, April 2008]	Fire did not spread: sufficiently contained to obviate evacuation	Remote location, no nearby assistance
P/C *Giant Feet* Near Candlestick Park, San Francisco, CA [Grounding, December 2008]	Intervention that worked. POB removed in small groups by fire department inflatable boats	Darkness, location, shallow water; CG boats unable to get close to vessel due to shallow water.
USAir 1549 Hudson River, New York, NY [Ditching, January 2009]	Multiple resources working together.	Survivor accountability, manifest uncertainties
F/V *Hou Chun 11* 50 nm North of Kingman Reef [Fire, February 2010]		Multiple transfers of rescued personnel. Sister ship too far away to assist.

Though the workshop focused on "rescue" gaps (with the intent of achieving the two project objectives), the primary gaps identified in the incident documentation as well as by the participants involved communications and survivor accountability. Gaps involving rescue equipment or procedures don't readily appear in the records. The workshop consensus was that either rescue failures tend not to occur, or that if there are gaps, the gaps haven't been documented.

As Table 4 lists actual incidents, workshop participants also discussed the potential (and probable) future incidents, and potential response gaps associated with those incidents. Attention focused on two specific types of vessel incidents: domestic passenger vessels and "expedition" cruises.

Workshop participants felt that most likely future MRO incident rescue gaps would concern expedition and/or high-latitude cruise ships. These cruises are becoming more common and are occurring in locations that may not have rescue resources readily available to respond to an incident. Participants noted that cruising offshore Mexico can be considered traveling in a remote location – response would not be timely.

Participants voiced a common theme that survivors of incidents in remote locations need to be "self-sufficient" and be sheltered from the cold and storms. Participant discussion indicated ships losing power at sea is more common than thought, and can result in much more significant problems. While these incidents may currently show up as casualty reports, they're not a SAR incident requiring response. The participants agreed it is only a matter of time for a remote MRO incident with a large passenger vessel to occur. Present CG SAR parameters (launch in 30 min, 90 min to scene) may not be applicable for remote incidents, while IMO guidance on "remote SAR" is somewhat limited.

As in the MROSS, consensus remains that domestic passenger vessels present a significant challenge for MRO. The passenger/crew ratio on U.S. domestic vessels, in some cases one certificated seaman for hundreds of passengers, remains a concern. A related issue is the sheer size of modern cruise ships: 5,400+ passengers.

2.4 Mass Rescue Intervention Performance Gaps

Based on the scenario discussions, workshop participants agreed on the following mass rescue intervention performance gaps:

- Rescue forces can't provide timely response to inaccessible or distant casualty locations.
- Disabled or incapacitated survivors can't perform (self-) rescue.
- Survivor retrieval to any height above water is difficult.
- Different types of rescue equipment have device-specific gaps:
  - Difficulty in deployment or operation by non-rescue personnel.
  - Unwieldy stowage/carriage/transport characteristics.
  - Difficult or impossible to use in challenging vessel conditions.
  - Difficulty in delivery to casualty/disaster.
  - Ineffective for use once onboard a casualty/disaster.
  - Lack of worldwide maritime applicability.
  - Don't permit simultaneous, multiple-person retrieval.

2.5 Functional Requirements Development (Required Functional Capability)

One of the project objectives, as requested by the Office of Search and Rescue, was to develop "functional requirements" that can be used as a basis for acquisition or procurement of mass rescue interventions, or that can be used by other potential response organizations in their own programs to improve mass-rescue capability. As part of the workshop, the project team explained an approach to determine inherent functional-capability requirements for possible interventions (see Figure 3). This allowed workshop participants the opportunity to describe what capabilities or material characteristics were needed, rather than focusing on any specific material solution.

In discussion, the participants voiced a combination of specific capabilities or characteristics that they felt interventions should have, and a series of higher-level functional requirements. Table 5 shows the result of this discussion, with the higher level functional requirements shown in the left-hand column. Some specifics mentioned were voiced as applicable to more than one high level requirement, as reflected in the table. The high-level functional requirements were then prioritized as high (H), medium (M), or low (L).

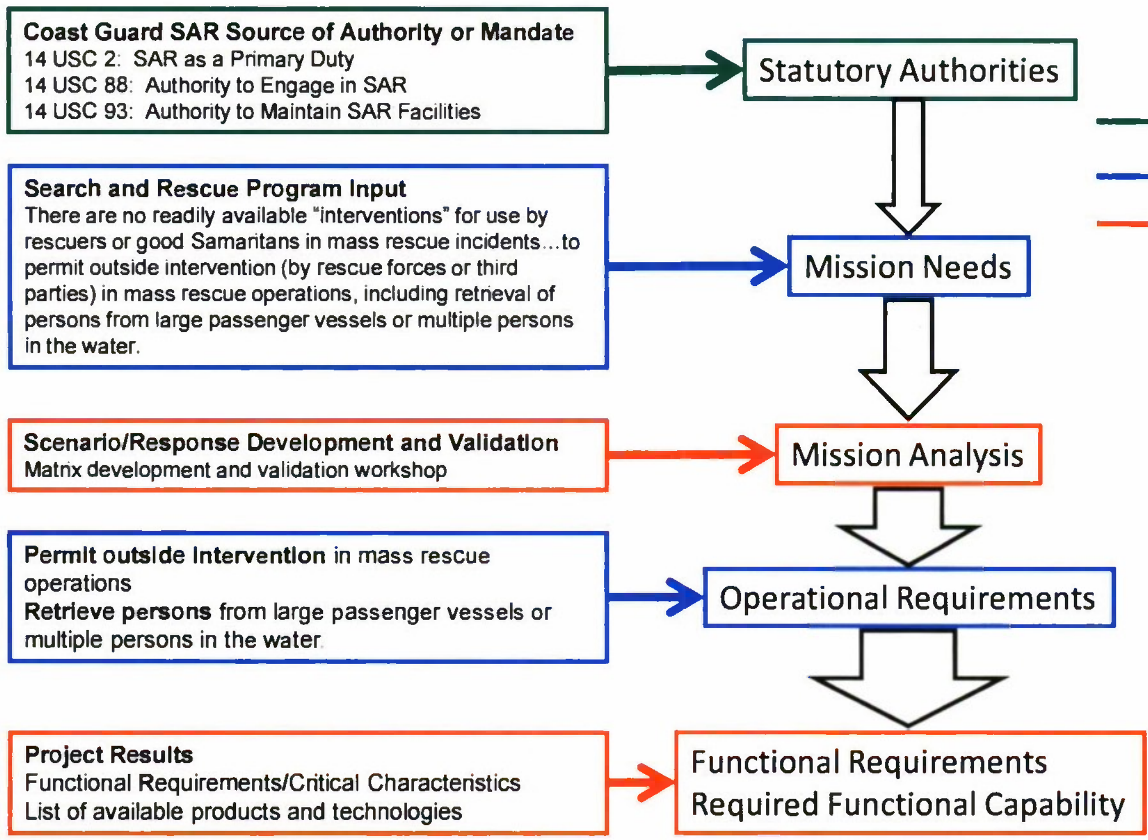

Figure 3. Requirements development model.

Table 5. Functional requirements from workshop.

Priority	High-level Functional Requirement	Specific Capabilities or Characteristics
H	Reach inaccessible casualty location	Deployable from different delivery platforms Air deployable - multiple airframes Vessel deployable – multiple vessel sizes/types Land deployable – e.g., from a cliff, remote area Long range deployable Multiple sizes to fit different delivery platforms Impact resistant Abrasion resistant to drag over ground
	Allow easy delivery to casualty/disaster	Allow easy delivery to casualty/disaster
	Facilitate deployment or operation by non-rescue personnel	Simple operation - only 1 or 2 steps Instructions with international signage Few moving parts Self righting or reversible Activation by rescues/survivors Deployment weight Deployment size Inherent buoyancy Shock/Impact resistant
	Permit retrieval to any height above water	Device can be lifted with survivors on board
	Meet stowage/carriage/transport characteristics	Capable of being carried on multiple platforms Man portable - weight - size – packaging Long shelf life Capable of being stowed in multiple environments (w/o climate control) No inadvertent auto-inflation (e.g. not water activated - restriction on helos) Minimal maintenance - easy - low cost – infrequent
	Facilitate simultaneous multiple person retrieval	Non-collapsing/rigid construction once deployed
M	Allow disabled or incapacitated survivor (self-) rescue	Low freeboard or ramp/platform Victims ability to rescue other victims (assist disabled survivors)
	Meet general characteristics	Abrasion resistant Minimal Leeway High visibility (day/night) Puncture resistant Chemical resistance Heat resistant (fire) Variety of person capacities - less than 50? Radar reflectivity
	Be effective for use onboard a casualty/disaster	Vessel condition does not defeat deployment or use
L	Use in challenging vessel condition (vessel on fire, unstable, capsized)	Vessel condition does not defeat deployment or use
	Provide worldwide maritime applicability	Short Term (<24 hrs) Long Term (48 hrs) Arctic Survival High Sea State Low Sea State Tropical Survival

3 EQUIPMENT AVAILABILITY AND ANALYSIS

3.1 Request for Information

The RDC issued an RFI to assess technologies that might permit outside intervention by rescue forces or other third parties in maritime mass-rescue incidents, including rescue or retrieval of persons from passenger vessels, hazardous predicaments in/or adjacent to water, or rescue of multiple persons in the water or from other hazardous maritime predicaments. The full text of the RFI, including a list of the commercial concerns that were directly notified of the RFI, can be found in Appendix B.

The project manager also attended two passenger vessel trade shows and a conference to conduct additional market research into rescue-related equipment availability. At each venue, the project manager inquired whether various representatives were aware of the RFI, and provided the internet link for their review.

3.2 RFI Responses and Equipment Listing

After aggregating information from the RFI responses and additional web search and discovery, the project team created a Mass Rescue Intervention Data and Equipment Listing as representative of commercially available equipment. The equipment vendors included in the listing and their contact information can be found in Appendix C.

Appendix D contains the catalog of representative equipment. The data entered for each piece of equipment includes (where available): company name, equipment/device name, description (based on information supplied by vendors or found in their literature or web sites), physical characteristics, life cycle costs, operational characteristics, and a "comparison" to a modified list of the desired equipment characteristics (see Table 6).

Project analysts developed Table 6 by reviewing the specific capabilities and characteristics in the workshop-derived functional requirements of Table 5. They combined items of rough-similarity or where characteristics could be grouped in logical characteristic bins, i.e. transportation and stowage, deployment, etc.

In most cases, the equipment description and information provided by the vendors did not directly address many of the functional requirements developed by the workshop participants.

3.2.1 Characteristics and Terminology

The project team determined that certain device characteristics played a more critical role in mass rescue efforts than others: delivery method, whether the device allowed direct lift or hoisting with survivors on board, whether the device provides a means of "refuge" or "rescue," and whether the device had a capacity of 25 survivors or more.

The distinction between "refuge" and "rescue" is important. In previous work, the project team began to distinguish between "evacuation" and "rescue." In fact, there are many large lifesaving devices called "mass evacuation systems" that allow many people to egress a casualty, and temporarily remain safely out of the water (i.e. "refuge"), until an outside agent arrives to remove them from the evacuation device ("rescue"). Throughout the project's work with the PVSS group, this concept of "rescue" has been discussed in terms of a "continuum of care," where the entire evolution is not complete until the survivors are in safe haven or adequate medical treatment facilities, ashore and accessible. In this project, one of the guiding requirements is the need "to rescue persons from large passenger vessels or multiple persons in the water." This requirement is not met by refuge alone.

Table 6. List of desired equipment characteristics.

Transportation and Stowage
Air deployable – rotary wing
Air deployable – fixed wing
Vessel deployable – ship/cutter (crane or hoist)
Vessel deployable – boat (over the side)
Land deployable – e.g., from a cliff, remote area
Lightweight – can be carried by 1 or 2 people
Easily/conveniently stowed
Capable of being stowed in multiple environments (w/o climate control)
Deployment
Self righting or reversible
Activation by rescues/survivors
No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
Non-collapsing/rigid construction once deployed
Inherent buoyancy (undeployed)
Inherent buoyancy (deployed)
Simple operation - only 1 or 2 steps
Few moving parts
Instructions with international signage
Device can be lifted with survivors on board
Physical Characteristics
Multiple sizes to fit different delivery platforms & capacities
Low freeboard or ramp/platform
Victims ability to rescue other victims (assist disabled survivors)
Minimal Leeway
High visibility (day/night)
Radar reflectivity
Abrasion resistant
Shock/Impact resistant
Puncture resistant
Chemical resistant
Heat resistant (fire)
Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
Maintenance
Long shelf life
Minimal maintenance - easy - low cost – infrequent
Life Support
Short Term (<24 hrs)
Medium Term (24-48 hrs)
Long Term (>48 hrs)
Arctic Survival
Tropical Survival
High Sea State

Table 7 shows how the selected equipment meets the critical characteristics and Figure 4 shows the number of devices on the list that met each of the critical requirements. Figure 4 shows that the majority of commercially available equipment identified here provides refuge (14) versus a means of rescue (7). Some devices provided refuge and, because they were capable of being lifted with survivors on board, also provided a means of rescue.

Table 7. Equipment list and critical characteristics.

	Air Deployable - rotary wing	Air deployable - fixed wing	Vessel deployable - ship/cutter (crane or hoist)	Vessel deployable boat(over the side)	Lift with survivors on board	Refuge	Rescue	Less than or equal to 25 people	Greater than 25 people
Aerial Machine & Tool Corp									
Squid	Y		Y		Y		Y	Y	
Airborne Systems Canada Ltd									
Aerial Rescue Kit (ARK)		Y				Y		Y	
Helicopter Aerial Rescue Kit (HARK)	Y					Y		Y	
Survival Kit Air Dropable (SKAD)		Y				Y		Y	
Billy Pugh Company, inc									
X-904 Transfer Device			Y		Y		Y	Y	
DBC Marine Safety Systems/Zodiac									
Davit Launched Liferafts			Y		Y	Y	Y	Y	
Inflatable Buoyant Apparatus Liferaft			Y			Y			Y
M.O.R Liferaft			Y		Y	Y	Y	Y	
Open Reversible Inflatable Liferaft			Y			Y		Y	Y
Reversible Liferaft			Y			Y			Y
Givens Marine Survival Company, Inc									
Givens Buoy Liferaft			Y	Y		Y		Y	
Liferaft Systems Australia									
Marine Evacuation System			Y				Y		Y
Self-righting Liferaft			Y			Y			Y
Open Reversible Liferaft (ORL)			Y			Y			Y
Lifesaving Systems Corporation									
Law Enforcement Emergency Pack	Y		Y	Y		Y		Y	
Precision Lift, inc									
Heli-Basket HB2000	Y		Y		Y		Y	Y	
RFD Beaufort Limited									
Survival Liferaft			Y			Y	Y	Y	
Viking Life-Saving Equipment A/S									
MOR Liferaft			Y			Y		Y	

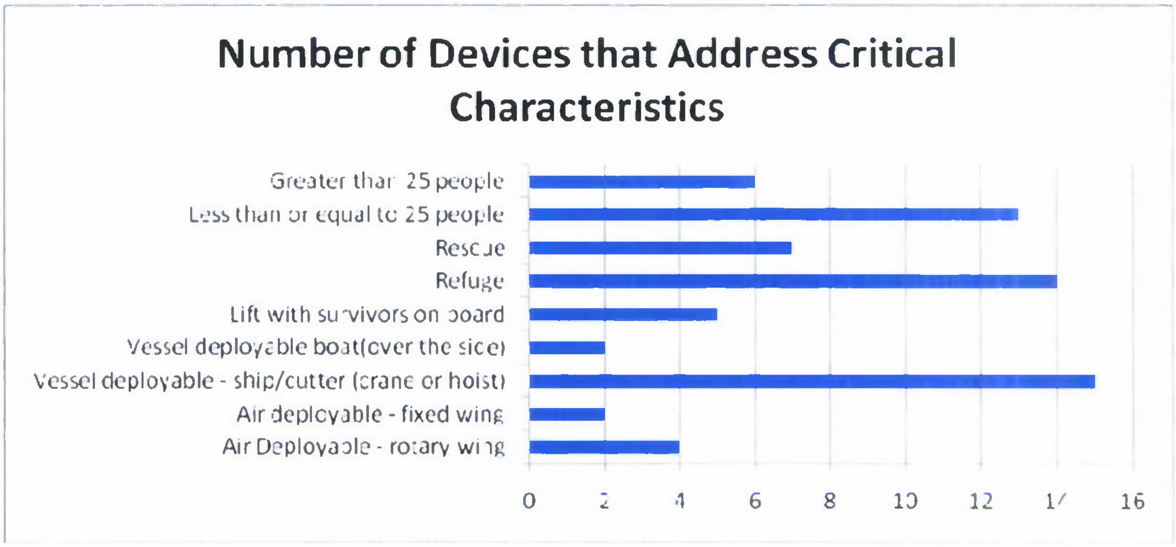

Figure 4. Count of equipment that address critical characteristics.

None of the large life rafts identified in this work with a capacity of over 25 people are currently designed or configured to be delivered by aircraft, although modifications and re-packaging could provide this capability. Also of significance, "rescue" devices included in these findings are all limited to 25 survivors or less.

Some very specialized equipment is designed to fit a specific scenario and has easily defined characteristics. For example - the Survival Kit Air Droppable (SKAD) from Airborne Systems Canada, Ltd, is capable of being attached to the wing of high speed aircraft and dropped upwind of survivors in the water, while the Heli-basket from Precision Lift, Inc., is specifically designed for helicopter sling-load use. RFI responses also included general survival liferafts, more-or-less limited to providing "refuge."

3.3 Validation of Equipment Characteristics List and Requirements Comparison

The project team forwarded the modified list of required functional capabilities and the Mass Rescue Intervention Data and Equipment Listing to the original workshop participants (and their command counterparts either Search and Rescue or Passenger Vessel Safety Specialist) for review. Project personnel then presented the information at a subsequent PVSS Workshop in Bar Harbor, ME in September 2010.

Participants re-validated the required functional capabilities, and discussed whether devices should be recommended for further investigation and potential further requirements development, or whether the presently available equipment appears to be suitable for CG.

3.3.1 Comments and Discussion on Required Functional Capabilities

The group agreed that the revised list of required functional capabilities fairly represented their input from the workshop. They also agreed that it is not possible for a single piece of equipment to meet all of the requirements.

There was full agreement in making the distinction between the two aspects of refuge (survivability of the people) and rescue (or recovery). The critical characteristics of a device needed to meet the different functional requirements associated with refuge and rescue may be different.

3.3.2 Comments and Discussion on Equipment Catalog

The group concurred that most of the equipment listed was designed for refuge rather that rescue, and in many cases met SOLAS requirements. Participants noted that "rescue" devices need not be SOLAS certified for shipboard use. A rescue service could deliver such devices to a "good Samaritan" so the good Samaritan does not need to expend or adapt their own equipment to provide refuge or rescue to the casualty. The group also thought that partnering with vendors to enhance current devices could better meet the required capabilities for rescue.

3.4 Equipment Analysis Summary

The results of the project team's assessment of the current state of the availability of mass rescue equipment are summarized below.

- The capability to provide refuge to large groups of survivors (50 to 100) by large raft from the casualty vessel or assisting large vessels exists from a variety of manufacturers. This capability is in the form of large capacity liferafts or evacuation systems of different designs and capabilities. The weight and deployment requirements significantly restrict the delivery methods.
- The capability to provide refuge to small groups of survivors (25 or less) by small raft or inflatable buoyant apparatus from any vessel or rotary or fixed wing aircraft is available from a variety of manufacturers.
- The capability to provide refuge to small groups of survivors (25 or less) from a large vessel exists from a variety of manufacturers in the form of rescue liferafts. Weight and designed deployment methods restrict delivery methods for this type of liferaft.
- The capability to provide rescue to group of survivors (25 or less) by rotary wing aircraft or large vessel with crane or heavy duty davit exists. These devices include semi-rigid baskets or platforms that would not provide any refuge for survivors.

4 INTERNATIONAL DEVELOPMENTS IN MASS RESCUE PROCEDURES

4.1 International Maritime Rescue Federation, Conference on Mass Rescue at Sea

4.1.1 Introduction

As part of "market research" on availability of mass-rescue equipment and techniques, the project manager participated in the International Maritime Rescue Federation (IMRF) Conference on Mass Rescue at Sea at the Swedish Sea Rescue Service (SSRS) Headquarters outside Göteborg (Gothenburg), Sweden. The market research was to obtain information on the availability of equipment, techniques, or procedures from governmental agencies or rescue services that address mass rescue interventions. This section, though not fully aligning with the project methodology described so far in the report, includes description of equipment, techniques and procedures that address the functional requirements and capabilities developed in section 2.

The particular venue for this conference has a significant level of "short-sea shipping." One of the more prolific types of vessels in short-sea shipping is the combination passenger and vehicle (Ro-Pax) or passenger and railcar ferry. Many of these vessels are more than 200 meters (660 ft) in length, and carry 1000+ passengers. The conference keynote address, "Disaster at Sea," discussed the 1994 capsize and sinking of the

M/V Estonia, a "cruise ferry" that was able to carry 460 cars, (much like a Ro-Pax), where 850 died. With this background, the sheer numbers of these large vessels and frequency of vessel transits provide a sense of the unlikely yet potential opportunity for casualties which would require mass-rescue intervention, and of equal importance, the almost-constant presence as mass-rescue response resources. Though not exactly the same as the "domestic passenger vessel" defined in the MROSS, the Ro-Pax and other large ferries present challenges throughout Europe, the Middle East, Asia, and the western Pacific.

The conference included an at-sea demonstration of rescue and recovery techniques by a commercial ship operator (Stena Line) and the SSRS, presentations, and general discussion on rescue and recovery techniques, guidance, and policies. Many presenters and delegates raised important issues and concerns which align closely to the concerns and issues identified in the U.S.

4.1.2 Issues and Concerns

4.1.2.1 Cooperation, coordination, and communication

The theme of cooperation, coordination, and communication among government, non-government agencies, and industry in developing new techniques and technology was underscored by several examples, including the demonstration. As one example, China Rescue & Salvage presented development of mass-rescue technologies as a result of cooperation among maritime universities, equipment manufacturers, industry, and the government. Three types of such technologies included: a floating, 8-12 person rescue basket (much like a purpose-built Heli-basket), a vessel mounted rescue net (supersized "Jason's Cradle" or roll-up device), and an inflatable floating "slideway" for survivor retrieval. From the presentation, it appears they train with all the devices in open water conditions, with suitably equipped vessels having cranes and davits, large recovery areas, etc.

4.1.2.2 Mass evacuation is not the same as mass rescue

A "mass-rescue systems approach" is needed. It must be goal-based, from casualty and evacuation to "safe place" ashore. Time is of the essence: from immediate response, to extending the "safety timeline" before evacuation is required, to safe removal of survivors from the casualty, to minimizing survivor exposure, to ensuring accountability once survivors are at a "safe-place ashore." As noted in Section 3 of this report, the CG PVSS community refers to this concept as "continuum of care." Each step in the continuum could have its own, distinct functional requirements.

Evacuation has been often addressed, but the rescue and recovery part needs work. Responders need to emphasize rescue from the vessel or evacuation system. Today's high-freeboard vessels, when put in the role of responder, present challenges to rescue and recovery. SAR organizations should focus on determining functional requirements for mass rescue at sea. This may require designing rescue capability into vessels at the outset. Lifesaving (and rescue) apparatus must be designed to meet functional requirements, with common sense driving design (e.g., liferafts shouldn't be black on the bottom), and multi-purpose applicability (e.g., inflatable buoyant apparatus-type devices or evacuation systems that *can* be used as rescue devices). Techniques and devices need to be evaluated in rough weather conditions.

Agreement is needed on core principles of maritime emergency response among industry, governments, and rescue authorities. (This distinction is made as in many cases, the lifeboat, lifesaving, or sea rescue organization may not necessarily be part of the "government" or the "coast guard," e.g. UK, Sweden, Netherlands, etc.). Practical exercise and training in techniques and methods is necessary to achieve effective response. However, practical exercise and training are expensive.

4.1.2.3 Effective use of aircraft

At the IMRF session, there was not a large degree of emphasis on use of aircraft. The conferees acknowledged that the effective use of aircraft needs to be investigated and addressed, whether to deliver interventions, or to affect partial rescue of multiple survivors.

4.1.2.4 Survivor behavior and survivor information

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

Survivor information and input is critical to system improvement. SAR organizations must actively collect it. The concept of "once in the water in heavy weather, it is more luck than effort that gets a survivor to a raft" is something a survivor understands first-hand. This leads directly into a strategic issue that needs further consideration: are more, smaller mass-rescue devices better than fewer large ones?

4.1.3 Rescue Demonstration

Stena Line, an international ship operator with a significant presence in northwestern Europe, and the SSRS demonstrated a method to effect recovery of survivor rafts in rough water. The program was based on the premise that an incident would occur in rough weather and the assumption that training in rough weather is not only possible, but necessary. Though the weather was calm for the demonstration, (Figure 5), techniques were said to have proven effective in 2-3 meter (6-10 foot) seas.

Figure 5. Stena Jutlandica conducting "wave flattening" turns around liferafts.

Two additional assumptions are the ship should be a "rescue station" and ***survivor craft would need to be hoisted*** aboard the ship [This second assumption nearly coincides with one of the project-determined functional requirements.]. To achieve this, they experimented with ways to "flatten" the water for raft recovery. They also determined that raft recovery would be more effective with a tool more versatile than the assigned fast response craft. The SSRS-Stena team experimented with the "Rescue Runner" to achieve this versatility.

Because of potential difficulties in raising partially deflated rafts, the Stena-SSRS team developed a floating cradle (figure 6), which is also used to deploy the Rescue-Runner. In a nutshell, the methodology includes (1) flattening turns to allow hoisting survivor rafts aboard the vessel, (2) deploying the rescue runner and cradle to assist with raft retrieval, and (3) hoisting rafts aboard.

The Master of the Stena Jutlandica stated that a 50-person raft is the largest that is possible to work with (4-5 tons loaded). Recovery of rafts onboard also has an added benefit: they do not remain possible targets in need of investigation. For Stena Jutlandica, the recovery target is 300 persons per hour (as compared to the 10 per hour as required by IMO). Stena has found that raft lines (lanyards) are extremely weak – the weak link in raft recovery. Though not designed for towing, they often part on deployment or in herding.

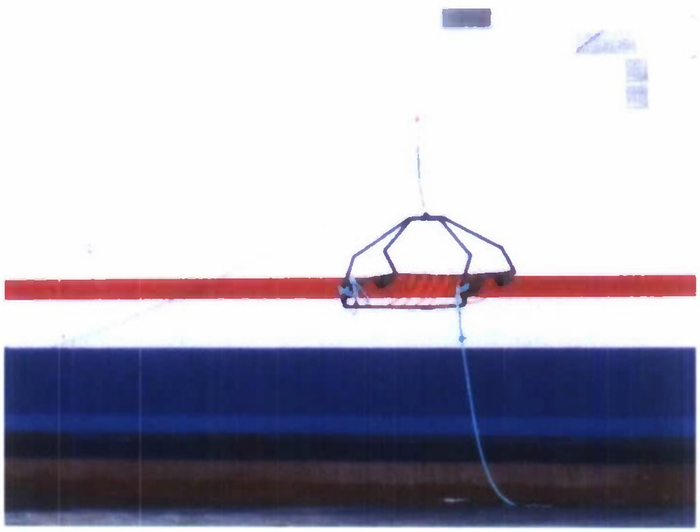

Figure 6. Stena Jutlandica lowering raft rescue cradle.

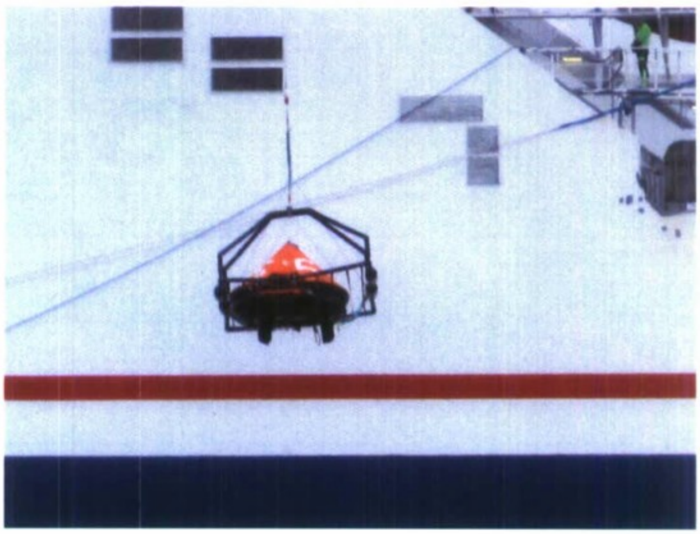

Figure 7. Stena Jutlandica hoisting raft (with cradle).

Figure 8. Stena Jutlandica hoisting raft (without cradle).

4.2 Toronto Police Service Marine Unit, Mass Rescue Boat Demonstration

4.2.1 Introduction

Through discussion with the CG Ninth District, the RDC found out about a specific mass-rescue capability in use by the Toronto Police Service Marine Unit. As part of the "market research" effort on availability of mass-rescue equipment and techniques by other agencies or rescue services, the RDC project manager accompanied the Ninth District PVSS representative to observe a planned training evolution that included deployment of a mass-rescue intervention.

Toronto Harbor is home to multiple excursion boats; ferries that transit between Harbour Front and the Toronto Islands; and the Toronto City Airport, a growing commuter airport also on one of the islands. Humber Bay, approximately 3 nm outside the immediate harbor, is the designated "ditch zone" for Toronto Pearson International Airport. The Marine Unit is responsible for all ice rescues, river rescues, Search and Recoveries, and other water-related rescues within its jurisdictions. Its fleet includes large utility-type boats, large rigid-inflatable boats, other craft (including Personal Water Craft), and a specialized mass-rescue response boat.

4.2.2 Equipment and Demonstration

The Toronto "mass rescue boat" (figure 8), is a Tyler 34 built by Bristol Marine, Port Credit, ON, in 1988. The 34-foot hull is similar to a Nelson-Halmatic design, often seen in the United Kingdom as a pilot boat or launch, suitable for heavy weather use with a good turn of speed. The Toronto boat is specially outfitted with compartments under the after side-decks to hold cannistered, 75-person, reversible inflatable buoyant apparatus (IBA) rafts.

The response process is simple: the boat transits to the distress site at high speed, the crew "winch-out" the IBAs as needed, then assist survivors as possible, including "herding" or maneuvering the IBAs. Finally, the IBAs are towed to shore or survivors are removed by other vessels. The key point here is that a capable hull shape has a specific modification that emphasizes mass-rescue, allows rapid response and deployment of high-capacity flotation devices that can be "worked" by other vessels, yet retains multi-use response capability.

Figure 9. Toronto Police Marine Unit Mass Rescue Boat.

Figure 10. Toronto Police Mass Rescue Boat, showing one of four 75-person IBAs.

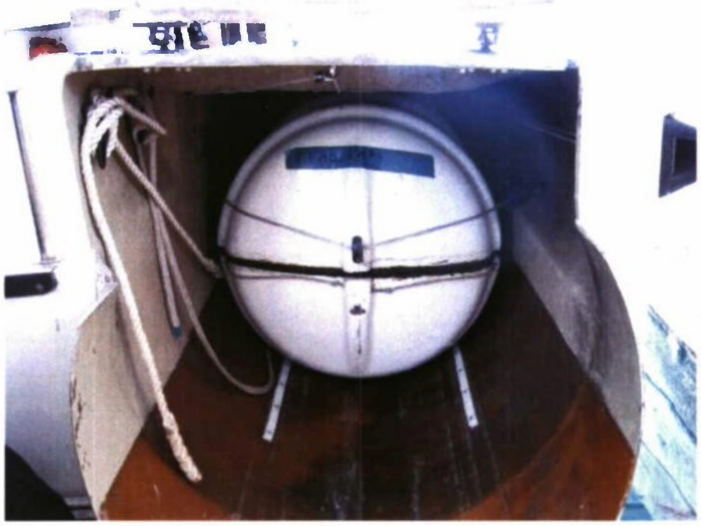

Figure 11. Close-up of Toronto Police Mass Rescue Boat IBA in discharge tube.

Figure 12. Toronto Police Boat with IBA deployed.

5 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Project Summary

5.1.1 Maritime Mass Rescue Incident Scenario Validation

- The review of risk-based ranking of mass-rescue incident scenarios (Table 1) indicated that the type of problems SAR forces are expected to encounter has not changed since the Mass Rescue Operations Scoping Study (MROSS).
- Though the project did not re-rank the scenarios, recent incidents (Deepwater Horizon rig explosion and U.S. Airways flight 1549 ditching) only serve to highlight how relatively infrequent events capture attention and highlight the importance of "third-party" response.
- Third party response (i.e. response by the non-government, "good Samaritan" responder of opportunity) is by far the most significant type of response in mass-rescue scenarios in terms of the number of people rescued (Figures 1 and 2).
- Post-incident analysis and gap identification was not specifically found in publicly available documents and MISLE case reports. Project staff and scenario-validation workshop participants inferred potential response and rescue performance gaps.
- Workshop participants expressed the concern that there is a significant gap in our ability to provide refuge and rescue in "remote" locations. The ability to respond in remote locations must also be factored in intervention device functional requirements.
- International concerns are similar to those identified in the MROSS. In other parts of the world, the equivalent to our domestic passenger vessel concern is the number of large passenger ferries and combination passenger-vehicle ferries (Ro-Pax).

5.1.2 Functional Requirements for Response Interventions

- Functional requirements for response interventions will not necessarily complement each other. The concepts of "refuge" and "rescue" are different and both need to be addressed in planning mass rescue response and development of equipment or devices.
- Requirements for "refuge" can vary based on intended operating environment, expected time before rescue, and available deployment methods. Requirements that apply to mass rescue devices in heavily travelled, tropical to temperate sea lanes may not address needs of survivors in infrequently travelled, high-latitude regions.
- Requirements for "rescue" directly relate to retrieval or removal of survivors from peril or temporary refuge. In a maritime environment, this most often will require a vertical hoist to some height, even to a relatively low-freeboard vessel deck.
- Long service life, minimal maintenance, and durability are standard required characteristics that apply across the board. Stowage and pre-deployment size and weights should be minimized where practicable to maximize potential delivery methods or numbers of available devices.

5.1.3 Results of Market Research and Potential Availability of Intervention Equipment

- The results of the formal RFI were less than hoped for, but indicated there are multiple devices presently available that provide a means of maritime mass rescue intervention, both for "refuge" and "rescue."
- There are multiple intervention devices that will allow varying degrees of "refuge." Deployment methods vary from fixed-wing or rotary-wing aircraft deployment, to vessel drop-rack deployment, to elements of an "own-ship" evacuation system. Deployment method determines whether intervention can be provided by rescue authorities or third parties.
- Of the eighteen intervention devices reviewed, only four of them were considered to be capable of providing both "refuge" and a means of "rescue." Three devices are rafts, designed to prevent folding or collapse, that allow hoisting (or deployment) from a vessel crane or davit, while one is an escape system that permits climbing up the evacuation ramp.
- There were three devices that provided a means of multiple-person rescue, but were not considered to have "refuge" capability. One rescue device (Heli-Basket) was specifically offered as a helicopter-deployed, multiple person rescue device. A second is a marine, personnel transfer device (Billy Pugh) that could be used for rescue. The remaining rescue-only device (SQUID) is designed to be deployed from either a helicopter or a ship's stores boom for retrieval of persons-in-the-water.
- Developments in mass rescue interventions have been occurring internationally. The efforts demonstrated by the Swedish Sea Rescue Service and Stena Line, and those discussed by the China Rescue & Salvage Service at the IMRF conference are similar to that of Transport Canada and the Canadian Coast Guard in the late 1990s—retrieving a liferaft with survivors.

5.2 Conclusions

5.2.1 No "magic bullet."

There is no magic bullet in the development of procedures and devices for maritime mass rescue interventions: one specific device or procedure will not fit all maritime mass rescue needs; functional requirements for various degrees of refuge do not necessarily align with one another, nor with functional requirements for rescue.

As an example, a device of weight and size that allows it to be successful deployed from a light helicopter or relatively-small vessel might not have the ability to provide anything but short-term refuge from immersion for a relatively small number of victims. However, the lack of a single solution does not preclude prioritizing requirements for a few generalized applications, and then selecting a combination of devices that provide a "best-fit" for those applications, from available technology.

5.2.2 Off-the-shelf Technology

As summarized in Section 3.4, there are a number of types of equipment that meet some of the mass rescue needs, such as providing refuge for up to 150 people per raft or hoisting 25 people or less onto a vessel. The various devices permit outside intervention by third parties or rescue forces, including retrieval from large passenger vessels or rescue of multiple persons in the water. The project team found no off-the-shelf-technology capabile of allowing simultaneous hoist rescue to a large group of survivors (greater than 25).

5.2.3 Lessons Learned Outside the United States

There are procedures, techniques, and devices being developed internationally that may have applicability to CG practices.

5.2.4 Application to Coast Guard Needs

The attendees at the PVSS workshop in Bar Harbor agreed that as a whole, the CG needed to better understand the mass rescue gaps associated with large passenger vessels and cruise ships. As the smaller-vessel capabilites of state and local responders and other third party responders (good Samaritans) are likely limited beyond 20 nm from the coast, CG response plans must include inland, nearshore, and offshore scenarios.

Response gaps are not limited solely to passenger vessels and cruise ships. Recent incident occurrence shows that large fishing vessels/processors, cargo ships, and oil rigs suffer casualties that require rescue of a significant number of survivors.

5.3 Recommendations

To permit effective third party invervention, the CG must develop doctrine to address mass rescue incident response scenarios, and determine specific response events, from delivery or deployment of devices for refuge, use of devices for rescue, and delivery of survivors to a safe place ashore. Scenario variables could include multiple, delivery methods, a variety of on-scene assistance and rescue, and multiple destinations as safe place ashore. As shown internationally, a government agency or rescue authority cannot expect to do everything on its own.

The SAR program should direct and oversee development of specific mass-rescue and recovery doctrine for Coast Guard vessels and aircraft, and general mass rescue guidance for various types of commercial vessels. The doctrine and guidance should include delivery, receipt of, deployment, and recovery of mass rescue intervention devices. This effort should be done in conjunction with capability managers and the commercial vessel safety program.

The SAR program should work with the Office of Cutter Forces (CG-751) to rank-order the type of vessels most suited for mass-rescue response, then, direct that mass-rescue response be specifically designated as a vessel mission, and included in training and readiness requirements.

The SAR program should request a test and evaluation program for specific devices to determine their suitability for mass rescue response, including the ability to be safely hoisted aboard Coast Guard vessels.

The SAR program, in conjunction with the aviation and cutter forces managers, should examine the utility of rescue-only devices (Heli-basket, Billy Pugh, and SQUID—or their equivalents), as means to provide multiple-person rescue, hoist to deck level or equivalent height, and short transit to safety.

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6 REFERENCES

Government Accountability Office. (2006). COAST GUARD: Observations on the Preparation, Response, and Recovery Missions Related to Hurricane Katrina. GAO-06-903 Report to Congressional Committees, July 2006.

IMO. (2003). Guidance for mass rescue operations. International Maritime Organization, Sub-Committee on Radiocommunications and Search and Rescue, COMSAR/Circ.31, February 6, 2003.

IMO (2006). Enhanced contingency planning guidance for passenger ships operating in areas remote from SAR facilities. International Maritime Organization, Maritime Safety Committee, Sub-Committee on Radiocommunications and Search and Rescue, MSC.1/Circ.1184, 31 May 2006.

Maritime Authority of Panama. (2007). Final report on the investigation of the M/V *Hai Tong 7* sinking, August 27, 2007.

National Transportation Safety Board. (2005). Marine Accident Report: Capsizing of U.S. Small Passenger Vessel *Taki-Tooo,* Tillamook Bay Inlet, Oregon, June 14, 2003. NTSB/MAR-05/02. Adopted June 28, 2005.

National Transportation Safety Board. (2006). Marine Accident Brief for Accident DCA-04-MM-020 (U.S. Passenger Vessel *LeConte*). NTSB/MAB-06/01. Adopted September 26, 2006.

National Transportation Safety Board. (2006). Marine Accident Report: Capsizing of U.S. Small Passenger Vessel *Lady D,* Northwest Harbor, Baltimore, Maryland, March 6, 2004. NTSB/MAR-06/01. Adopted March 7, 2006.

National Transportation Safety Board. (2006). Marine Accident Brief for Accident DCA-05-MM-008 (M/V *Selendang Ayu*). NTSB/MAB-05/02. Adopted July 28, 2005.

National Transportation Safety Board. (2007). Marine Accident Brief for Accident DCA-06-MF-016 (M/V *Massachusetts*). NTSB/MAB-07/01. Adopted March 20, 2007.

National Transportation Safety Board. (2007). Marine Accident Report: Fire Aboard Construction Barge *Athena 106,* West Cote Blanche Bay, Louisiana, October 12, 2006.
NTSB/MAR-07/01. Adopted June 14, 2007.

National Transportation Safety Board. (2008). Marine Accident Report: Grounding of U.S. Passenger Vessel *Empress of the North,* Intersection of Lynn Canal and Icy Strait, Southeast Alaska, May 14, 2007.
NTSB/MAR-08/02. Adopted November 4, 2008.

National Transportation Safety Board. (2009). Marine Accident Report: Sinking of U.S. Fish Processing Vessel *Alaska Ranger,* Bering Sea, March 23, 2008. NTSB/MAR-09/05. Adopted September 30, 2009.

National Transportation Safety Board. (2009). Marine Accident Summary: Engineroom Fire On Board U.S. Small Passenger Vessel *Queen of the West* Columbia River, near Rufus, Oregon April 8, 2008. NTSB/MAR-09/04/SUM. Adopted November 17, 2009.

Paterson, R. B. and Sullivan, C. A., Fleet Technology Limited, The Development of an Easily Recovered Liferaft (TP 13041E), Transportation Development Center, Transport Canada. (March 1997).

Price, Scott. A Bright Light on the Darkest of Days: The U.S. Coast Guard's Response to Hurricane Katrina. Deputy Historian, USCG.

Republic of Liberia Bureau of Maritime Affairs. (2009). Report of Investigation in the Matter of Sinking of Passenger Vessel *Explorer* (O.N. 8595), 23 November 2007, in the Bransfield Strait near the South Shetland Islands. Monrovia, Liberia, 26 March 2009.

Tebeau, Peter, LTJG Mario Teixeira, Marion Lewandowski, and LT John Natale, Mass Rescue Operations Scoping Study, USCG R&D Center, March 2007.

Transportation Safety Board of Canada. (2008). Marine Investigation Report: Striking and Subsequent Sinking, Passenger and Vehicle Ferry *Queen of the North,* Gil Island, Wright Sound, British Columbia, 22 March 2006. Report Number M06W0052, 30 January 2008.

Transportation Safety Board of Canada. (2009). Marine Investigation Report: Engine Room Fire, Sail Training Vessel *Fair Jeanne,* Off Amherst Island, Lake Ontario, Ontario, 13 July 2007.
Report Number M07C0034, 26 March 2009.

United Kingdom Marine Accident Investigation Branch. (2004). Report on the investigation of the capsize of *Breakaway 5,* River Bure, Norfolk, 19 July 2003. Report No 2/2004. February 2004.

United Kingdom Marine Accident Investigation Branch. (2007). Report on the investigation of the capsize of an un-named Haitian sloop with the loss of at least 60 lives, while under tow by Turks and Caicos police launch *Sea Quest* 1.5nm south east of South Dock, Providenciales, Turks and Caicos Islands on 4 May 2007. Report No 17/2007. August 2007.

United Kingdom Marine Accident Investigation Branch. (2008). Report on the investigation of the structural failure of *MSC Napoli,* English Channel, on 18 January 2007. Report No 9/2008. April 2008.

United Kingdom Marine Accident Investigation Branch. (2008). Reports on the investigations of the fire on board the fishing vessel *Shark* 74 miles west-north-west of Malin Head, 19 January 2008, and the foundering of the fishing vessel *Royalist* 180 miles west-north-west of Dingle, Ireland, 23 January 2008. Report No 13/2008. August 2008.

United Kingdom Marine Accident Investigation Branch. (2009). Report on the investigation into the grounding, and subsequent loss, of the Ro-ro cargo vessel *Riverdance,* Shell Flats – Cleveleys Beach, Lancashire, 31 January 2008. Report No 18/2009. September 2009.

USCG (2005). Investigation into the explosion and sinking of the chemical tanker *Bow Mariner* in the Atlantic Ocean on February 28, 2004 with loss of life and pollution. USCG Marine Safety Office, Hampton Roads, Virginia, December 14, 2005.

USCG (2009). Report of Investigation into the Capsizing of the Small Passenger Vessel LADY D Resulting in the Loss of Five Lives and Multiple Serious Injuries on 03/06/2004. USCG Sector Baltimore, Maryland, February 25, 2009.

USCG Marine Information for Safety and Law Enforcement (MISLE) database cases:

Name	MISLE Case #
Empress of the North	349045
Lady D	165934
Miners Castle	257920
M/V Massachusetts	294003
LeConte	174049
Toki-Tooo	222966
Giant Feet	435986
F/V Pacific Glacier	393860
F/V Alosko Ranger	396604
F/V Hou Chun 11	490049
Migrant vessel - FL	451753
US1549	438974
Kayakers	246970
Bow Moriner	165127
M/V Selendang Ayu	212461
M/V Hoi Tong 7	360559
M/V Cougor Ace	303115
Atheno 106	319556
Lake Erie Ice Rescue	441279
Haitian sloop - TCI	347567

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APPENDIX A. SCENARIO MATRIX

Table A-1. Scenario matrix.

Incident					Pers affected			Pers Rescued				Rescue Resources					
Vessel Type	Date	Incident Type	Name	Incident Location	Pax	Crew	Other	Source	PIW	LB Raft	Other	GOV Vsl	Other Vsl	GOV AC	Other AC	Rescue Activity	Rescue Gaps/Success
Large PV	5/14/07	Grounding	*Empress of the North*	Lynn Canal, SE AK	206	75		252			29	2	4			CG evacd 131. Comml Vsls evacd others; 29 remained on board	The evacuees either walked directly into the rescuing vsls or used the gangways
Small PV	3/6/04	Capsize	*Lady D*	Baltimore, MD	23	2			25			3	10	1		LCM-8 evacd or recovered 22 pers	Passenger inability to escape from overturned boat – assisted by LCM-8
Small PV	9/18/05	Fire	*Miners Castle*	Munsing, MI	73	3		73			3		1			73 PAX evacuated by tug. Crew remained on board	
Small PV	4/8/08	Fire	*Queen of the West*	Columbia River	124	53										None required	
Commuter Ferry	6/12/06	Fire	*M/V Massachusetts*	Boston Harbor, MA	65	4		69				1	6			*Laura* evacd 65 pax., CG evacd 4 crew	
Passenger Ferry	5/10/04	Grounding Sinking	*LeConte*	Cozian Reef, Sitka, AK	86	23		2		99	8	7	5	5	2	CG medevacd 2; Comml Vsls evecd 99 from rafts; 8 crew remained on board	
Charter FV	6/14/03	Capsize	*Taki-Tooo*	Tillamook Bay Inlet, OR	17	2			19			3		2		MLB recovered 1 victim (died later), FW recovered 2 bodies, Survivors swam or were washed ashore	MLB unable to approach PV (too dangerous)
52 ft PC	12/14/08	Grounding	*Giant Feet*	Near Candlestick Park, SF, CA	25	1		26				3	3	1		CG RW dropped 20-man LR & RS. mult FD sm boats xferred all POB in groups to Coyote Point marina.	CG boats unable to get close to vsl due shallow water. POB removed in small groups.
Fish Process-ing Vsl	2/26/08	Fire	*F/V Pacific Glacier*	135 nm NE of Dutch Harbor		106	15	90				1	11	4		4 good Sam vsls evacd 90 crew. 16 crew + 15 good Sam pers remained on vsl to extinguish fire	

Table A-1. Scenario matrix (Continued).

Incident					Pers affected			Pers Rescued				Rescue Resources					
Vessel Type	Date	Incident Type	Name	Incident Location	Pax	Crew	Other	Source	PIW	LB Raft	Other	GOV Vsl	Other Vsl	GOV AC	Other AC	Rescue Activity	Rescue Gaps/Success
Fish Process-ing Vsl	3/23/08	Sinking	*F/V Alaska Ranger*	Bering Sea		47			25	22		1	1	3		*Alaska Warrior* rescued 22 pers in rafts and recovered 3 bodies fm water , 21 PIW rescue by CG RW	PIW had difficulty reaching life rafts; cold water
Fishing Vsl	2/8/10	Fire	*F/V Hou Chun 11*	50 nm N of Kingman Reef		28				28		1		2	1	WMEC282 boats rescued crew fm 2 LRs w/ vectoring assistance fm C-130	Multiple tranfers of recued personnel. Sister ship too far away to assist.
Migrant Vsl	5/13/09	Capsize	[unknown]	14 nm offshore Lake Worth, FL	28				28			3	3	3		*Semia* rescued 3 pers fm water, then notified CG of 30 others. CG & local assets rescued/recovered	
Medium Airliner A320	1/15/09	Ditching	*US1549*	Hudson River	150	5		85	20	50			5				Pilot ditched near available rescue assets
Kayakers	7/28/05	Trapped in sea caves		Squaw Bay, WI	31			28	3			3	1	1		Good Sam rescued 3 fm water; others made it to beach	
Chemical Tanker	2/28/04	Explosion and sinking	*Bow Mariner*	Off coast of Virginia		27			3	6	18	1	3	2			
Bulk carrier	12/8/04	Grounding	*M/V Selendang Ayu*	Bering Sea		26	3		10			1	2	3		Helo evac	Evac in extreme wx; time delay due to single hoist operation
Bulk carrier	7/11/07	Sinking	*M/V Hai Tong 7*	375 nm NW Guam		22			12			2	7	2	2		
Car carrier	7/24/06	Taking on Water	*M/V Cougar Ace*	230 nm S of Adak		23		23				2	2	3	5	Helo evac	Vsls unable to assist due to ship's extreme list.

Table A-1. Scenario matrix (Continued).

Incident					Pers affected			Pers Rescued				Rescue Resources					
Vessel Type	Date	Incident Type	Name	Incident Location	Pax	Crew	Other	Source	PIW	LB Raft	Other	GOV Vsl	Other Vsl	GOV AC	Other AC	Rescue Activity	Rescue Gaps/Success
Construction Barge	10/12/06	Fire	*Athena 106*	West Cote Blanche Bay, LA		8			3				9	2		Crew transport *Captain Mitch* recued 1; Athena small boat rescued 1	Local FD did not have marine firefighting capabilities. Fire extinguished by other vsls in area. Rescuers unable to get close due heat.
Stranding on ice floe	2/7/09	Stranded	Lake Erie Ice Rescue	Locust Point, OH	134			132	2			4	5	4	3		
Large PV	11/23/07	Sinking	*Explorer*	Antarctica	100	54				154			2	1			Master abandoned ship early enough to get all successfully into lifeboats or RIBs. Crew did not inform pax of equipt in lifeboats.
Passenger & vehicle ferry	3/22/06	Striking & sinking	*Queen of the North*	Wright Sound, BC	59	42										Vsl abandoned by pax & crew prior to sinking. CCG cutter, CCG ship & other vsls xferred survivors & transported to shore. 2 pax later found to be missing & eventually declared dead.	2 pax not accounted for during muster to abandon ship.
Sail training Vsl	7/13/07	Engine room fire	*Fair Jeanne*	Lake Ontario	22	9	1	25			7	1				CCG SAR cutter arrived & sent 2 crew mbrs to assess. 20 cadets, 2 naval pers & 3 crew mbrs evacd to cutter. 6 crew mbrs remained on vsl	

Table A-1. Scenario matrix (Continued).

Incident					Pers affected			Pers Rescued				Rescue Resources					
Vessel Type	Date	Incident Type	Name	Incident Location	Pax	Crew	Other	Source	PIW	LB Raft	Other	GOV Vsl	Other Vsl	GOV AC	Other AC	Rescue Activity	Rescue Gaps/Success
Small PV	7/19/03	Capsizing	*Breakaw ay 5*	River Bure, Norfolk UK	10			1	8		1	2	1	1		Motor cruiser recovered 8 pax that had cleared capsized vsl. 2 pax trapped in vsl later rescued by GOV. One died.	
Container ship	1/18/07	Structural Failure	*MSC Napoli*	English Channel		26				26		1		3		26 crew abandoned vsl into enclosed lifeboat; recovered by 2 RN helo	
Migrant Vsl	5/4/07	Capsizing while under tow	Haitian sloop	Turks and Caicos Islands	150				78		72	3		2		Police launch raised alarm & rescued 67 survivors & brought to shore. Next rescue assets arrived hours after capsize. Fishery patrol boats rescued 11 survivors clinging to upturned hull of sloop, the last to be found alive. 60 bodies later recovered, 12 fm deck & hold of sloop	Improved rescue equpt, incl emergency LR & scramble nets, & in Sea Quest's case a larger rescue craft, would enhace the rescue ability of the present TCI police launches. Had sloop been marked with a Dan buoy & light, this would have aided relocation & ID.

Table A-1. Scenario matrix (Continued).

Incident					Pers affected			Pers Rescued				Rescue Resources					
Vessel Type	Date	Incident Type	Name	Incident Location	Pax	Crew	Other	Source	PIW	LB Raft	Other	GOV Vsl	Other Vsl	GOV AC	Other AC	Rescue Activity	Rescue Gaps/Success
Small fishing Vsl	1/19/08	Fire	*Shark*	Malin Head, Ireland		15	7	14			8	3	2	2		After 6 hrs attempting to put out vsl fire, skipper contacted MRCC. C252 patrol aircraft, SAR helo, lifeboat & patrol ship tasked to scene. Helo winched 7 crew & xferred to shore. 7 crew xferred to lifeboat. Fire party fm ship put out fire & restored power. Patrol ship & tug escorted vsl to shore under own power.	
Small fishing Vsl	1/23/08	Sinking	*Royalist*	Dingle, Ireland		18				18			1			Stbd & port LRs launched into water. Port LR initially wedged on stbd side of wheelhouse roof, crew retrieved & donned immersion suits. Responding FV recovered all 18 crew fm LRs.	Skipper assessed vsl was sinking & initiated distress alarm & message. VHF broadcast received & responded to by FV 5 miles away.
Ro-ro cargo Vsl	1/31/08	Grounding	*Riverdance*	Shell Flats, Lancashire UK	4	19		23				2	7	3		2 RAF rescue helos, plus addl helo were dispatched. Initial winching of 4 pax & 10 rew by two helos. Remaining crew prepd to refloat vsl. Upon failure to refloat vsl, second Mayday bcst. Helo retuned for 9 remaining crew.	

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APPENDIX B. REQUEST FOR INFORMATION

U.S. Coast Guard Maritime Rescue Technology Market Research
Solicitation Number: HSCG32-10-I-R00012
Agency: Department of Homeland Security
Office: United States Coast Guard (USCG)
Location: Contracting Office, USCG Research and Development Center
Notice Type: Sources Sought
Posted Date: March 10, 2010
Response Date: May 05, 2010 5:00 pm Eastern
Archiving Policy: Automatic, 15 days after response date
Archive Date: May 20, 2010
Original Set Aside: N/A
Set Aside: N/A
Classification Code: A -- Research & Development

NAICS Code: 541 -- Professional, Scientific, and Technical Services/541712 -- Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology)

Synopsis: This Request for Information (RFI) is part of a market research effort to assess technologies that might permit outside intervention by rescue forces or "good Samaritans" in maritime mass-rescue incidents, including rescue or retrieval of persons from passenger vessels, hazardous predicaments in/or adjacent to water, or rescue of multiple persons in the water or from other hazardous maritime predicaments. As the primary agency for maritime Search and Rescue in the United States, the Coast Guard endeavors to minimize the loss of life and injury by rendering aid to persons in distress in the maritime environment. This RFI is issued for information and planning purposes only and does not constitute a solicitation. The Government does not intend to award a contract on the basis of this RFI or to otherwise pay for information received in response to this RFI.

The Coast Guard Research and Development Center (RDC) is conducting research to identify both operational and state-of-the art technologies and associated equipment applicable to maritime mass rescue. "Operational" in this context refers to existing technologies and equipment that are currently used in commercial and/or Government application, while "state-of-the art" in this context refers to proven and near-proven technologies that are expected to be available in the commercial and/or Government lifesaving, rescue and assistance market in the next 30 to 36 months.

The RDC intends to use the information collected from this RFI to conduct detailed systems analysis that quantifies and evaluates technology readiness and applicability, device or equipment capability, and acquisition and life-cycle operating costs. You are invited to respond with information to assist the RDC with its market research to identify potential sources of rescue technologies and associated equipment applicable to maritime mass rescue appropriate for use on, or deployment from Coast Guard/Government vessels or commercial vessels, 25 ft (7.6M) and larger, or capable of being deployed from fixed or rotary-wing aircraft operating in the worldwide maritime environment. Information on devices that rely on inflation, as well as those that rely on rigid structural elements (including fixed framing, foam flotation, or rigid shell) is also invited.

RESCUE TECHNOLOGY AREAS OF INTEREST

I. Rescue of multiple persons in the water

II. Rescue of large numbers of persons from a vessel that has sustained a significant casualty

III. Rescue of multiple persons from hazardous maritime predicaments

IV. Ability to provide multiple persons temporary refuge from the water

V. Ability to provide a platform for safe hoisting of a large number of persons simultaneously from the water, to working deck levels associated with high-freeboard cargo vessels, passenger vessels, and large combatant vessels (or ability to be raised by medium-lift helicopter).

SPECIFIC TECHNICAL INFORMATION REQUESTED

The following information, or best available estimate, is requested for each proposed solution. If multiple solutions are presented by the same entity, the information should be specific to each solution.

A. Equipment characteristics;

B. Equipment specifications;

C. Equipment capabilities/capacities;

D. Equipment Reliability;

E. Acquisition Cost;

F. Service Life;

G. Life Cycle Cost Parameters, Mean time between overhaul (MTBO), Mean Time Between Failures (MTBF), Planned Maintenance, training;

H. Operational Practices (e.g., including whether device operation relies on compressed gas, explosive or electrical charge, whether the deployed device allows unassisted victim use and self-rescue, etc.);

I. Space, Weight and Storage condition, along with Transportation Requirements; and

J. Ability to be delivered by aircraft (fixed-wing or rotary-wing) or from the deck of high-freeboard vessels (greater than 66 feet (20M)).

Note: The rescue technologies of interest are intended to be used in a maritime environment. Flotation, buoyancy, thermal protection, and ability to withstand exposure to winds and seas should be addressed with respect to each technology's specific technical information. In addition, the U.S. Coast Guard is frequently called upon to provide evacuation and rescue support in terrestrial natural and man-made disasters (earthquake, flood, fire, structural collapse, etc). Technologies associated with these potential uses should also be addressed.

GENERAL QUESTIONS APPLICABLE TO ALL AREAS OF INTEREST

The following questions/statements should be addressed for each solution response to this RFI. If multiple solutions are presented by the same entity, the responses to these questions should be specific to each solution.

A. What technologies/devices do you have that have the potential to address maritime mass rescue requirements in the five 'Rescue Technology Areas of Interest' listed above?

B. What agencies, governments, or other rescue service providers currently use the solution described?

C. What are your company's technical capabilities and technology development approach?

D. Are any development efforts or test activities currently underway or planned to mature your technology and/or assess its maturity?

E. Describe the effort required to mature your technology to a fully tested, ready for production technology readiness level in terms of development time and expense.
F. For each proposed solution, cite the appropriate standard or regulation that the equipment is intended to be certified/qualified to (e.g., IMO SOLAS, Code of Federal Regulations, ICAO/FAA, MILSTD, etc.)

RESPONDING TO THIS MARKET RESEARCH

Organizations responding to this RFI may respond to one or more of the five topics discussed with regard to the Rescue Technology Areas of Interest: I. Rescue of multiple persons in the water; II. Rescue of large numbers of persons from a vessel that has sustained a significant casualty; III. Rescue of multiple persons from hazardous predicaments; IV. Ability to provide multiple persons temporary refuge from the water; V. Ability to provide a platform for safe hoist of a large number of persons simultaneously from the water, to working deck levels associated with high-freeboard cargo vessels, passenger vessels, large combatants (or under medium-lift helicopters). Topics may be combined or treated individually.

When responding to each RFI topic, please include the following information:

- A one page cover letter that provides a brief summary of the response and indicating if supporting documentation is included.
- Descriptive material that addresses all areas of information requested by this RFI including the sections "SPECIFIC TECHNICAL INFORMATION REQUESTED" and "GENERAL QUESTIONS APPLICABLE TO ALL AREAS OF INTEREST." If pre-developed marketing or technical information and specification sheets are provided, please include additional information, as necessary to "fill the gaps" between pre-developed material and the information required. Digital photographs, line drawings, and illustrations that clarify descriptive text are encouraged.
- A description of any information relative to what capabilities are currently possible, and what additional capabilities may be achievable over the next 30 to 36 months
- A list of U.S. (or international) Government contracts for products being submitted where applicable
- Any digital photos and/or digital videos of the products in operation
- Business Size with regard to NAICS 541712

This RFI is issued for information and planning purposes only and does not constitute a solicitation. The Government does not intend to award a contract on the basis of this RFI or to otherwise pay for information received in response to this RFI. In accordance with FAR 15.201(e), responses to this RFI are not offers and will not be accepted by the U.S. Government to form a binding contract. Responses to this market survey should be sent to RDC-PF-MassRescue@uscg.mil. All questions regarding this RFI should also be sent to e-mail address RDC-PF-MassRescue@uscg.mil.

List of RFI targeted vendors:

- Air Cruisers: Aircruisers@zodiacaerospace.com
- Billy Pugh Company: bpc@billypugh.com
- Brooke-Ocean Technology, Ltd: sales@brooke-ocean.com
- DBC Marine Safety Systems - Zodiac: mark.hansen@zmp-zodiac.com
- Givens Marine Survival Company Incorporated: lperrino@givensliferafts.com
- Liferaft Systems Australia: info@LSAMES.com
- Lifesaving Systems Corporation: info@lifesavingsystems.com
- Markus Lifenet Ltd: info@markuslifenet.com
- MARSARS Water Rescue Systems: robert.davis02@snet.net
- Precision Lift Incorporated: jtollenaere@precisionliftinc.com
- Reflex Marine: info@reflexmarine.com
- RFD Beaufort: info@rfdbeaufort.com
- SES-System-Innovation: sessysteminnovation@chello.se
- Switlik Parachute Company: info@switlik.com
- Viking Life-Saving Equipment: VIKING@VIKING-life.com

APPENDIX C. EQUIPMENT VENDORS

Aerial Machine & Tool Corp.
4298 JEB Stuart Hwy
Vesta, VA 24177
www.aerialmachineandtool.com
(386) 624-5387

Airborne Systems Canada Ltd
35 Wilson Ave
Belleville, Ontario, Canada K8P 1R7
www.airborne-sys.com
(613) 967-8069 ext 4101

Billy Pugh Company, Inc.
5878 Agnes Street
Corpus Christi, TX 78406
www.billypugh.com
(361) 884-9351

DBC Marine Safety Systems/Zodiac
Unit 101 3760 Jacombs Road
Richmond V6V 1Y6, BC Canada V6V 1Y6
www.dbcmarine.com
(800) 931-3221 (In North America)

Givens Marine Survival Company, Inc.
550 Main Road
Tiverton, RI 02878
www.givensliferafts.com
(401) 624-7900

Liferaft Systems Australia
5 Sunmont Street
Derwent Park, Tasmania 7009
www.liferaftsystems.com.au
(604) 780-0016

Lifesaving Systems Corporation
220 Elsberry Road
Apollo Beach, FL 33572
www.lifesavingsystems.com
(813) 645-2748

Precision Lift, Inc
130 South Oak Pointe Drive
Seneca, SC 29672
www.precisionliftinc.com
(864) 985-0804

RFD Beaufort Limited
Kingsway, Dunmurry
Belfast BT17 9AF
Northern Ireland
+44 (028) 9030 1531
www.rfdbeaufort.com

Viking Life-Saving Equipment A/S
Saedding Ringvej 13
6710 Esbjerg V
Denmark
+45 76 11 81 00
www.viking-life.com

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APPENDIX D. CATALOG OF EQUIPMENT

The criteria in Table D-1 were used to determine equipment characteristic alignment with requirements. In a number of instances the available literature did not directly address equipment capabilities and specifications.

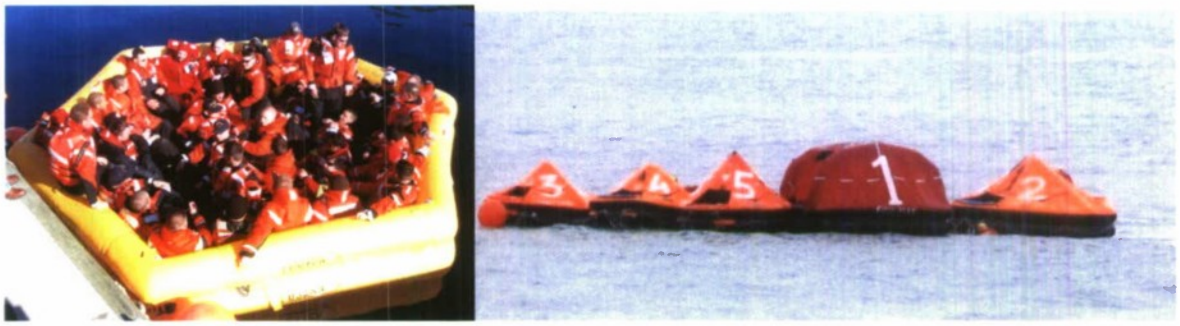

Figure D-1. Mass rescue equipment trials.

Table D-1. Criteria for equipment characteristic alignment with requirements.

Characteristic	Criteria
Transportation and Stowage	
Air deployable – rotary wing	Can be delivered/used by helicopter with no modifications to device and no or minor modifications to aircraft
Air deployable – fixed wing	Can be delivered by fixed wing aircraft with no modifications to device and no or minor modifications to aircraft
Vessel deployable – ship/cutter (crane or hoist)	Can be delivered/used by a vessel with a crane or hoist capable of lifting the device as designed (e.g. raft > 150 lbs configured to be delivered/used by said vessel)
Vessel deployable – boat (over the side)	Can be delivered/used by small vessel with no modifications to the vessel and deployed by no more than 2 people (e.g. raft < 150 lbs)
Land deployable – e.g., from a cliff, remote area	
Lightweight – can be carried by 1 or 2 people	Less than 150 lbs and capable of being carried by no more than 2 people
Easily/conveniently stowed	Device can be stored in folded or deflated state allowing stowage of multiple devices in space equivalent to the deployed condition
Capable of being stowed in multiple environments (w/o climate control)	Device is designed to be stored on deck of vessel or environmental requirements stated in literature

Table D-1. Criteria for equipment characteristic alignment with requirements (Continued).

Characteristic	Criteria
Deployment	
Self righting or reversible	Stated in literature
Activation by rescuees/survivors	
No inadvertent auto-inflation (e.g. not water activated - restriction on helos)	
Non-collapsing/rigid construction once deployed	Device is designed to be hoisted with survivors on board or device has rigid construction
Inherent buoyancy (undeployed)	Literature stated undeployed device has positive buoyancy
Inherent buoyancy (deployed)	Liferafts or literature stated device has positive buoyancy deployed
Simple operation - only 1 or 2 steps	
Few moving parts	
Instructions with international signage	SOLAS compliant or stated in literature
Device can be lifted with survivors on board	Intended design or stated in literature (e.g. Means of Rescue Life Raft)
Physical Characteristics	
Multiple sizes to fit different delivery platforms & capacities	Stated in literature
Low freeboard or ramp/platform	Ramp/ladder/design allows access be unassisted able personnel in the water
Victims ability to rescue other victims (assist disabled survivors)	
Minimal Leeway	Ballast devices or drogue equipped
High visibility (day/night)	SOLAS compliant or stated in literature
Radar reflectivity	SOLAS compliant or stated in literature
Abrasion resistant	Stated in literature
Shock/Impact resistant	Stated in literature or metal construction
Puncture resistant	Stated in literature
Chemical resistance	Stated in literature
Heat resistant (fire)	Stated in literature
Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)	
Maintenance	
Long shelf life	
Minimal maintenance - easy - low cost – infrequent	
Life Support	
Short Term (<24 hrs)	Refuge from water – no protection from sun/weather
Medium Term (24-48 hrs)	Refuge from water – protection from sun/weather
Long Term (>48 hrs)	Refuge from water – protection from sun/weather – some medical/food/water supplies
Arctic Survival	
Tropical Survival	
High Sea State	

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Company: Aerial Machine & Tool Corp. **Equipment Name: SQUID**

Description: The SQUID is a foldable aluminum frame with five nets. The flotation is given by synthetic foam and neoprene. Considered by the manufacturer to be light, easy to operate, easy to maintain, the SQUID is designed to be intuitive. According to the vendor, due to its fully adapted shape and structure, deployment of SQUID over sea is a quick operation.

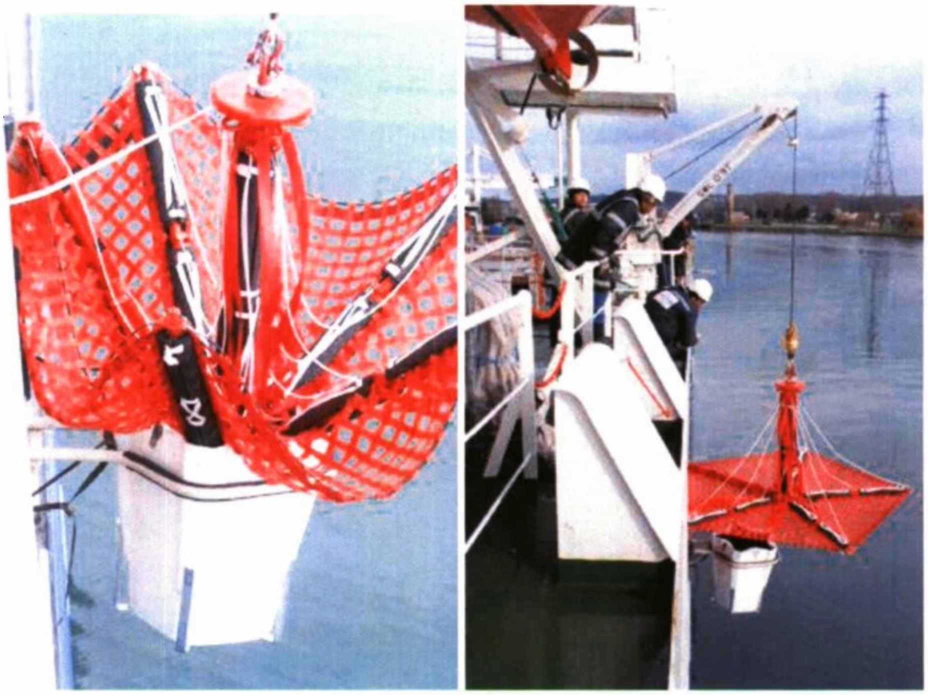

Figure D-2. SQUID.

Physical Characteristics

Length Stored (ft):	5.5	**Length Deployed (ft):**	9.5	**Capacity People:**	10
Width Stored (ft):	2.5	**Width Deployed (ft):**	9.5	**Capacity Payload:**	3300 lbs
Height Stored (ft):	2.5	**Height Deployed (ft):**	4.9		
Weight Stored (lbs):	176.4				

LifeCycle Cost

Acquisition Cost Each:	$66,124	**Planned Annual Maint Hrs:**	12 hours - carried out by personnel on-board
Service Life:	15 years	**MTBO:**	5 years

Operational Characteristics

Transport Requirements: Designed to be stored on deck and deployed over the side with hoist or crane.

Delivery Methods: Ability to be delivered by rotary - wing aircraft or from the deck of high-freeboard vessels (greater than 66 feet (20 m))

Flotation: The inherent flotation capacity is given by synthetic foam and neoprene.

Company: Aerial Machine & Tool Corp. **Equipment Name: SQUID**

Table D-2. SQUID characteristics.

				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
X				Air deployable – rotary wing *(with modifications to the device)*
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
			X	Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
			X	Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
		X		Self righting or reversible
		X		Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
		X		Inherent buoyancy (undeployed)
		X		Inherent buoyancy (deployed)
X				Simple operation - only 1 or 2 steps
X				Few moving parts
			X	Instructions with international signage
X				Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
	X			Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
		X		Minimal Leeway
		X		High visibility (day/night)
		X		Radar reflectivity
		X		Abrasion resistant
		X		Shock/Impact resistant
		X		Puncture resistant
		X		Chemical resistance
		X		Heat resistant (fire)
	X			Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
X				Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
	X			Short Term (<24 hrs)
	X			Medium Term (24-48 hrs)
	X			Long Term (>48 hrs)
	X			Arctic Survival
	X			Tropical Survival
	X			High Sea State

Company: Airborne Systems Canada Ltd **Equipment Name: Aerial Rescue Kit**

Description: The Aerial Rescue Kit (ARK) is a manually deployed air-to-sea rescue system that can be deployed as a single unit or as an interconnected system of multiple life raft units. The system is hand-deployed from aft ramps or side door of fixed wing aircraft.

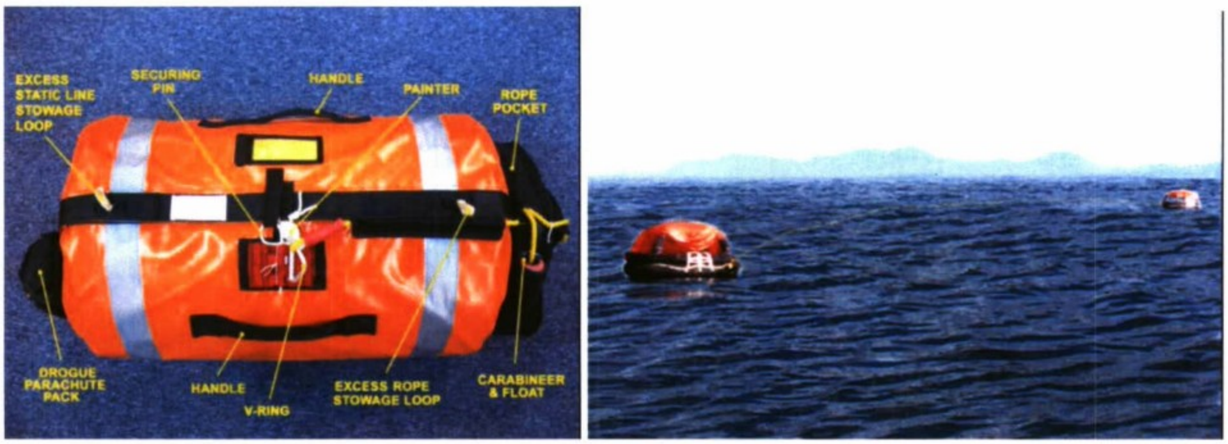

Figure D-3. Aerial Rescue Kit.

Physical Characteristics

Length Stored (ft):	3.0	**Length Deployed (ft):**		**Capacity People: 10 per raft**
Width Stored (ft):	1.3	**Width Deployed (ft):**		**Capacity Payload:**
Height Stored (ft):	1.3	**Height Deployed (ft):**		
Weight Stored (lbs):	90.0			

LifeCycle Cost

Acquisition Cost Each:	$15,000	**Planned Annual Maint Hrs:**	
Service Life:	10 Years	**MTBO:**	

Operational Characteristics

Transport Requirements: The ARK system can be deployed with 1 to 4 kits (or more if desired) for each drop with a release altitude typically between 150 and 1000 ft. As system operation is not dependent on release altitude, a suitable increase in release altitude would allow for additional kits to be added.

Delivery Methods: The system is hand-deployed from fixed wing aircrafts at an altitude of 150 to 1000 feet above ground level (AGL) and at a speed of 130-150 knots. The deployment is made from the aft ramp or from the side door of the aircraft. Descent rate is less than 70 ft/sec with the assistance of a stabilizing drogue parachute. Accuracy of delivery is enhanced by a proprietary water-activated device which inflates the life raft upon the kit's immersion in water and minimizes wind drift during descent. A fast-acting, automatically-deployed sea anchor improves raft inflation and stability characteristics. Although "right way up" inflation cannot be guaranteed, the life rafts employed by the Canadian Forces are packed in such a manner that it has achieved 100% right way up inflation in more than thirty consecutive drops during trials.

Flotation: Upon entering the water, the water-activated inflation device initiates the inflation of the life raft.

Company: Airborne Systems Canada Ltd **Equipment Name: Aerial Rescue Kit**

Table D-3. Aerial Rescue Kit characteristics.

				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
X				Air deployable – fixed wing
	X			Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
X				Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
			X	Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
	X			Self righting or reversible
	X			Activation by rescues/survivors
	X			No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
			X	Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
X				Simple operation - only 1 or 2 steps
X				Few moving parts
			X	Instructions with international signage
			X	Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
			X	Victims ability to rescue other victims (assist disabled survivors)
			X	Minimal Leeway
			X	High visibility (day/night)
			X	Radar reflectivity
			X	Abrasion resistant
X				Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
		X		Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
			X	Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
X				Medium Term (24-48 hrs)
	X			Long Term (>48 hrs)
	X			Arctic Survival
			X	Tropical Survival
			X	High Sea State

Company: Airborne Systems Canada Ltd **Equipment Name: HELICOPTER AERIAL RESCUE KIT**

Description: The Helicopter Aerial Rescue Kit (HARK) System is deployed from a rotary wing transport aircraft. The HARK is a manually deployed air-to-sea rescue system – each kit deployed provides temporary shelter, with sufficient survival contents to sustain life for 6-10 persons for 24 hours. Up to 2 kits with buoyant, connecting rope can be dropped allowing for refuge for 12-20 persons in one deployment pass.

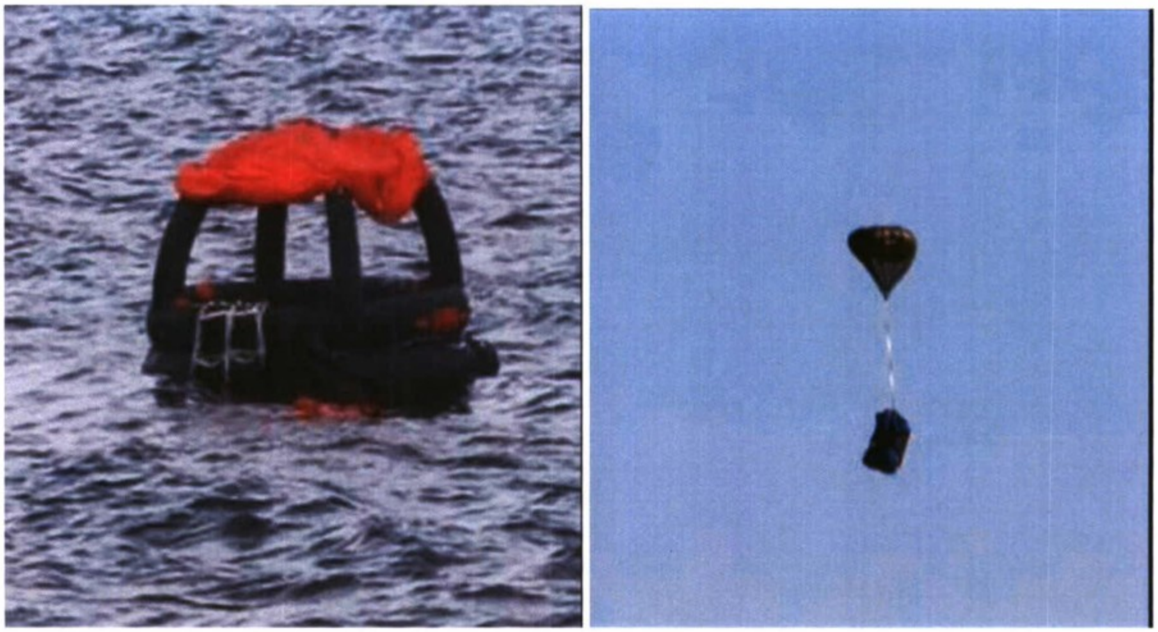

Figure D-4. Helicopter Aerial Rescue Kit.

Physical Characteristics

Length Stored (ft):	2.7	**Length Deployed (ft):**		**Capacity People: 10 per raft**
Width Stored (ft):	1.3	**Width Deployed (ft):**		**Capacity Payload:**
Height Stored (ft):	1.0	**Height Deployed (ft):**		
Weight Stored (lbs):	90.0			

LifeCycle Cost

Acquisition Cost Each:	**Planned Annual Maint Hrs:**
Service Life:	**MTBO:**

Operational Characteristics

Transport Requirements: The HARK System is deployed from a rotary wing transport aircraft at an altitude of 30 to 1000 ft AGL.

Delivery Methods: The system includes a drogue chute to slow and stabilize the descent to a safe velocity on water impact. An added feature is the option to disengage the drogue chute for low-level drops.

Flotation: Upon entering the water, the water-activated inflation device initiates the inflation of the life raft.

Company: Airborne Systems Canada Ltd **Equipment Name: HELICOPTER AERIAL RESCUE KIT**

Table D-4. Helicopter Aerial Rescue Kit characteristics.

				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
X				Air deployable – rotary wing
	X			Air deployable – fixed wing
			X	Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
			X	Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
			X	Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
	X			Self righting or reversible
	X			Activation by rescues/survivors
	X			No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
			X	Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
X				Simple operation - only 1 or 2 steps
X				Few moving parts
			X	Instructions with international signage
			X	Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
			X	Victims ability to rescue other victims (assist disabled survivors)
X				Minimal Leeway
			X	High visibility (day/night)
			X	Radar reflectivity
			X	Abrasion resistant
X				Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
		X		Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
			X	Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
X				Medium Term (24-48 hrs)
	X			Long Term (>48 hrs)
	X			Arctic Survival
			X	Tropical Survival
			X	High Sea State

Company: Airborne Systems Canada Ltd **Equipment Name: SURVIVAL KIT AIR DROPPABLE**

Description: The Survival Kit Air Droppable (SKAD) system is a torpedo- like container mounted on the "Hard Points" of all fighter and patrol Aircraft. This system is suitable for delivery under special conditions: when fast delivery and/or deliveries over very long distances are required.

Figure D-5. Survival Kit Air Droppable.

Physical Characteristics

Length Stored (ft):		**Length Deployed (ft):**		**Capacity People:**	10 per raft
Width Stored (ft):		**Width Deployed (ft):**		**Capacity Payload:**	
Height Stored (ft):		**Height Deployed (ft):**			
Weight Stored (lbs):	330.0				

LifeCycle Cost

Acquisition Cost Each:		**Planned Annual Maint Hrs:**	
Service Life:		**MTBO:**	

Operational Characteristics

Transport Requirements: Each SKAD system is capable of delivering 2 valises - each valise contains a life raft (6 or 10-man) and survival contents. The life raft is automatically inflated by a compressed gas cylinder and survival contents are vacuum-packed and secured inside the life raft for easy access and to avoid loss, damage, or accidental cut-away by survivors.

Delivery Methods: The heavyweight SKAD is deployed from Maritime Patrol Aircraft. It is carried on the weapons racks of fighter and patrol aircraft and delivers two 10-man life rafts complete with survival contents.

Flotation: Upon entering the water, the water-activated inflation device initiates the inflation of the life raft.

Company: Airborne Systems Canada Ltd **Equipment Name: SURVIVAL KIT AIR DROPPABLE**

Table D-5. Survival Kit Air Droppable characteristics.

				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
X				Air deployable – fixed wing
	X			Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
X				Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
			X	Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
	X			Self righting or reversible
	X			Activation by rescues/survivors
	X			No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
			X	Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
X				Simple operation - only 1 or 2 steps
X				Few moving parts
			X	Instructions with international signage
			X	Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
X				Minimal Leeway
			X	High visibility (day/night)
			X	Radar reflectivity
			X	Abrasion resistant
X				Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
		X		Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
			X	Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
X				Medium Term (24-48 hrs)
	X			Long Term (>48 hrs)
	X			Arctic Survival
			X	Tropical Survival
			X	High Sea State

Company: Billy Pugh Company, Inc. **Equipment Name: X-904 Transfer Device**

Description: This device is designed to transfer people between oil platforms and vessels. It is made of an aluminum skeleton. It is available in sizes for 4, 6, 8, 10, or 12 people. The data below are for the 12-person version.

Figure D-6. X-904 Transfer Device.

Physical Characteristics

Length Stored (ft): 10
Width Stored (ft): 10
Height Stored (ft): 2.3
Weight Stored (lbs): 850

Length Deployed (ft): 10
Width Deployed (ft): 10
Height Deployed (ft): 8.3

Capacity People: 12
Capacity Payload (lbs): 3600

LifeCycle Cost

Acquisition Cost Each: $51,156
Service Life: The frame is guaranteed for a minimum of 6 years.

Planned Annual Maint Hrs: 2
MTBO: Vendor recommends that the unit be refurbished every two years of operation.

Operational Characteristics

Transport Requirements: The unit will have to be transported via permit as it is too large to ship common carrier.

Delivery Methods: This device is moved using a crane. Passengers need to be able to hold on to the device and interlock arms with each other.

Flotation: This device is not designed for use on the water.

Company: Billy Pugh Company, Inc. **Equipment Name: X-904 Transfer Device**

Table D-6. X-904 Transfer Device characteristics.

				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
			X	Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
			X	Lightweight – can be carried by 1 or 2 people
			X	Easily/conveniently stowed
			X	Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
	X			Self righting or reversible
		X		Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
	X			Inherent buoyancy (undeployed)
	X			Inherent buoyancy (deployed)
X				Simple operation - only 1 or 2 steps
X				Few moving parts
			X	Instructions with international signage
X				Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
		X		Low freeboard or ramp/platform
			X	Victims ability to rescue other victims (assist disabled survivors)
		X		Minimal Leeway
		X		High visibility (day/night)
		X		Radar reflectivity
X				Abrasion resistant
X				Shock/Impact resistant
		X		Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
		X		Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
X				Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
	X			Short Term (<24 hrs)
	X			Medium Term (24-48 hrs)
	X			Long Term (>48 hrs)
	X			Arctic Survival
	X			Tropical Survival
	X			High Sea State

Company: DBC Marine Safety Systems/Zodiac **Equipment Name: Davit Launched Liferafts**

Description: Davit launched liferafts are specially designed for use on passenger vessels and cruise ships where they are inflated at deck level in front of muster stations and then lowered by a davit with the passengers on board. An extensive range includes 12, 16, 20, 25, and 37 person liferafts. The 37 person SOLAS A pack version is described here.

Figure D-7. Davit Launched Liferafts.

Physical Characteristics

Length Stored (ft):	4.9	**Length Deployed (ft):**	17.9	**Capacity People:**	37
Width Stored (ft):	3.1	**Width Deployed (ft):**	15.2	**Capacity Payload (lbs):**	6,105
Height Stored (ft):	3.1	**Height Deployed (ft):**	9.8		
Weight Stored (lbs):	683.4				

LifeCycle Cost

Acquisition Cost Each: $ 12,575

Planned Annual Maint Hrs: 12 (by authorized Zodiac service station only)

Service Life: 12-20 years (subject to annual service)

MTBO: 1 year (regulatory requirement)

Operational Characteristics

Transport Requirements: Mounted to ship in float free arrangement.

Delivery Methods: Inflated at deck level in front of muster stations and then lowered by a davit with the passengers on board. Designed to be launched by a davit, ZODIAC davit-launched liferafts can also be dropped from up to 36 meters in emergency evacuation conditions. 25 and 37 person davit-launched liferaft (A Pack) can be dropped from 25 meters.

Flotation: Packed raft also floats. This allows for raft to float away from sinking ship.

Company: DBC Marine Safety Systems/Zodiac **Equipment Name: Davit Launched Liferafts**

Table D-7. Davit Launched Liferafts characteristics.

Transportation and Stowage				
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
X				Capable of being stowed in multiple environments (w/o climate control)
Deployment				
Y	**N**	**N/A**	**UNK**	
			X	Self righting or reversible
	X			Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
X				Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
	X			Simple operation - only 1 or 2 steps
			X	Few moving parts
			X	Instructions with international signage
X				Device can be lifted with survivors on board
Physical Characteristics				
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
			X	Minimal Leeway
X				High visibility (day/night)
X				Radar reflectivity
			X	Abrasion resistant
			X	Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
X				Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
Maintenance				
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
	X			Minimal maintenance - easy - low cost – infrequent
Life Support				
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
X				Medium Term (24-48 hrs)
			X	Long Term (>48 hrs)
			X	Arctic Survival
			X	Tropical Survival
			X	High Sea State

Company: DBC Marine Safety Systems/Zodiac **Equipment Name: Inflatable Buoyant Apparatus Liferaft**

Description: The inflatable buoyant apparatus (IBA) liferafts have been designed for passenger carrying vessels operating on protected waters where a full offshore liferaft is not required. The 4, 6, 10, 20, 30, 50, and 100 person sizes are available. The 100 person capacity version is described here.


Figure D-8. Inflatable Buoyant Apparatus Liferaft.

Physical Characteristics

Length Stored (ft):	5.1	**Length Deployed (ft):**	36.8	**Capacity People:**	100
Width Stored (ft):	2.8	**Width Deployed (ft):**	20.0	**Capacity Payload (lbs):**	16,500
Height Stored (ft):	2.7	**Height Deployed (ft):**	3.3		
Weight Stored (lbs):	665.8				

LifeCycle Cost

Acquisition Cost Each: $12,395

Planned Annual Maint Hrs: 9 (by authorized Zodiac service station only)

Service Life: ~12-20 years (subject to annual service)

MTBO: 1 year (regulatory requirement)

Operational Characteristics

Transport Requirements: Mounted to ship in float free arrangement with self launching rack.

Delivery Methods: Launched by self launching rack, inflated after container is in water and positioned to correct area. Used by itself or in association with chute or slide marine evacuation system. Typical maximum stowage height is ~59 ft (18 m).

Flotation: Packed raft also floats. This allows for raft be positioned after launching from rack to an embarkation area easily and so the raft can float away from sinking ship.

Company: DBC Marine Safety Systems/Zodiac **Equipment Name: Inflatable Buoyant Apparatus Liferaft**

Table D-8. Inflatable Buoyant Apparatus Liferaft characteristics.

				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
	X			Easily/conveniently stowed
X				Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
			X	Self righting or reversible
			X	Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
X				Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
X				Simple operation - only 1 or 2 steps
			X	Few moving parts
			X	Instructions with international signage
	X			Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
			X	Minimal Leeway
			X	High visibility (day/night)
			X	Radar reflectivity
			X	Abrasion resistant
			X	Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
X				Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
	X			Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
	X			Medium Term (24-48 hrs)
	X			Long Term (>48 hrs)
	X			Arctic Survival
	X			Tropical Survival
	X			High Sea State

Company: DBC Marine Safety Systems/Zodiac **Equipment Name: MOR Liferaft**

Description: The Zodiac MOR (Means of Rescue) was specially developed to meet the latest requirements introduced for Roll On/Roll Off passenger ships and is fully approved. Now mandatory on board Ro-ro passenger ships, it provides a safe transfer of survivors from sea level to the deck of the ship in rescue operations.

Figure D-9. MOR Liferaft.

Physical Characteristics

Length Stored (ft):	4.2	**Length Deployed (ft):**	13.8	**Capacity People:**	10
Width Stored (ft):	2.0	**Width Deployed (ft):**	13.8	**Capacity Payload (lbs):**	1,650
Height Stored (ft):	1.9	**Height Deployed (ft):**	6.2		
Weight Stored (lbs):	264.6				

LifeCycle Cost

Acquisition Cost Each: $6,450

Service Life: ~12-20 years

Planned Annual Maint Hrs: 8.5 (by authorized Zodiac service station only)

MTBO: 1 year (regulatory requirement)

Operational Characteristics

Transport Requirements: Mounted to ship in float free arrangement.

Delivery Methods: Inflated at deck level while attached to davit. The MOR is then lowered to the water for those in the water to board. The MOR, with passengers, is then raised up again by the davit to deck level to disembark. Typical maximum stowage height is ~ 59 ft (18 m).

Flotation: Packed raft also floats. This allows for raft to float away from sinking ship.

Company: DBC Marine Safety Systems/Zodiac **Equipment Name: MOR Liferaft**

Table D-9. MOR Liferaft characteristics.

Y	N	N/A	UNK	
				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
X				Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
			X	Self righting or reversible
	X			Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
X				Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
			X	Simple operation - only 1 or 2 steps
			X	Few moving parts
			X	Instructions with international signage
X				Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
			X	Minimal Leeway
			X	High visibility (day/night)
			X	Radar reflectivity
			X	Abrasion resistant
			X	Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
X				Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
	X			Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
	X			Medium Term (24-48 hrs)
	X			Long Term (>48 hrs)
	X			Arctic Survival
	X			Tropical Survival
	X			High Sea State

Company: **DBC Marine Safety Systems/Zodiac** **Equipment Name:** **Open Reversible Inflatable Liferaft**

Description: These liferafts are used by passenger ship and fishing vessels on inland or coastal waters. Open Reversible Inflatable Liferafts (ORILs) are designed for immediate use, no matter which side up they inflate. An extensive range includes 4, 6, 10, 20, 30, 50, 100, and 151 person liferafts. The 151 person capacity version is described here.

Figure D-10. Open Reversible Inflatable Liferaft.

Physical Characteristics

Length Stored (ft): 5.1
Width Stored (ft): 3.1
Height Stored (ft): 3.1
Weight Stored (lbs): 791.5

Length Deployed (ft): 48.6
Width Deployed (ft): 18.1
Height Deployed (ft): 3.4

Capacity People: 151
Capacity Payload (lbs): 24,915

LifeCycle Cost

Acquisition Cost Each: $22,625

Planned Annual Maint Hrs: 10.5 (by authorized Zodiac service station only)

Service Life: ~12-20 years (subject to annual service)

MTBO: 1 year (regulatory requirement)

Operational Characteristics

Transport Requirements: Mounted to ship in float free arrangement with self launching rack.

Delivery Methods: Launched by self launching rack, inflated after container is in water and positioned to correct area. Used by itself or in association with chute or slide marine evacuation system. Typical maximum stowage height is 59 ft (18 m).

Flotation: Packed raft also floats. This allows for raft be positioned after launching from rack to an embarkation area easily and so the raft can float away from sinking ship.

Company: DBC Marine Safety Systems/Zodiac **Equipment Name: Open Reversible Inflatable Liferaft**

Table D-10. Open Reversible Inflatable Liferaft characteristics.

Transportation and Stowage				
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
			X	Capable of being stowed in multiple environments (w/o climate control)
Deployment				
Y	**N**	**N/A**	**UNK**	
X				Self righting or reversible
			X	Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
	X			Non-collapsing/rigid construction once deployed
X				Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
			X	Simple operation - only 1 or 2 steps
			X	Few moving parts
			X	Instructions with international signage
	X			Device can be lifted with survivors on board
Physical Characteristics				
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
			X	Minimal Leeway
			X	High visibility (day/night)
			X	Radar reflectivity
			X	Abrasion resistant
			X	Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
X				Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
Maintenance				
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
	X			Minimal maintenance - easy - low cost – infrequent
Life Support				
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
	X			Medium Term (24-48 hrs)
	X			Long Term (>48 hrs)
	X			Arctic Survival
	X			Tropical Survival
	X			High Sea State

Company: **DBC Marine Safety Systems/Zodiac** **Equipment Name:** **Reversible Liferaft**

Description: This is a canopied reversible liferaft which is stable in a seaway and capable of operating safely whichever way up it is floating. It is available in a 50 person capacity as well as the 150 person capacity described here. Self-righting liferafts also available.

Figure D-11. Reversible Liferaft.

Physical Characteristics

Length Stored (ft):	7.4	**Length Deployed (ft):**	48	**Capacity People:**	150
Width Stored (ft):	3.8	**Width Deployed (ft):**	11.9	**Capacity Payload (lbs):**	24,750
Height Stored (ft):	3.8	**Height Deployed (ft):**	10		
Weight Stored (lbs):	1165				

LifeCycle Cost

Acquisition Cost Each: $54,600

Planned Annual Maint Hrs: 26.5 (by authorized Zodiac service station only)

Service Life:~12-20 years (subject to annual inspection)

MTBO: 1 year (regulatory requirement)

Operational Characteristics

Transport Requirements: Mounted to ship in float free arrangement with self launching rack.

Delivery Methods: Launched by self launching rack, inflated after container is in water and positioned to correct area. Used by itself or in association with chute or slide marine evacuation system. Typical maximum stowage height is 59 ft (18 m). 82 ft (25 m) height available for some rafts. Maximum slide height 30.5 ft (9.3 m). Slides can be used with rope ladders to bring people on board.

Flotation: Packed raft also floats. This allows for raft be positioned after launching from rack to an embarkation area easily and so the raft can float away from sinking ship.

Company: DBC Marine Safety Systems/Zodiac **Equipment Name: Reversible Liferaft**

Table D-11. Reversible Liferaft characteristics.

Y	N	N/A	UNK	
				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
	X			Easily/conveniently stowed
X				Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
X				Self righting or reversible
			X	Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
X				Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
X				Simple operation - only 1 or 2 steps
			X	Few moving parts
			X	Instructions with international signage
	X			Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
X				Minimal Leeway
			X	High visibility (day/night)
			X	Radar reflectivity
			X	Abrasion resistant
			X	Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
			X	Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
	X			Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
X				Medium Term (24-48 hrs)
			X	Long Term (>48 hrs)
			X	Arctic Survival
			X	Tropical Survival
			X	High Sea State

Company: Givens Marine Survival Company, Inc. **Equipment Name: Givens Buoy Life Raft**

Description: The Givens Buoy Life Raft is designed to protect occupants in extreme weather conditions. Vendor claims it has been tested by both the U.S. Coast Guard and the U.S. Navy, every time proving itself as the most stable life raft available. It will not capsize, even under hurricane force winds and 35 foot seas.

Figure D-12. Givens Buoy Life Raft.

Physical Characteristics

Length Stored (ft):	3.3	**Length Deployed (ft):**		**Capacity People:**	10
Width Stored (ft):	2.2	**Width Deployed (ft):**		**Capacity Payload:**	
Height Stored (ft):	1.3	**Height Deployed (ft):**			
Weight Stored (lbs):	130.0				

LifeCycle Cost

Acquisition Cost Each: **Planned Annual Maint Hrs:**
Service Life: **MTBO:**

Operational Characteristics

Transport Requirements:
Delivery Methods:
Flotation:

Company: Givens Marine Survival Company, Inc. **Equipment Name: Givens Buoy Life Raft**

Table D-12. Givens Buoy Life Raft characteristics.

Y	N	N/A	UNK	
				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
X				Vessel deployable – boat (over the side)
			X	Land deployable – e.g., from a cliff, remote area
X				Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
X				Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
			X	Self righting or reversible
X				Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
			X	Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
X				Simple operation - only 1 or 2 steps
X				Few moving parts
			X	Instructions with international signage
	X			Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
X				Minimal Leeway
			X	High visibility (day/night)
			X	Radar reflectivity
X				Abrasion resistant
X				Shock/Impact resistant
X				Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
			X	Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
			X	Long shelf life
			X	Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
X				Medium Term (24-48 hrs)
			X	Long Term (>48 hrs)
			X	Arctic Survival
X				Tropical Survival
X				High Sea State

Company: Liferaft Systems Australia **Equipment Name: Marine Evacuation System**

Description: The Liferaft Systems Australia (LSA) marine evacuation system (MES) delivers passengers and crew, dry shod, directly into liferafts. The system also has the unique capability of recovering passengers back on board in a rescue situation. The inflatable slide comes in a variety of lengths from 9-20 m (29-66 ft).

Figure D-13. Marine Evacuation System (Slide Only).

Physical Characteristics

Length Stored (ft): 5.7 **Length Deployed (ft):** 29-66 **Capacity People:** N/A
Width Stored (ft): 6.7 **Width Deployed (ft):** **Capacity Payload:** N/A
Height Stored (ft): 6.6 **Height Deployed (ft):**
Weight Stored (lbs): 2580 (includes Open Reversible Life Raft)

LifeCycle Cost

Acquisition Cost Each: **Planned Annual Maint Hrs:**
Service Life: **MTBO:**

Operational Characteristics

Transport Requirements:

Delivery Methods: The system can either be released by a manually operated vacuum release system or by a hydrostatic release unit.

Flotation:

Company: Liferaft Systems Australia **Equipment Name: Marine Evacuation System (Slide Only)**

Table D-13. Marine Evacuation System (Slide Only) characteristics.

				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
		X		Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
X				Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
		X		Self righting or reversible
		X		Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
			X	Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
X				Simple operation - only 1 or 2 steps
X				Few moving parts
			X	Instructions with international signage
	X			Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
		X		Victims ability to rescue other victims (assist disabled survivors)
		X		Minimal Leeway
		X		High visibility (day/night)
		X		Radar reflectivity
		X		Abrasion resistant
		X		Shock/Impact resistant
		X		Puncture resistant
		X		Chemical resistance
		X		Heat resistant (fire)
			X	Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
	X			Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
	X			Short Term (<24 hrs)
	X			Medium Term (24-48 hrs)
	X			Long Term (>48 hrs)
	X			Arctic Survival
	X			Tropical Survival
	X			High Sea State

Company: Liferaft Systems Australia **Equipment Name: Self-righting Liferaft**

Description: The 100 person self-righting liferaft is made from polyurethane coated polyamide textile (50-person model also available). A weather-proof canopy is double skinned for insulation purposes. The canopy incorporates two entrances, with closures, vents, rainwater catchment system, and observation ports. The liferaft is equipped with internal and external life lines, a sea anchor, battery powered internal and external lights, boarding ramps and water pockets for stability. The liferaft is inflated with a carbon dioxide/nitrogen gas mixture stored in four high pressure aluminum gas bottles. SOLAS "A" scale or SOLAS "B" scale emergency packs are packed together with written instructions, paddles and bailers. The complete liferaft is packed in a two part cylindrical glass reinforced plastic fiber container.

Figure D-14. Self-righting Liferaft.

Physical Characteristics

Length Stored (ft):	6.3	Length Deployed (ft):	37.7	Capacity People:	100
Width Stored (ft):	3.0	Width Deployed (ft):	17.1	Capacity Payload:	
Height Stored (ft):		Height Deployed (ft):	10.3		
Weight Stored (lbs):	902				

LifeCycle Cost

Acquisition Cost Each:	Planned Annual Maint Hrs:
Service Life:	MTBO:

Operational Characteristics

Transport Requirements: The liferafts are operationally packed and stowed in a purpose built glass-fibre container which is held closed by a series of tensioned webbing straps.

Delivery Methods: The raft is connected to the MES slide and deploys with it.

Flotation:

Company: Liferaft Systems Australia **Equipment Name: Self-righting Liferaft**

Table D-14. Self-righting Liferaft characteristics.

Y	N	N/A	UNK	
				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
			X	Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
X				Self righting or reversible
			X	Activation by rescues/survivors
			X	No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
			X	Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
X				Simple operation - only 1 or 2 steps
X				Few moving parts
X				Instructions with international signage
	X			Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
X				Minimal Leeway
X				High visibility (day/night)
X				Radar reflectivity
			X	Abrasion resistant
			X	Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
			X	Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
			X	Long shelf life
			X	Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
X				Medium Term (24-48 hrs)
			X	Long Term (>48 hrs)
			X	Arctic Survival
			X	Tropical Survival
			X	High Sea State

Company: Liferaft Systems Australia **Equipment Name: Open Reversible Liferaft (ORL)**

Description: The 128 person open-reversible liferaft is made from polyurethane coated polyamide textile. The liferaft is equipped with internal and external life lines, a sea anchor, boarding ramps and water pockets for stability. The liferaft is inflated with a carbon dioxide/nitrogen gas mixture stored in four high pressure aluminum gas bottles. High-Speed Craft scale emergency packs are packed together with written instructions, paddles and bailers. The complete liferaft is packed in a two part cylindrical glass reinforced plastic fiber container.

Figure D-15. Open Reversible Liferaft.

Physical Characteristics

Length Stored (ft):	6.3	Length Deployed (ft):	37.7	Capacity People:	128
Width Stored (ft):	3.0	Width Deployed (ft):	17.1	Capacity Payload:	
Height Stored (ft):		Height Deployed (ft):			
Weight Stored (lbs):	816				

LifeCycle Cost

Acquisition Cost Each:
Service Life:

Planned Annual Maint Hrs:
MTBO:

Operational Characteristics

Transport Requirements: The liferafts are operationally packed and stowed in a purpose built glass-fibre container which is held closed by a series of tensioned webbing straps.

Delivery Methods:

Flotation:

Company: Liferaft Systems Australia **Equipment Name: Open Reversible Liferaft (ORL)**

Table D-15. Open Reversible Liferaft characteristics.

Y	N	N/A	UNK	
				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
			X	Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
X				Self righting or reversible
	X			Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
			X	Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
X				Simple operation - only 1 or 2 steps
X				Few moving parts
X				Instructions with international signage
	X			Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
	X			Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
X				Minimal Leeway
			X	High visibility (day/night)
			X	Radar reflectivity
			X	Abrasion resistant
			X	Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
			X	Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
			X	Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
	X			Medium Term (24-48 hrs)
	X			Long Term (>48 hrs)
	X			Arctic Survival
	X			Tropical Survival
	X			High Sea State

Company: Lifesaving Systems Corporation **Equipment Name: Law Enforcement Emergency Pack**

Description: The Law Enforcement Emergency Pack is offered in a 4-person life raft system but can be scaled up to 6, 8, or 12 person sizes to meet end user requirements. It is a lightweight, air-droppable and auto-deployable life raft system. It enables the aircrew of coastal and lakeside operators that do not possess a hoist or other recovery capability to render immediate assistance to survivors of an in-water related emergency. Just hover and deploy upwind of survivors, in seconds you have a 4-person life raft ready for boarding. The 10 ft static line initiates inflation prior to the raft hitting the water, and the bi-directional (reversible) design ensures the raft can be boarded no matter how it lands. Entire system is packed in an indestructible Pelican Case for easy transport, or transfer between aircraft.

Figure D-16. Law Enforcement Emergency Pack.

Physical Characteristics

Length Stored (ft):	1.54	Length Deployed (ft):		Capacity People:	4
Width Stored (ft):	1.29	Width Deployed (ft):		Capacity Payload:	
Height Stored (ft):	0.58	Height Deployed (ft):			
Weight Stored (lbs):	23.0				

LifeCycle Cost

Acquisition Cost Each:	Planned Annual Maint Hrs:
Service Life:	MTBO:

Operational Characteristics

Transport Requirements:
Delivery Methods: Deployed by helo and inflated with static cord.
Flotation:

Company: Lifesaving Systems Corporation **Equipment Name: Law Enforcement Emergency Pack**

Table D-16. Law Enforcement Emergency Pack characteristics.

Y	N	N/A	UNK	Transportation and Stowage
X				Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
X				Vessel deployable – boat (over the side)
			X	Land deployable – e.g., from a cliff, remote area
X				Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
			X	Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
X				Self righting or reversible
	X			Activation by rescues/survivors
X				No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
	X			Non-collapsing/rigid construction once deployed
			X	Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
X				Simple operation - only 1 or 2 steps
X				Few moving parts
	X			Instructions with international signage
	X			Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
	X			Victims ability to rescue other victims (assist disabled survivors)
	X			Minimal Leeway
			X	High visibility (day/night)
			X	Radar reflectivity
			X	Abrasion resistant
			X	Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
	X			Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
			X	Long shelf life
			X	Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
	X			Medium Term (24-48 hrs)
	X			Long Term (>48 hrs)
	X			Arctic Survival
	X			Tropical Survival
	X			High Sea State

Company: Precision Lift, Inc **Equipment Name: HELI-BASKET HB2000**

Description: The Heli-Basket External Air Transport (EAT) system is a metal frame basket specifically designed to transport cargo or personnel under a helicopter using standard sling load equipment, technology, tactics, techniques, and procedures. The Heli-Basket HB2000 is capable of carrying 15 seated people and the HB1000 is capable of carrying 6 people. The metal basket is attached to a 120-foot-long braided polyester cable underneath the aircraft.

Figure D-17. Heli-Basket HB2000.

Physical Characteristics

Length Stored (ft):	8.9	Length Deployed (ft):	8.9	Capacity People:	15
Width Stored (ft):	4.9	Width Deployed (ft):	4.9	Capacity Payload:	4500 lbs
Height Stored (ft):	8.4	Height Deployed (ft):	8.4		
Weight Stored (lbs):	640.0				

LifeCycle Cost

Acquisition Cost (each):	$32,895	Planned Annual Maint Hrs:
Service Life:	> 10 years	MTBO: 5 year recertification

Operational Characteristics

Transport Requirements: It is the vendor's opinion that the Heli-Basket® or First Responders Module could be deployed by parachute from the aft ramp of a fixed wing aircraft. The HB2000 has been approved for all DOD helicopters for utility use. The Heli-Basket® was approved for sea rescues and deck use by the US Navy during Kaman Aerospace's Vertical Replenishment contracts. The Heli-Basket® with flotation was tested in Atlantic seas by the USAF.

Delivery Methods: The Heli-Basket® can be used with either the long line attached to a Helicopter or attached to the cable from a winch and lifted to safety on high free-board vessels.

Flotation: The Heli-Basket® has bomb blast resistant flotation kit that form fits into the long sides. The kit will float the Heli-Basket® and 900lbs.

Company: Precision Lift, Inc **Equipment Name: HELI-BASKET HB2000**

Table D-17. Heli-Basket HB2000 characteristics.

				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
X				Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
X				Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
		X		Self righting or reversible
		X		Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
		X		Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed) *(with optional kit)*
			X	Simple operation - only 1 or 2 steps
X				Few moving parts
			X	Instructions with international signage
X				Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
		X		Minimal Leeway
		X		High visibility (day/night)
		X		Radar reflectivity
X				Abrasion resistant
X				Shock/Impact resistant
X				Puncture resistant
X				Chemical resistance
X				Heat resistant (fire)
X				Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
X				Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
		X		Short Term (<24 hrs)
		X		Medium Term (24-48 hrs)
		X		Long Term (>48 hrs)
		X		Arctic Survival
		X		Tropical Survival
		X		High Sea State

Company: RFD Beaufort Limited **Equipment Name: Survival Liferaft**

Description: Surviva liferafts are our core product range and are undoubtedly our most popular liferafts. Manufactured to the highest quality standards and stowed in a variety of containers designed to suit most deck spaces, this product is fully approved ensuring its suitability for any vessel throughout the world. The davit launched rafts are available in 12, 16, 20, and 25 person capacities.

Figure D-18. Survival Liferaft.

Physical Characteristics

Length Stored (ft):	5	**Length Deployed (ft):**	13.4	**Capacity People:**	25
Width Stored (ft):	2.7	**Width Deployed (ft):**	13.4	**Capacity Payload:**	
Height Stored (ft):	1.7	**Height Deployed (ft):**	7.4		
Weight Stored (lbs):	403				

LifeCycle Cost

Acquisition Cost Each:	**Planned Annual Maint Hrs:**
Service Life:	**MTBO:**

Operational Characteristics

Transport Requirements: Stowed in lightweight streamlined GRP containers enabling maximum deck space utilization.

Delivery Methods: Available in davit launch and throw over versions.

Flotation:

Company: RFD Beaufort Limited **Equipment Name: Survival Liferaft**

Table D-18. Survival Liferaft characteristics.

Y	N	N/A	UNK	
				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
			X	Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
X				Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
	X			Self righting or reversible
			X	Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
			X	Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
			X	Simple operation - only 1 or 2 steps
			X	Few moving parts
			X	Instructions with international signage
			X	Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
	X			Minimal Leeway
X				High visibility (day/night)
			X	Radar reflectivity
			X	Abrasion resistant
			X	Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
			X	Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
			X	Long shelf life
			X	Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
X				Medium Term (24-48 hrs)
X				Long Term (>48 hrs)
			X	Arctic Survival
			X	Tropical Survival
X				High Sea State

Company: Viking Life-Saving Equipment A/S **Equipment Name: MOR Raft**

Description: Intended for transfer of people from the water to the deck in an emergency. Operated in a way similar to standard davit-launched life rafts and kept to the ship's side by means of bowsing lines. Vendor suggests the carrying capacity is 12 persons lying down, 25 persons sitting, or a mixture of both.

Figure D-19. MOR Raft.

Physical Characteristics

Length Stored (ft):	4.5	**Length Deployed (ft):**	15.1	**Capacity People:**	25
Width Stored (ft):		**Width Deployed (ft):**	10.4	**Capacity Payload (lbs):**	4200
Height Stored (ft):	2.4	**Height Deployed (ft):**	8.1		
Weight Stored (lbs):	333				

LifeCycle Cost

Acquisition Cost Each:	$7,900	**Planned Annual Maint Hrs:**	24
Service Life:	15 years	**MTBO:**	12 months

Operational Characteristics

Transport Requirements: Potentially the MOR raft could be packed in a valise to be delivered from a rotary-wing aircraft or in a special container to be delivered from a fixed- wing aircraft. This however, would at present require further product development of the standard model, but the vendor would be happy to discuss in detail what requirements would be optimal for delivering the MOR raft from an aircraft.

Delivery Methods: For standard deployment or retrieving, the MOR raft requires support from a davit or deck crane capable of lifting > 2640 lb (1200 kg) (12 person capacity) or > 4620 lb (2100 kg) (25 person capacity).

Flotation:

Company: Viking Life-Saving Equipment A/S **Equipment Name: MOR Raft**

Table D-19. MOR Raft characteristics.

Transportation and Stowage				
Y	**N**	**N/A**	**UNK**	
	X			Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
X				Capable of being stowed in multiple environments (w/o climate control)
Deployment				
Y	**N**	**N/A**	**UNK**	
			X	Self righting or reversible
	X			Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
			X	Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed)
	X			Simple operation - only 1 or 2 steps
X				Few moving parts
			X	Instructions with international signage
X				Device can be lifted with survivors on board
Physical Characteristics				
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
X				Minimal Leeway
			X	High visibility (day/night)
			X	Radar reflectivity
X				Abrasion resistant
X				Shock/Impact resistant
			X	Puncture resistant
			X	Chemical resistance
			X	Heat resistant (fire)
	X			Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
Maintenance				
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
	X			Minimal maintenance - easy - low cost – infrequent
Life Support				
Y	**N**	**N/A**	**UNK**	
X				Short Term (<24 hrs)
	X			Medium Term (24-48 hrs)
	X			Long Term (>48 hrs)
	X			Arctic Survival
	X			Tropical Survival
	X			High Sea State

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