A STUDY OF LIFESAVING SYSTEMS FOR SMALL PASSENGER VESSELS

Based on an Analysis of Casualties since 1973

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Introduction

On January 30, 1989, the Coast Guard published a Notice of Proposed Rulemaking (NPRM) on Small Passenger Vessels. One of the proposals that attracted a large number of comments, both in writing and at public hearings, would have required certain small passenger vessels operating on cold waters to carry inflatable liferafts or inflatable buoyant apparatus. Although some comments supported the proposal and some even suggested increases in the proposed requirements, most comments from operators opposed them, citing a good safety record which did not justify the cost required to comply.

The NPRM proposals were based on the assumption that passengers would be at increasing risk of dying from the effects and complications of hypothermia as water temperatures decreased, and the time to rescue increased. Consequently, the NPRM proposed increasing levels of protection from immersion in cold water as water temperatures decreased, and distance offshore increased.
These proposals are consistent with survival time/water temperature data which have been widely published in various documents, including the International Maritime Organization (IMO) "Guide for Cold Water Survival," "Search and Rescue Manual," and "Merchant Ship Search and Rescue Manual." This data has also appeared in the U.S. "National Search and Rescue Manual," the Coast Guard's "Guide to Cold Water Survival," the "Ship's Medicine Chest and First Aid at Sea," and the Personal Flotation Device (PFD) "Think Safe" manual attached to every new PFD sold at retail in the United States.

Comments were received from several segments of the industry and general public. These comments did not necessarily agree with Coast Guard proposals, or NTSB recommendations. Comments from one segment of the industry sometimes disagreed with comments from another segment. The comments objecting to some part of the proposed rules raised many issues of varying merit, including:

Distance from shore - Assistance should be available very quickly in the case of vessels operating within 1 - 10 miles from shore, making survival craft unnecessary. Current requirements are satisfactory for vessels operating within 20, 40, 50, or 100 miles from land or a harbor of safe refuge.

Local waivers - Local Coast Guard Officers in Charge, Marine Inspection (OCMI) should be allowed to vary local rules for survival craft depending upon local geography, rescue times, or only brief cold water seasons.

Length of trip - Vessels on short trips (less than 12 hr) should be exempt from expensive requirements for inflatable survival craft.

Water temperature - Water temperature criteria and boundaries are arbitrary. Inflatables would be required in water of temperatures where they are not necessary. Water temperatures in particular areas are below 59ºF only a few weeks of the year, which would either require unnecessary expense or seasonal shutdown.

Depth of water - Water depth should be considered in determining requirements for survival craft.

Survival craft capacity - Inflatable survival craft should not be required for everyone on board, or they should be allowed to be "overloaded" in certain circumstances.

Vessel design - Larger vessels with metal hulls, one compartment subdivision, and structural fire

protection, are safer than some others. These vessels are their own best survival craft and should be exempt from requirements for inflatable survival craft. Emphasis should be placed on avoiding the need to abandon the vessel.

Safe operating record - No vessels of a particular operation or in particular geographic areas have ever been lost. Offshore party fishing vessels are the only ones involved in casualties.

Cost - Inflatables are expensive, especially when considering annual servicing requirements, structural modifications needed, adverse effect on stability, and loss of passenger carrying capacity.

Reliability of inflatables - Inflatables are prone to puncture and other failures. Therefore they are less efficient and effective than life floats and buoyant apparatus.

Number of passengers - Requirements for inflatables should not be different for vessels with over 150 passengers. If passenger number is to be used, it should be 400.

"Grandfathering" - Existing life floats and buoyant apparatus should be permitted to be used until no longer serviceable before they are required to be replaced by inflatable survival craft.

Invalid reasoning - Proposals for inflatables are based on commercial fishing vessel casualties, collusion with equipment manufacturers, or pressure from Canadian interests.

Further study - Further study needed into requirements for survival craft at different water temperatures. Inflatables would have been no help in some of the cited casualties. There is risk involved in abandoning vessels which was not considered.

In order to address these comments, this study reexamines the requirements for survival craft on small passenger vessels. It is somewhat more thorough than the unpublished studies undertaken for the NPRM of January 30, 1989. The analysis for that NPRM did not fully take into account the effect the new 406 MHz satellite EPIRBs would have on distress alerting, and search and rescue operations. Since the NPRM was prepared, the National Transportation Safety Board published its safety study on passenger vessels operating from U.S. ports, and five more losses of small passenger vessels certificated under Subchapter T have occurred, two with loss of life.

Scope

This study examines the casualty record of the "smaller" small passenger vessels lost over the past 20 years which involved abandonment of the vessel or persons in the water.

This study does not include a detailed study of casualties involving "larger" small passenger vessels. For the purpose of regulation, these larger vessels will be defined as those which carry more than 150 day passengers, or those with overnight accommodations for more than 49 passengers. This group would include vessels such as the PILGRIM BELLE and the MAJESTIC EXPLORER which were abandoned after they went aground. The PILGRIM BELLE launched its life floats and passenger launch, but rather than have passengers jump into the water, other vessels in the area accomplished the abandonment in calm seas and good weather in about 40 minutes. The MAJESTIC EXPLORER used its inflatable liferafts to evacuate passengers, but one passenger was tragically killed when a liferaft container was dropped from the deck on top of the liferaft the victim was in. The abandonment was otherwise carried out successfully.

When considering safety systems for vessels carrying large numbers of passengers, the "socially acceptable state of risk" must be taken into account. A major loss of life due to a casualty involving a passenger vessel would be viewed as socially unacceptable, as it is when an airline accident results in a major loss of life. This socially unacceptable state of risk exists even though the mode of transport may

be safer than others by any objective measure of safety.

The loss of a large passenger vessel is a rare event, but one which could result in a large loss of life if it were to occur. Very low probability, high consequence accidents are impossible to predict. Statistical models are not meaningful. An admirable safety record can not be used as an argument to say that either no major accidents will happen in the future, since none have occurred to date, or that one is unlikely to happen, by the law of averages. [1]

The PILGRIM BELLE and MAJESTIC EXPLORER groundings illustrate that casualties requiring abandonment can occur to the larger small passenger vessels. When these vessels operate near shore in the daytime, other vessels can be expected to be on scene quickly, but they may not be of adequate size to accommodate everyone on board the vessel. These vessels should be equipped with lifesaving equipment to provide out-of-the-water flotation, such as liferafts or inflatable buoyant apparatus, if they operate far offshore, or if they carry large numbers of passengers in overnight service.

Large vessels in more limited service may be provided with lifesaving equipment of less than 100% capacity, recognizing that other vessels will be able to assist quickly. Life floats should be adequate for this purpose in warm waters, but in cold waters, liferafts or inflatable buoyant apparatus should be provided, since additional assistance may take some time to arrive. OCMIs should have the authority, however, to require an upgrade in the lifesaving equipment carried when the vessel operates in remote coastal areas where the assumption on availability of assistance may not be valid.

Vessels at Risk

Table 1 lists the 16 casualties to the smaller small passenger vessels identified as fitting the criteria for the study. A number of characteristics of the vessel and the casualty are also listed. Appendix I contains a short narrative on the survival aspects of each and summarizes the lifesaving equipment actually used, the minimum lifesaving equipment needed to prevent loss of life, and the lifesaving equipment needed to prevent injury. The significance of this information is explored in the following sections. Appendix I includes a short narrative on a seventeenth case concerning the recent sinking of the DEBBY JOANN, which is not included in any further analysis in this study. This case has a number of unusual aspects which make it difficult to analyze completely until the investigation is complete.

As a group, the vessels involved in these casualties appear to be "old." Their average age at the time of the casualty is about 26 years. The average age of the total small passenger vessel fleet is approximately 16 years.

All but one of the vessels, or 94%, involved in these casualties had a wood hull. This compares to 32% of the entire small passenger vessel fleet with wood hulls. An examination of the casualties show that they fall into three groups:

1. Capsizings: Six of the casualties were capsizings or near-capsizings. Five of these accidents occurred as a result of wave action. The sixth was the result of exceptionally high winds. In none of these cases was the hull material or condition of the hull implicated as a cause or contributing factor to the accident. The near-capsizing involved a vessel with a fiberglass reinforced plastic (FRP) hull. These accidents probably would have occurred to any vessel of similar form, proportions and stability characteristics regardless of hull construction.

2. Fires: Four of the casualties were fires. All started in the engine compartment. In these cases, fire fighting efforts were started too late, or were ultimately unable to keep the fire from spreading throughout the vessel. It appears that wood construction is an important factor in these losses. There

[1] Statement by Richard Lee Storch, Public Hearing on Ferry Lifesaving Systems, Seattle, WA October 17, 1989.

have been no fires leading to abandonment of a steel, aluminum, or FRP small passenger vessel.

3. Hull or fitting failures: Assuming the loss of the BRONX QUEEN will be attributed to some type of hull failure, the remaining six casualties have been the result of loss of watertight integrity. The newest of the vessels in this group was the ZEPHYR II, 26 years old at the time of the casualty. The average age of this group is 38 years. In the case of the COUGAR, the failure of a through-hull fitting or wet exhaust system was cited as a possible cause. Loss of watertight integrity of hatches was also cited as a contributing factor in some cases. These are symptoms of age to which any vessel would be susceptible, regardless of hull construction, although the condition of metal hulls is easier to assess during inspections. Often the exact cause of the casualty is not known, but planking failures were most often cited as the probable cause. In the case of the COMET, serious hull deficiencies had been found in a Coast Guard inspection, but the vessel was operated anyway without a valid certificate of inspection. The other vessels were not being operated with any known hull deficiencies. The investigation into the sinking of the SUNRISE II in June of 1983 included a report of a computer search into casualty case records. The report states:

> A computer search of G-MMI-3 records revealed that of all the vessel casualty cases reported in the years 1981, 1982, and 1983, 134 involved a wooden vessel in which the primary cause of the casualty was "failed materials, structural". These structural material failures resulted in either flooding or foundering (sinking) of all 134 vessels. The size of the vessel ranged up to 141 gross tons and lengths varied between 26 ft and 100 ft. Of the 134, 6 are Coast Guard inspected passenger vessels, the remaining are mainly various types of uninspected fishing vessels. [None of the 6 cases cited are included in the 15 under study here.]

It may therefore be concluded that:

1. Old vessels (over 20 years?) are more susceptible to flooding and foundering casualties than newer vessels. A large percentage of vessels in this age group at this time are wood, but aging vessels of steel, aluminum, and FRP will also be subject to undetectable deterioration of fittings and to a lesser extent, hulls. In most cases, this will not result in catastrophic failure, so that bilge pumps should be able to keep up with leakage. In the case of a catastrophic failure, those vessels without subdivision sufficient to withstand the flooding of any one compartment, will be at risk.

2. Wood vessels of any age are more susceptible to loss than vessels with other types of hulls. Older wood vessels are susceptible to undetectable deterioration of the hull, but newer wood vessels have been destroyed by engine compartment fires which could not be contained. FRP vessels might also be susceptible to similar loss by fire, except that most have been built with fire retardant resins which will burn, but will not normally sustain a fire without an outside flame source. In recent years, general purpose resins have been permitted in the construction of FRP vessels, provided that certain fire risk-reducing measures are taken, including installation of fixed fire extinguishing systems in the engine compartment.

3. Vessels of any age or hull construction are vulnerable to capsize in waves large enough to overcome them, or under "microburst" or other transient high wind conditions which create an overturning moment sufficient to overcome the vessel's inherent righting energy.

The Role of Water Temperature on Survival Times

One of the tools used for many years in search and rescue planning is a water chill graph which estimates the probability of survival based on time in water of varying temperatures. The graph is based in part on data generated many years ago. It is concerned primarily with the effects of hypothermia, and doesn't take into account the effect of rough water in drowning or increasing the rate of onset of hypothermia due to energy expended in rough water. The graph also does not take into account the hypothermia protection provided by any clothing the individual may be wearing. Nevertheless, no better survival time prediction method has been developed for general use.

Figures 1, 2, and 3 are the water chill graph, with the water temperatures of 15 of the casualties superimposed. Most of the casualty reports were detailed enough to determine how many persons used various types of lifesaving equipment, and what the survival rates were as the casualty progressed. Figure 1 shows the mortality rates for those persons who did not have any lifesaving equipment or other flotation assistance available to them. Figure 2 shows persons wearing lifejackets. Figure 3 shows mortality rates for persons using life floats, buoyant apparatus, or other debris or equipment providing roughly equivalent flotation assistance. For example, this includes in various cases, a swamped dinghy, coolers, and floating pieces of the vessel which broke away as the vessel sank. Anyone wearing a lifejacket and using a life float or buoyant apparatus is included in Figure 3. No other survival equipment was available in any of the cases, except for an inflatable liferaft on the FINALISTA 100 which could not be lifted over the rail to launch. To the extent that they could be identified, the mortality rates do not include those who died directly or indirectly from injuries sustained as a result of the accident. In some cases, this required an assumption that some of those lost and not seen in the water, were trapped inside the vessel and drowned.

The following conclusions can be drawn from a study of Figures 1, 2, and 3:

1. Persons in the water without lifesaving equipment died at a much higher rate than predicted by the graph. This is not unexpected. The primary cause of death is drowning rather than hypothermia or its complications.

2. Lifejackets, life floats, and buoyant apparatus seem to extend survival time well beyond that predicted by the graph. There are several points where there was a relatively low incidence of death well into the supposed "lethal, 99% expectancy of death" zone.

3. The present requirements for lifejackets, life floats, and buoyant apparatus have proven adequate in all studied casualties where water temperature was 60º F or more.

4. In the BRONX QUEEN, there were deaths of people apparently wearing lifejackets, but in the supposed "safe" zone on the graph. Because the report is not complete, there is not yet an explanation for this fact.

5. In the ZEPHYR II, and FISH-N-FOOL casualties, there were deaths of people using flotation equipment in the supposed "safe" zone on the graph. In the ZEPHYR II case, the individual who died was the only one not wearing a lifejacket. Holding onto the buoyant apparatus without any additional means of flotation might have required too much energy. In the FISH-N-FOOL case, the individual that died was actually holding onto a piece of plywood, and he also had no lifejacket. For persons who can not get on top of a life float or buoyant apparatus, and who are not wearing lifejackets, there may be a lower probability of survival than for a person in a lifejacket. This may seem to contradict the notion of life floats and buoyant apparatus as "higher" level lifesaving devices than lifejackets, but a person in a properly worn lifejacket does not have to expend any energy to stay afloat.

6. The graphs do not suggest a marked advantage of life floats and buoyant apparatus over having just lifejackets available. However, in some cases such as sudden capsizings where no one had time to get lifejackets, life floats and buoyant apparatus floated free and provided support to survivors. In other cases, such as the COUGAR and FISH-N-FOOL, one or two people were able to get on top of life floats and buoyant apparatus, and thereby manage a fairly dry ride.

The Effect of Satellite EPIRBs on Rescue Times

Class A EPIRBs have been required for 15 years on small passenger vessels operating beyond 20 miles from a harbor of safe refuge. Class A EPIRBs operate on 121.5 and 243 MHz aircraft distress and calling frequencies. The signal is monitored by aircraft on long overwater flights when a radio receiver is not required for other frequencies. The signal is also monitored by satellites in the COSPAS/SARSAT system, relayed to ground stations and on to the National Atmospheric and Oceanographic

Administration (NOAA). A NOAA computer calculates the most probable position of the signal.

This system suffers from several shortcomings. As an aircraft distress and calling frequency, most transmissions are not emergencies. Aircraft Emergency Location Transmitters (ELT) also operate on these frequencies. The ELT design makes it susceptible to inadvertent activation. The positions developed from the signal are not precise, especially on the first satellite pass when the position solution yields two positions, one on either side of the satellite track. The signal is a simple beacon, so that its source can not be identified. Because of these shortcomings, response to actual emergencies must be delayed, because they can not be distinguished from non-emergencies. These shortcomings were demonstrated in 2 of the 16 small passenger vessel casualties, the FISH-N-FOOL and the CONNIE D. Rescue was delayed for several hours after the EPIRB was first heard.

The 406 MHz satellite EPIRB resolves these Class A EPIRB problems. Each beacon is separately coded, so that the source of a signal can be determined immediately from registration data. The system uses a dedicated frequency. Position information is accurate on the first satellite pass. For these reasons, rescue operations can begin immediately after an alert is received. An example is the commercial fishing vessel FINITE, which capsized. Survivors activated the 406 MHz EPIRB, and the vessel was located by a helicopter 45 minutes after the air station, 100 miles away, was notified. Two of the three persons on board died, however, from the effects of hypothermia in water believed to be about 57° F. The FINITE apparently carried no immersion suits or liferaft.

The NOAA weather satellites and the Soviet satellites which carry the COSPAS/SARSAT equipment are polar orbiting. The maximum time between satellite passes in Alaskan latitudes is 1.6 hours. At the equator, it extends to as much as 3 hours. Small passenger vessels, of the type of concern in this study, will generally be limited to operations in coastal areas of the United States. Therefore, the average time for a satellite EPIRB signal to be received by a satellite is on the order of one hour, but the longest time will be about 2 hours.

The typical time required to process the signal relayed by the satellite is 20 minutes. This includes reception of the signal by a ground station (Local User Terminal or "LUT"), relay of the information to the NOAA mission control center, analysis of the data for location and beacon identification, and notification of the appropriate Coast Guard Rescue Control Center. Once the Coast Guard is alerted, a helicopter can usually be airborne in 15 minutes. Therefore, for casualties occurring off the coast of the Untied States, rescue forces should be underway in about 2 hours, maximum after the satellite EPIRB is activated. A more typical time should be 1 hours.

The casualty record shows that EPIRBs either were an important part of the rescue, or would have been an important part of the rescue if they had been available in the following cases:

> COMET, 7 mi offshore when it sank. It was 3 hours until another vessel happened to come across survivors. Depending upon satellite position at time of occurrence, rescue might have come sooner and lives might have been saved.
>
> PEARL C, 18 mi offshore when it lost power. An EPIRB would have brought assistance faster and probably would have prevented the accident completely.
>
> CONNIE D, 30 mi offshore when it burned. A satellite EPIRB would have brought dramatically faster rescue than the over 10 hours it took for the Class A EPIRB signal to be recognized and located.
>
> COUGAR, 45 mi offshore when it sank. A satellite EPIRB would have brought rescue much sooner than 17 hours, with a significant saving of lives.
>
> FISH-N-FOOL, 2.6 mi offshore, but 150 miles from the closest U.S. port. A satellite EPIRB would have brought rescue sooner than 7 hours, with a possible significant saving of lives.

The casualty record also shows that EPIRBs would not have been a factor in the following cases which occurred close to shore, and which were seen by other vessels or persons on shore. The operator did not, or was not able to summon help by radio. Although these cases illustrate that casualties close to shore are likely to be seen and reported, there is no guarantee that this will always be the case. Had these accidents had not been witnessed by others, search and rescue would not have been initiated until the vessel was considered missing. An EPIRB would bring help much faster in such a case. These cases were:

SAN MATEO, harbor entrance.

MERRY JANE, harbor entrance.

FANTASY ISLANDER, river.

DIXIE LEE II, Hampton Roads.

CAPT JIM, 4 mi offshore in the Atlantic Ocean.

ZEPHYR II, 5 mi offshore in the Atlantic Ocean.

JOAN LA RIE III, 14 mi offshore in the Atlantic Ocean. However, the casualty report indicates that it was extremely fortunate that the JOAN LA RIE III was in a crossing situation with another vessel five miles away, whose bridge watch saw the JOAN LA RIE III disappear.

EPIRBs were also not factors in the following cases, because the operator was able to summon help by radio. Rescue would have been longer in coming if a power failure or sudden loss of the vessel would have prevented use of the radio:

ALMA III, 2 mi offshore in Long Island Sound.

BRONX QUEEN, 4 mi offshore in the Atlantic Ocean.

SUNRISE II, 13 mi offshore in the Gulf of Mexico.

FINALISTA 100, 37 mi offshore in the Pacific Ocean.

When all of these casualties are considered, it is apparent that the present Class A EPIRB requirement applying only to vessels more than 20 miles from a harbor of safe refuge, is inadequate. Satellite EPIRBs should be required on vessels operating on the high seas (generally more than 3 miles offshore), just as they are now required for commercial fishing vessels.

The Role of Life Floats and Buoyant Apparatus

The suitability of life floats and buoyant apparatus for a particular survival situation will depend upon water temperature, and how long survivors of an accident have to wait for rescue. As discussed in a preceding section on hypothermia, it is apparent that these devices can extend survival times beyond that which would be predicted by the water chill graph, especially if lifejackets are also in use.

The casualty record also points up some of the shortcomings of this equipment. In the case of the COUGAR, two people managed to get themselves on top of a buoyant apparatus nominally rated for 13 persons. These two were the only survivors who did not require hospitalization. This action prevented anyone else from using the buoyant apparatus to get themselves partially out of the water. Life floats have more buoyancy and a platform to stand on. If the COUGAR had been equipped with a life float instead of a buoyant apparatus, death and injury would probably have been reduced. Similarly, in the case of the ZEPHYR II, if the device had been a life float instead of a buoyant apparatus, the person

without a lifejacket would have been able to use the platform and might have survived the few minutes in the water.

Considering anticipated rapid rescue times with the benefit of satellite EPIRBs, it is useful to look at the casualties to determine what expected survival times would be with decreasing water temperatures.

As discussed in a preceding section, the present requirements for lifejackets, life floats, and buoyant apparatus have proven adequate in all studied casualties where water temperature was 60º F or more.

In the FISH-N-FOOL case, five people had some type of flotation assistance soon after the accident in 59º F water. Four survived four hours or longer, but only one actually had the use of a life float. The rest relied on flotsam and tried to swim to shore. One of this group died in the first hour, but his flotation was a Clorox bottle -- probably significantly less effective than a life float. An empty gallon bottle would have about 8 lb of buoyancy. That's about one-half the minimum buoyancy required of a Type IV PFD used on recreational boats.

In the COUGAR case, eight people had some type of flotation in 55º F water. Seven survived four hours or longer. The one who died reportedly expended a lot of energy swimming to the group gathered at the buoyant apparatus, and putting on his lifejacket. Seeing that the 13-person buoyant apparatus would not accommodate all eight, this individual and two others used a plywood overhang for flotation. He died about two hours after the casualty. With the benefit of the added buoyancy and a platform to stand on, a life float might have enabled this person to survive longer, although an inflatable buoyant apparatus would have been a superior lifesaving device.

The JOAN LA RIE III capsized in 53º F water. Neither the Coast Guard nor the NTSB reports were very detailed about the survival aspects of this casualty. Apparently about 18 persons found some type of flotation, but only 2 made their way to a buoyant apparatus and a life float which were lashed together. Both survived. Four others, apparently relying on flotsam, died in the 90 minutes it took for rescue to arrive.

The COMET sank in 48° F water. About 15 of the survivors held onto the buoyant apparatus at some point. Eight others used some type of debris for flotation. After three hours, five of these people were dead. Two more were dead hour later. A total of 16 persons died in 4 hours. The COMET would have to have had an inflatable buoyant apparatus to save a significant number of these people.

From these casualties, it can be seen that life floats or buoyant apparatus are adequate for short term survival in water temperatures of 60° F or more. Life floats are adequate to marginal in temperatures between 50° F and 60° F. Inflatable buoyant apparatus are necessary below 50° F.

Present regulations require life floats and buoyant apparatus to have hydrostatic releases or else lashings which can easily be released. Survivors in several of the casualties were assisted by life floats or buoyant apparatus which floated free of the sinking vessel. New regulations should require float free stowage arrangements.

Inflatable Liferafts and Inflatable Buoyant Apparatus

In some of the casualties studied, it was evident that the life floats or buoyant apparatus did not provide adequate flotation to enable survival. In these cases, it would have been necessary to get survivors out of the water. In each case, it appears that an inflatable buoyant apparatus would have provided sufficient flotation for this purpose. In the coastal areas where these boats normally operate, rescue comes fast enough that the long term survival capability of the inflatable liferaft is not needed. This is especially true, considering that we expect satellite EPIRBs to enable rescuers to be on scene quickly.

For small passenger vessels, inflatable liferafts would appear to be necessary only for those few vessels certificated for unlimited ocean voyages.

Conclusions

Old vessels are more susceptible to flooding and foundering casualties than newer vessels, particularly those without subdivision sufficient to withstand the flooding of any one compartment.

Wood vessels of any age are more susceptible to loss due to uncontrolled engine compartment fires than vessels with other types of hulls. FRP vessels constructed of non-fire retardant resin may also be susceptible to similar loss by fire, but all FRP small passenger vessels have been required to be equipped with fixed fire extinguishing systems in machinery spaces.

All fires leading to vessel losses started in the engine room.

Vessels of any age or hull construction are vulnerable to capsize in waves large enough to overcome them, or under "microburst" or other transient high wind conditions which create an overturning moment sufficient to overcome the vessel's inherent righting energy.

The reason that most of the casualties involve party fishing vessels is that these are the vessels that are most likely to operate in exposed waters. These vessels may not have time to return to port if the weather turns bad, or they may find hazardous bar conditions on their return. The primary attraction of tour and dinner boats is sight-seeing. Consequently there is usually no reason for them to travel far offshore, nor is there good business in bad weather.

Satellite EPIRBs should be required on vessels operating on the high seas (generally more than 3 miles offshore).

A vessel which will rely primarily on satellite EPIRBs for distress alerting and locating, should have survival equipment sufficient to sustain survivors for the few hours it will take for rescue to arrive. Vessels carrying large numbers of passengers and those operating at great distances offshore will need survival craft suitable for longer survival periods, since rescue will take longer to complete. Vessels carrying passengers in overnight service may also need more capable survival craft since the many vessels which operate primarily in the daytime would not be able to assist in a casualty that occurs at night.

The present requirements for lifejackets, life floats, and buoyant apparatus have proven adequate in all studied casualties where water temperature was 60° F or more.

In a number of cases, the only equipment needed for survival was lifejackets, however, for various reasons they were not used and the life floats and buoyant apparatus served a lifesaving role.

Life floats are adequate to marginal for short term survival in temperatures between 50° F and 60° F.

At a minimum, inflatable buoyant apparatus are necessary for more than a few hours survival below 50° F.

Life floats and buoyant apparatus where used should be required to be arranged to float free, using hydrostatic releases where necessary.

Life floats, buoyant apparatus and liferafts were difficult to lift over rails and other obstructions in several cases.

Vessels involved in casualties within 3 miles of the shore were quickly assisted by other nearby vessels. However, large numbers of persons in the water would overwhelm available resources even close to shore. This is an example of a very low probability, high consequence accident where a large loss of life would be socially unacceptable. Lifesaving equipment appropriate for the expected water temperature should be provided in such cases.

There were no casualties in this group which occurred on the Great Lakes, nor were there any which occurred off the coast of New England north and east of Block Island, Rhode Island. There is no reason, however, to believe that small passenger vessel operations in these areas are inherently less risky than those in other offshore areas. This is more likely the result of random distribution of a small number of casualties ("small" in terms of mathematical statistics).

Recommendations

> The following recommendations apply to small passenger vessels which are permitted to carry a limited number of persons (generally those less than 65 ft in length and carrying less than 150 daytime passengers, and with overnight accommodations for 49 or fewer passengers). Large numbers of persons in the water as a result of a casualty could overwhelm rescue resources which could be on scene in short notice.

Vessels of wooden construction should be included in the group of vessels required to be equipped with fixed fire extinguishing systems in the engine compartment. Systems should either be automatic, or manual if a fire detection system is also installed. This would be in addition to the retrofit proposed for FRP vessels in the NPRM of January 30, 1989, and in addition to systems already required for vessels with gasoline engines. The NPRM preamble discussion indicates that FRP vessels have higher monetary loss ratios from machinery space fires than other types of construction, but this study shows that such fires in a wooden vessel are much more likely to result in the loss of the vessel.

All vessels operating on the high seas (generally more than 3 miles offshore) and more than 3 miles from the coastline of the Great Lakes, should carry 406 MHz satellite EPIRBs.

Changes to the lifesaving regulations should be considered in three broad sea areas:

1. Beyond 50 miles from the coastline. Few small passenger vessels will operate this far offshore. Those that do should have satellite EPIRBs and inflatable liferafts for everyone on board. At these distances, it may be difficult to get rescue resources on scene quickly. Shore-based helicopters have limited ranges which may be strained at these distances. These vessels should be equipped for long term survival in open ocean conditions.

2. Oceans up to 50 miles from the coastline, and Great Lakes. In this region, rescue should be quickly available, either because the vessel operates on routes close to shore, or else because it carries a satellite EPIRB.

a. Unless limited to operation very close to shore, as a minimum, vessels should carry life floats for 100% of the persons permitted on board. This would represent an increase in requirements for vessels in coastwise service presently required to carry 100% buoyant apparatus, and for vessels within 20 miles of a harbor of safe refuge, which are required to carry 50% buoyant apparatus.

b. Within one mile of shore, present regulations permit an unspecified reduction in the number of life floats and buoyant apparatus carried. Within one mile of shore, based on casualty experience, the following reductions in a 100% life float requirement can be considered:

(1) On the Great Lakes, life floats need not be required. (No change in current minimum requirement.) Lifejackets should provide adequate flotation for the short time expected for rescue.

(2) In warm ocean waters (above 59° F), life floats need not be required. (No change in current minimum requirement.) Lifejackets should provide adequate flotation for the short time expected for rescue.

(3) In cold ocean waters (below 59° F), life floats may be reduced to 50% capacity, but

only if the vessel meets current standards for subdivision. No reduction should be permitted for those vessels which do not meet current subdivision requirements.

c. Lifesaving equipment superior to life floats should be provided for higher risk vessels operating beyond one mile from shore. Specifically, 100% inflatable buoyant apparatus to provide out-of-the-water flotation should be required on:

(1) Vessels operating in water temperatures less than 59° F and not meeting current subdivision standards. (Existing non-wood vessels 65 ft or less in length, carrying 49 or fewer passengers with a collision bulkhead and simplified subdivision in way of the engine room and lazarette could be considered as meeting current subdivision standards for this purpose.)

(2) Wood vessels operating beyond 20 miles from shore.

d. These recommendations would require retrofitting of certain existing vessels with inflatable buoyant apparatus, and are contrary to present normal practice of "grandfathering" lifesaving equipment arrangements on existing vessels. However, implementation of this recommendation would require inflatable buoyant apparatus aboard those vessels most at risk of a casualty resulting in loss of the vessel. Grandfathering discourages the construction of new and safer vessels. Such a retrofit requirement would have the beneficial effects of requiring the vessels most at risk to have adequate lifesaving equipment, and removing some of the cost disincentive for replacement of older vessels with newer ones.

e. Vessels required to carry life floats should be allowed to count any existing buoyant apparatus toward meeting the life float requirement, until such time as the buoyant apparatus is no longer serviceable, and must be replaced.

3. Other waters. Requirements for vessels operating on lakes, bays, and sounds, and on rivers should be reviewed. Proposed revisions should be based on risk related to water temperature, subdivision, and distance from shore. Consideration should be given to phasing in life floats to replace buoyant apparatus.

OCMIs should have the authority to impose more stringent requirements for remote areas where there is a higher hazard level, such as rough sea conditions, exceptionally cold water, and limited search and rescue capabilities.

The "high seas" designation was introduced into the lifesaving regulatory scheme by the acts which required fishing vessels and other uninspected vessels to carry EPIRBs. This designation should be carried over into inspected vessel regulations for EPIRBs so that commercial vessels of all types operating in the same waters are required to carry EPIRBs. The high seas criterion tracks well with the demonstrated need for EPIRBs in the small passenger vessel casualty record. The present exemption for vessels within 20 miles from a harbor of safe refuge is clearly not appropriate, as shown from a review of the casualties. In the future, requirements for survival craft might be changed to be based on whether a vessel operates in waters where satellite EPIRBs are required. This should be considered at a future time when there is sufficient experience with SAR heavily reliant on satellite EPIRBs. Basing these requirements on the high seas area, rather than the current structure of ocean service, coastwise service, lakes, bays, and sounds, etc., would be a departure from present practice. Nevertheless, it may make sense, especially since some sounds, such as Long Island Sound and Block Island Sound, include high seas areas and are just as likely as other places more than 3 miles offshore to be the scene of a casualty. For example, the COMET accident occurred in the high seas area of Block Island Sound.

Rather than describing the areas subject to 59° F lifesaving requirements in detail in the final rules, consideration should be given to describing them in an NVIC, as is planned for fishing vessels. This would allow easier adjustment of the cold water zones if better water temperature data or particular problems with operating patterns are brought to our attention.

New regulations should require float free stowage arrangements for life floats and buoyant apparatus, as in the NPRM of January 30, 1989.

New regulations should require that if survival craft have to be lifted to be launched, they should either be light enough to lift or have a lifting device available. Such a requirement was proposed in the NPRM of January 30, 1989.

TABLES

TABLE 1. CASUALTIES

Vessel	Age(yr)	Hull	Svc type	Cause
COMET 5/73	32	wood	fishing	hull failure
ZEPHYR II 2/74	26	wood	fishing	foundered
PEARL C 9/76	33	wood	fishing	capsize (bar X-g)
DIXIE LEE II 6/77	10	wood	fishing	capsize (wind)
FINALISTA 100 10/82	12	wood	fishing	fire
JOAN LA RIE III 10/82	14	wood	fishing	capsize
SAN MATEO 2/83	25	wood	whale watching	capsize (bar X-g)
SUNRISE II 6/83	29	wood	fishing	flooding
FANTASY ISLANDER 9/84	29	wood	dinner/ tour	fire
MERRY JANE 2/86	8	FRP	fishing	near capsize
FISH-N-FOOL 2/87	23	wood	fishing	capsize
CAPT JIM 10/87	17	wood	fishing	fire
COUGAR 9/88	45	wood	fishing	flooding
ALMA III 12/88	48	wood	fishing	flooding
CONNIE D 4/89	13	wood	fishing	fire
BRONX QUEEN 12/89	47	wood	fishing	flooding?

FIGURES

T Boat Study Fig1.gif

T Boat Study Fig2.gif

T Boat Study Fig3.gif

APPENDIX I - CASUALTY ANALYSIS Each of the 15 casualties are described briefly below. At the end of each summary is an estimation of the number of lives that could have been saved and the number of injuries prevented by the indicated equipment. If an EPIRB was or would have been a factor in a rescue, the additional equipment needed both with and without an EPIRB is listed. In several cases, flotsam was used by survivors. For the purpose of this analysis, that kind of flotation is considered equal to a life float or buoyant apparatus. Where life floats or buoyant apparatus are indicated as needed, it is assumed that the capacity available is sufficient for everyone on board, rather than the 50% capacity now required on many small passenger vessels.

COMET, 5/73

The COMET had 27 persons on board and sank in Block Island Sound, Rhode Island, about seven miles offshore, in 48_ F water. The COMET had no EPIRB and the only lifesaving apparatus was a 20-person buoyant apparatus. About 15 of the survivors held onto the buoyant apparatus at some point, including two of three who set out in a swamped dinghy to get to the buoyant apparatus. Six others were able to use an 8' x 10' piece of flotsam for partial support. Almost everyone on board had a lifejacket on when they abandoned ship. The two or three people who were not able to get a lifejacket were able to use either the buoyant apparatus or the flotsam. The first death occurred in the dinghy about 1/2 hour after the sinking. Deaths continued until rescuers happened on scene 4 hours later. A total of 16 persons died in this time.

If the COMET had been equipped with an operating satellite EPIRB, and if a satellite pass had occurred shortly after the accident, Coast Guard rescue units might have been on scene in a few hours. This would have been in time to save all but 2 of those who died. To save everyone on board, the vessel would have had to have an inflatable buoyant apparatus.

The most probable cause for the loss of the COMET was determined to be poor hull condition, which can be linked to its age and wood hull material. However, the COMET was not operating with a valid Coast Guard inspection, because of its numerous deficiencies, including deteriorated hull planking. For this reason, it may be appropriate not to include the COMET in a casualty analysis relevant to inspected vessels.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
5	6		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

	Lifejackets	L/F-B/A	Inf. B/A	Liferaft
w/ sat. EPIRB	11	14	2	
w/ no EPIRB	5	6	16	

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
	(Insufficient information	)	

ZEPHYR II, 2/74

The ZEPHYR II had 12 persons on board and sank five miles offshore at the entrance to New York harbor in 40_ F water. The ZEPHYR II had no EPIRB and the only lifesaving apparatus was a buoyant apparatus. As the vessel sank, everyone but the operator got a lifejacket on. Flares were used to attract the attention of nearby vessels, the first of which were on scene as the vessel went under. The operator, helped by a passenger, held onto the buoyant apparatus for about 5 minutes until pulled from the water. Nevertheless, the operator died of drowning, probably complicated by the effects of hypothermia. All others in lifejackets survived the 10 or 15 minutes it took to get them on board vessels which had come to the rescue.

If the ZEPHYR II had been equipped with an EPIRB, there would have been no difference in this casualty. Help was summoned with flares and by radio. Coast Guard helicopters were on scene just a few minutes after the sinking. If the operator had been wearing a lifejacket, he probably would have survived the few minutes it took for help to arrive. Everyone on board was taken to hospitals and treated for exposure. The passenger who helped the operator was on the critical list for six days as a result of his few minutes in the cold water. An inflatable buoyant apparatus would have been needed to prevent the injuries from hypothermia.

The most probable cause for the loss of the ZEPHYR II was determined to be poor hull condition, which can be linked to its age and wood hull material.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
11	0		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
12			

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
		12	

PEARL C, 9/76

The PEARL C had 10 persons on board and sank crossing the Columbia River bar in the tow of a Coast Guard 44 ft lifeboat. Water temperature was 57_ F. The PEARL C had an 8 person buoyant apparatus which was recovered after the accident, but there is no indication it was used. No one on board was wearing a lifejacket. The only two survivors were picked up within 10 minutes of the capsizing.

Since two Coast Guard boats were on scene when the vessel capsized, EPIRBs would not have been a factor in the survival of those on board immediately after the capsizing. However, when the PEARL C lost power and radioed for help at 1:30 P.M., it took the Coast Guard boats four hours to find, although the PEARL C was only 18 miles from the Coast Guard station. This was due in part to the operator's confusing and contradictory position reports on the VHF radio. With an EPIRB, the vessel could have been located and taken in tow in about two hours. This might have led to crossing the bar while there was more daylight, and under better bar conditions. The capsizing occurred during maximum ebb current and a 30 knot wind. Two hours earlier, the wind had been reported at 18 knots. Therefore, there is some reason to believe that a satellite EPIRB might have prevented loss of life in this case. If the probability that a satellite EPIRB would have prevented this accident is taken as 50%, then it may be assumed for statistical purposes that an such an EPIRB would have saved four lives in this case.

There is no reason to conclude that any additional survival equipment carried on the PEARL C would have contributed to the saving of lives after the capsizing. The rigid buoyant apparatus that was on board floated free, but was not used.

The primary cause of the accident was concluded to be the manner in which the Coast Guard conducted the tow. Contributing to the vessel's loss of stability was the taking of water into the engine compartment. Leakage through hatchboards and inadequate engine compartment closures were cited as problems. To this degree, the wooden construction of the vessel and its age of 33 years could be considered factors in the casualty.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
0	0		

(2 rescued from water without benefit of any eq uipment)

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

	Lifejackets	L/F-B/A	Inf. B/A	Liferaft
w/ EPIRB	(EPIRB could have prevented accident)			
w/ no EPIRB	10*			

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

	Lifejackets	L/F-B/A	Inf. B/A	Liferaft w/
EPIRB	(EPIRB could have prevented accident)			
w/ no EPIRB	10*			

* Lifejackets should have been worn under hazardous bar conditions.

DIXIE LEE II, 6/77

The DIXIE LEE II had 27 persons on board and was capsized by a sudden and extremely high wind in Hampton Roads about 3/4 mi offshore, in water estimated to be at 65_ F. The DIXIE LEE II had no EPIRB and the lifesaving apparatus was a 13-person buoyant apparatus. The buoyant apparatus floated free and was carried away too quickly to be used by anyone. This casualty was the basis for the present rule requiring buoyant apparatus and life floats to be secured to vessels by a painter and float-free link. A total of 14 persons survived the accident. It is not known how many of the 13 who died might have drowned in the overturned vessel, and how many might have drowned after escaping. For the purposes of this analysis, it has been assumed that about half (7) of the deaths were a result of the capsizing and the remainder occurred later.

The DIXIE LEE II capsized suddenly and without warning. There was no distress message sent. The survivors were discovered by a fishing vessel which happened on the scene about 1/2 hour after the accident. If the vessel had been equipped with an operating satellite EPIRB, the outcome would probably have been no different. Since no alert would be received until a satellite passed overhead and the signal processed, it is doubtful that Coast Guard rescue units could have been on scene any faster. Also, since the vessel did not sink, the EPIRB might not have been released. The operator did not survive the accident, so when the vessel rerighted itself shortly after capsizing, it is unlikely that any of the passengers or bait-boys would have known how to activate the EPIRB manually.

It is unlikely that any other piece of lifesaving apparatus would have resulted in any additional lives saved. Most of those who died probably drowned when the vessel capsized. The warm water would not have been an immediate threat of hypothermia. The buoyant apparatus, if held close by a painter would have provided adequate flotation until rescue arrived.

The capsizing of the DIXIE LEE II is attributed solely to weather phenomena. The age of the vessel or its wood hull construction is not implicated in any way.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
14	0		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft

14 6

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
	20		

FINALISTA 100, 10/82

The FINALISTA 100 had 43 persons on board when it caught fire, burned, and sank about 37 miles off of the central California coast. Water temperature was not reported, but according to NOAA data for October, it would probably have been about 55_ F. The FINALISTA 100 should have had a Class A EPIRB on board, but if it did, it was not a factor in the rescue. From the limited information available on the accident, it appears that the operator was able to summon help from a nearby vessel by radio. The FINALISTA 100 did have an inflatable liferaft on board, but it was behind a fixed rail and too heavy for three crewmen to lift over the rail to launch. The 43 persons on board apparently used lifejackets and the life floats until rescue arrived 30 minutes later.

The vessel was certificated for 50 persons on ocean voyages, and would have to have had a life float for 25 persons. The inflatable liferaft was carried voluntarily as additional equipment. The life float proved adequate for the 30 minutes it was used, and apparently no one sustained permanent injury. The water chill chart suggests that everyone should have survived at least one hour in water of 55_ F. Had rescue taken 2 to 3 hours or more, an inflatable buoyant apparatus, as a minimum, would have been required to prevent deaths.

A satellite EPIRB would have made no difference in this particular casualty, since close-by help was summoned by radio. If help had not been close by, or if the operator had been unable to use the radio, a satellite EPIRB would have been essential for rapid location and rescue.

The FINALISTA 100 was 12 years old, which is not old for a wooden vessel. The fire started in the engine room due to a fuel leak. The crew had the fire contained with extinguishers, but once the extinguishers were used, fire spread throughout the vessel which then burned completely. It may be concluded that wooden construction contributed to the loss of the vessel, but age or condition was probably not a factor.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
21	22		0

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
21	22		

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
	(Insufficient information	)	

JOAN LA RIE III, 10/82

The JOAN LA RIE III had 22 persons on board and sank about 8 miles off of the New Jersey coast in 53_ F water. Although it was not required, the JOAN LA RIE III had an EPIRB when it was inspected 8 months before the sinking, but no EPIRB signal was heard during the rescue operations and no EPIRB was found with the rest of the debris. Lifesaving apparatus consisted of a 7-person buoyant apparatus and a 15-person life float. Most of the passengers where resting in the deckhouse when the vessel was hit by rogue wave, heeled over, and began to flood. Two persons are missing as a result of this casualty. They may have drowned in the deckhouse. The remaining 20 persons were able to escape into the

water, but none was able to put on a lifejacket. Apparently all but two persons made it to the life float and buoyant apparatus, which were secured together. Those two died. Of the remaining 18 gathered at the life float and buoyant apparatus, 14 survived and 4 died in the 90 minutes it took for rescue to arrive. No distress message was ever sent by the JOAN LA RIE III. The vessel happened to be in a crossing situation with a Brazilian cargo vessel which noticed that the JOAN LA RIE III, five miles away had suddenly disappeared. Its distress messages alerted the Coast Guard, which dispatched three boats and two helicopters. This Brazilian vessel changed course, and when it arrived on scene, it launched a lifeboat and recovered 7 of the 14 survivors. Coast Guard rescuers arrived about the same time, rescued the other seven, and retrieved five bodies.

The survivors of the JOAN LA RIE III were fortunate that the Brazilian vessel saw the accident. If this had not occurred, its likely that most of those in the water would have died in another 2 to 3 hours. No other vessels happened upon the scene, even those which had been fishing nearby and had been in contact.

A satellite EPIRB would not have brought rescue any faster, since the Brazilian vessel gave an immediate alert and accurate position information. Had the Brazilian vessel not been there, a satellite EPIRB would have resulted in a rescue within a few hours, depending upon satellite position at the time of the casualty. The water chill chart suggests that many or most would have died in that time.

An inflatable buoyant apparatus might have saved all 18 persons who made it to the life float and buoyant apparatus. Because of the gusty wind and high seas, this would have been a wet ride, but probably sufficient for the length of time it took for rescue to arrive, even if the survivors would have had to rely on an EPIRB alert. An inflatable liferaft with a canopy would have been better in these conditions, however.

The loss of the JOAN LA RIE III was attributed to loss of stability due to the adverse affect of a pilot house added on top of the cabin, boarding seas primarily from a rogue wave, and possible lack of watertight integrity of a hatch. The casualty can not therefore be related to its wood construction, or its age (14 years).

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
0	14		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
	14	4	

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
	11	7	

SAN MATEO, 2/83

The SAN MATEO had 32 persons on board, including 23 children, when it capsized in breaking waves exiting Morro Bay, California. About half of those in the water were able to use a buoyant apparatus which floated free. The other half had nothing, except for a few lifejackets which had been thrown to them by a deckhand who saw a lifejacket box float free from the capsized vessel. A harbor patrol boat was nearby when the capsizing occurred, and rescue began immediately. They were soon joined by another harbor patrol boat and a Coast Guard boat. Everyone was rescued from the 56_ F water in just a few minutes. Three persons were admitted to the hospital, two in critical condition. There is no indication that different survival equipment would have mitigated these injuries.

Because of the location of the casualty right outside of the harbor entrance, an EPIRB would have not been a factor. The buoyant apparatus performed its function in supporting survivors out of the water. An inflatable liferaft or buoyant apparatus could have been put to a similar use, but its unlikely that it would

have performed any better than the rigid buoyant apparatus in this case.

The SAN MATEO was lost as a result of a loss of directional control and subsequent broaching in waves. There is no reason to implicate the vessel's wooden construction or its age in this casualty.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
8	16		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
24*			

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
24*			

* Lifejackets should have been worn under hazardous harbor entrance conditions.

SUNRISE II, 6/83

The SUNRISE II had 21 persons on board when it sank at night in four to ten foot seas in the Gulf of Mexico, about 13 miles offshore. When the boat began to sink, the three life floats were launched with only two or three people aboard each one, even though one float had a rated capacity of 15 persons, and the other two were rated for 12. Six people stayed aboard the sinking boat, while the rest jumped into the water in their lifejackets, and eventually hung onto the life floats. A nearby offshore supply vessel heard the SUNRISE II's Mayday over the radio, and arrived just as the boat sank. The survivors swam to the offshore supply vessel, and within 45 minutes, despite darkness, and poor weather and sea conditions, everyone was brought on board. NOAA water temperature data for the Gulf of Mexico in June indicates a water temperature of around 82_ F, so hypothermia would not be a threat. There were no reported injuries as a result of this casualty.

The life floats and lifejackets on board were adequate for this casualty, although the life floats were not used correctly. Because the operator was able to broadcast a Mayday on VHF-FM channel 16, he was able to get help from a nearby vessel. The Coast Guard also received the call and was responding. The SUNRISE II had a Class A EPIRB on board. The investigation reports that the battery was new, but there is no indication in the report as to whether or not the Coast Guard helicopter had acquired the signal, or if it was being used to home in on the location. An EPIRB homing signal is normally an important means of locating casualties for Coast Guard search and rescue forces.

The SUNRISE II was probably lost as a result of planking being torn away and general weakness of the hull. The casualty is therefore directly related to the advanced age of the wooden hull.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
13	8		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
21			

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
21			

FANTASY ISLANDER, 9/84

The FANTASY ISLANDER had 37 persons on board when it caught fire in Charlotte Harbor, Florida. The fire was noticed by a nearby recreational vessel, which was able to take 24 passengers on board and take them back to the dock. As the fire started to consume the vessel, the remaining 11 passengers and 2 crewmembers abandoned ship to the 15-person life float. None of these people were wearing lifejackets, since the operator did not have everyone on board put them on when the fire broke out. The operator was able to get a distress message transmitted on VHF-FM channel 16, which was heard by other vessels in the area. By the time the decision to abandon ship was made, the area where the lifejackets were stowed had been consumed by flames. The people on the life float were rescued by other vessels in the area which were on scene within 25 minutes. Water temperature at the time is believed to have been about 85_ F. There were no injuries.

The life float was adequate for this casualty, only because some of those on board were able to transfer to another boat just as the fire was getting out of control. Life jackets would have been adequate for the sheltered harbor area where the fire occurred, had the operator instructed the passengers to put them on in a timely manner. The FANTASY ISLANDER had no EPIRB, nor would one have been of any use in the harbor area where the fire occurred.

The FANTASY ISLANDER was lost as a result fire destroying its wooden structure. The fire started in the engine room, apparently as a result of poor design and material selection for a dry exhaust system. The casualty is therefore directly related to the wooden hull structure, but not to the age of the vessel.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
0	13		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
13			

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
13			

MERRY JANE, 2/86

Unlike all of the other boats in this study, the MERRY JANE was of fiberglass reinforced plastic construction. The vessel experienced a near-capsizing entering Bodega Bay, California and 19 people fell overboard into 52_ F water. The MERRY JANE was able to recover and assisted in the recovery of those in the water. Like the SAN MATEO, this casualty was witnessed and even photographed from shore. The deckhand was able to transmit an immediate call for help on VHF-FM channel 16, and assistance from another small passenger vessel and Coast Guard boats was on scene in several minutes. One passenger had a lifejacket on and was picked up by the MERRY JANE shortly after the accident. The crew got two of the three life floats into the water with some difficulty due to their weight and the height of the rack in which they were stowed. One person was able to reach and hold onto one of the life floats. He too was rescued. The others were in the water without flotation assistance, except for some floating debris such as coolers, a table, and a bench, which some survivors were apparently able to use with limited effectiveness. All ten who survived were picked up within 10-20 minutes. Nine were lost.

The life floats and lifejackets were of limited effectiveness, assisting only 2 of the 19 persons overboard. Some lifejackets were thrown into the water, but no one was able to reach them. In view of the harbor entrance conditions, the most effective measure would have been requiring everyone on the open decks to wear a lifejacket while in the hazardous waters entering the bay. An EPIRB was on board, but was not

needed or used.

The MERRY JANE accident was in no way related to hull condition or material of construction.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
1	1		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
19*			

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
19*			

* Lifejackets should have been worn under hazardous harbor entrance conditions.

FISH-N-FOOL, 2/87

The FISH-N-FOOL capsized in a 20 ft high wave about 4 miles off the mainland of Baja California, and 2 miles from an island. Twelve people were forced into 59_ F water. Three of them apparently died shortly afterward, directly or indirectly as a result of injuries sustained in the capsizing. One survivor - the alternate operator - managed to stay near the capsized boat hanging onto a hatch cover and a barrel. About an hour later, the boat turned in the water in such a way that its four trapped life floats and EPIRB were released. She lashed the life floats together and secured a board over one of them to provide a platform on which she could sit on and stay relatively dry. She made sure the EPIRB was operating and then awaited rescue by a Coast Guard helicopter over seven hours later.

The other eight survivors became separated from the capsized boat. As a group, they decided to swim for the island. Four of them found debris including an ice chest, a bleach bottle, and a piece of plywood to provide flotation. Only one was still alive 6 hours later when he got close enough to the island to call for help from fishermen on shore.

There was no opportunity to call for help over the radio. The EPIRB worked and was heard by a Coast Guard HU-25 aircraft about 1 hours after the accident which happened to be carrying a helicopter part to La Paz, Mexico. With the source of the signal unknown, and considering the HU-25's location and fuel constraints, it was decided to send another HU-25 from San Diego, 150 miles away, to locate the signal. This aircraft located the EPIRB and the survivor about 4 hours after the casualty. An HH-65 helicopter was launched from San Diego to perform the rescue. It arrived and picked her up 7 hours after the casualty. No SARSAT information was apparently used during the search and rescue phase of this casualty.

The life floats and the EPIRB probably saved the life of the alternate operator. She was fortunate in that she had a board to put over the floats to get completely out of the water. It is unlikely that inflatable buoyant apparatus or inflatable liferafts would have made any difference in this case. Only the alternate operator was in the vicinity of the capsized boat when the life floats floated free. The same situation would have existed with float free lifesaving appliances of any type. The only possible difference might have been made by the parachute flares on board an inflatable liferaft. Being so close to land, she might have been able to attract attention from people on shore. This could have led to the rescue of some of the others who did not survive the 6 hours swim to the island.

A satellite EPIRB might also have brought rescue faster. Because its signal identifies the source and its location, some of the ambiguity associated with a Class A EPIRB would have been eliminated. This would have saved valuable time in locating the signal, and deciding whether or not to enter Mexican

airspace to pursue the search.

The FISH-N-FOOL accident was in no way attributed to hull condition or material of construction.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

	Lifejackets	L/F-B/A*	Inf. B/A	Liferaft
w/ Class A EPIRB	0	2		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

	Lifejackets	L/F-B/A*	Inf. B/A	Liferaft
w/ sat. EPIRB		7		
w/ no EPIRB				7

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

	Lifejackets	L/F-B/A	Inf. B/A	Liferaft
w/ sat. EPIRB		7		
w/ no EPIRB				7

* Includes flotsam providing flotation equivalent to buoyant apparatus.

CAPT JIM, 4/89

The CAPT JIM had 61 persons on board when it caught fire, burned to the waterline and sank about 4 miles off of the South Carolina coast. Water temperature was reported as 68__ F. The CAPT JIM had no EPIRB. The operator was unable to broadcast a distress message due to loss of power as a result of the fire. The fire was discovered about 9:00 A.M., and everyone abandoned ship wearing lifejackets. Lifejackets stowed in the passenger lunge were unaccessible due to the fire, but the lifejackets stowed in a deck box were sufficient for the number of persons on board at the time. Four life floats were on board, but because of their 200-lb weight, they were difficult to lift and launch. Consequently, only one was launched into the water. Fouling of painter lines also complicated the launching. Rescue was carried out within 30 minutes by other vessels in the area which were attracted to the fire by the smoke.

The vessel was certificated for 120 persons on coastwise voyages within 20 miles of a harbor of safe refuge. Life floats for a total of 60 persons were provided in accordance with the 50% requirement for vessels in such services. Because of the favorable conditions and the proximity of assistance, the lifejackets were adequate for survival of all on board. Limited availability of some of the life floats and lifejackets could have been a problem if the vessel was fully loaded with 120 persons.

Because of the proximity of assistance, a satellite EPIRB would not have been a factor in this casualty. If the other vessels had not been in the area to assist, an EPIRB would have been the only means of communicating any report of a distress.

The CAPT JIM was 17 years old, which is not old for a wooden vessel. The fire started in the engine room, possibly in electrical wiring, but spread throughout the vessel which then burned to the waterline. It may be concluded that wooden construction contributed to the loss of the vessel, but age was probably not a factor.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

	Lifejackets	L/F-B/A	Inf. B/A	Liferaft
	46	15		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

	Lifejackets	L/F-B/A	Inf. B/A	Liferaft
w/ sat. EPIRB	61			
w/ no EPIRB	61			

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

	Lifejackets	L/F-B/A	Inf. B/A	Liferaft
w/ sat. EPIRB	61			
w/ no EPIRB	61			

COUGAR, 9/88

The COUGAR had nine persons on board and sank about 36 miles off of the Oregon coast in 56_ F water. The COUGAR had no EPIRB and the only lifesaving apparatus was a 13-person buoyant apparatus. Such a device is designed for survivors to hold onto and would have a buoyancy of about 420 lb. Two of the survivors sat on top of the buoyant apparatus, and after 17 hours, they were the only ones who did not require hospitalization. Sitting with only their legs in the water, these two probably reduced the buoyancy available to others to about 120 lb. Their centers of gravity a foot or so above the water surface would also have reduced the stability of the buoyant apparatus. Indeed, additional survivors were unable to climb on top because of the combined effects of reduced buoyancy and stability. Three others were able to hold onto the buoyant apparatus, but two died before they could be rescued. An additional three people used a piece of wooden debris for flotation. The only survivor of this group was the only one able so stay on top of the debris for most of the time. One last survivor was wearing a lifejacket and also had an additional lifejacket for flotation. This survivor was hospitalized with a body core temperature of 77^{o}. Literature on hypothermia indicates that this is a temperature at which "apparent death" occurs.

If the COUGAR had been equipped with an operating satellite EPIRB, Coast Guard rescue units probably would have been on scene in a few hours. This would have been in time to save at least 8 of the 9 persons on board. To save everyone on board, the vessel would have needed an inflatable buoyant apparatus.

Considering the COUGAR's double planked hull and drydock inspection four months before, investigators tended to rule out hull failure as the cause of the sinking, but did cite possible failed through-hull fittings, wet exhaust system, faulty bilge system, or faulty hatch covers. The loss of the COUGAR can not therefore be related to its wood construction, but could be related to its age (45 years).

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A*	Inf. B/A	Liferaft
1	4		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

	Lifejackets	L/F-B/A*	Inf. B/A	Liferaft
w/ sat. EPIRB	1	7	1	
w/ no EPIRB	1	4	4	

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

	Lifejackets	L/F-B/A*	Inf. B/A	Liferaft
w/ sat. EPIRB		4	5	
w/ no EPIRB		2	7	

* Includes flotsam providing flotation equivalent to buoyant apparatus.

ALMA III, 12/88

The ALMA III had five persons on board and sank about 2 miles off of the south coast of Long Island in 48_ F water. The ALMA III had no EPIRB, but the master was able to broadcast a Mayday message on VHF channels 16 and 22. This message was received by a nearby Coast Guard station, which responded with a 28 ft boat, which was on scene within 30 minutes. The vessel was certificated for 53 persons on coastwise voyages, and so had three buoyant apparatus with a combined capacity for 29 persons. All persons on board had time to put on lifejackets, and were able to hold onto one of the

buoyant apparatus. Everyone was treated for hypothermia and survived this casualty, although one crewmember with health problems had to be hospitalized.

An EPIRB would have made no difference in this casualty since the operator was able to get off a Mayday message on VHF. A Coast Guard station was nearby, and had sufficient location information form the Mayday to proceed directly to the scene. Additional survival craft would have made no difference in lives saved, since all survived, but an inflatable buoyant apparatus would have prevented the injuries and hospitalization due to hypothermia.

The source of the flooding in this case was not conclusively determined. A sprung plank was identified as a possibility, as was planking damage resulting from a line or net caught in the screw. Within the year, the ALMA III had replaced rotted structural members. The loss of the ALMA III can therefore be related to its wood construction and its age (48 years).

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
5			

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
5			

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
		5	

CONNIE D, 4/89

The CONNIE D had eight persons on board when it caught fire, burned to the waterline and sank about 30 miles off of the South Carolina coast. Water temperature was not reported in the message traffic, but according to NOAA data for April, it would probably have been about 68_ F. The CONNIE D had a Class A EPIRB which was what eventually led to the rescue of all eight persons. The operator was unable to broadcast a distress message due to loss of power as a result of the fire. The fire was discovered about 9:00 A.M., and everyone abandoned ship into the 22-person life float. The 121.5 MHz signal from the Class A EPIRB was received and relayed by the COSPAS/SARSAT system, but because of frequent false alerts and position ambiguity, the Coast Guard does not respond to single hits on this frequency. After four hours of multiple reports, however, the location of the signal was determined and it was identified as a distress. An HH-65A helicopter was launched from Air Station Savannah (200 mi away) at 6:08 P.M., and homing on the EPIRB signal, located the survivors one hour and 15 minutes later at 7:20 P.M. The limited passenger capacity of the HH-65A required it to make two trips to the Myrtle Beach airport to get all survivors on shore. Nevertheless, the last survivor was aboard at 8:50 P.M., a little under 3 hours after departure from the air station, 200 miles away.

The vessel was certificated for 43 persons on ocean voyages, and so had a life float for 22 persons. Since there were only 8 persons on board, and the water was relatively warm, the life float proved adequate for the 12 hours it was used, however, all eight persons had to be treated for hypothermia at a hospital.

The survivors of the CONNIE D owe their lives to the Class A EPIRB. Nevertheless, the Coast Guard did not respond until 9 hours after the casualty, because of shortcomings in the operation of the 121.5 MHz alerting system. A satellite EPIRB probably would have enabled the rescue to be completed within a few hours after the casualty. The search and rescue operation would have been completed in full daylight, and its likely that the survivors would not have needed treatment for hypothermia. Had the water temperature been just 10_ F colder, this time might have meant the difference between life and death.

At 50_ F or 55_ F, the water chill chart suggests that it's unlikely anyone would have survived a five-hour period. An inflatable buoyant apparatus would have been required for longer survival times.

The CONNIE D was 13 years old, which is not old for a wooden vessel. The fire started in the engine room, but spread throughout the vessel which then burned to the waterline. It may be concluded that wooden construction contributed to the loss of the vessel, but age was probably not a factor.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

	Lifejackets	L/F-B/A	Inf. B/A	Liferaft
w/ Class A EPIRB		12		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

	Lifejackets	L/F-B/A	Inf. B/A	Liferaft
w/ sat. EPIRB		12		
w/ no EPIRB			12	

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

	Lifejackets	L/F-B/A	Inf. B/A	Liferaft
w/ sat. EPIRB		12		
w/ no EPIRB			12	

BRONX QUEEN, 12/89

The investigation on the BRONX QUEEN casualty is not yet complete, so the information in this section is taken from news stories. The BRONX QUEEN had 19 persons on board when it sank at the entrance to New York harbor. The BRONX QUEEN was able to broadcast a distress message before it sank, enabling rescuers to respond promptly. A Coast Guard 41 foot boat, and a rigid hull inflatable from the pilot boat NEW JERSEY were on scene just as the vessel sank. Everyone on board had put on life jackets and jumped into the 43_ F water. The two boats worked together to pull everyone from the water quickly. Two died apparently from hypothermia, and three survivors had to be hospitalized. The BRONX QUEEN did not carry an EPIRB. None of the four buoyant apparatus were apparently used. The operator stated that the sinking might have been caused by a collision with a submerged object, but hull failure will also be considered by the investigation.

Because the BRONX QUEEN was able to get a distress message broadcast before it sank, an EPIRB would have had no effect on this casualty. The survivors might have fared better if the buoyant apparatus were launched for them to hang onto. The better device would have been an inflatable buoyant apparatus. Survivors could have jumped into an inflatable buoyant apparatus alongside the sinking vessel, and awaited rescue out of the water.

The BRONX QUEEN was a 47 year-old boat, which may have been a factor in its sinking, but this has not yet been conclusively established since the investigation is not complete.

ACTUAL LIVES SAVED BY INDICATED EQUIPMENT:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
17	0		

MINIMUM EQUIPMENT NEEDED TO SAVE INDICATED NUMBER OF LIVES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
17		2	

MINIMUM EQUIPMENT NEEDED TO PREVENT INDICATED NUMBER OF INJURIES:

Lifejackets	L/F-B/A	Inf. B/A	Liferaft
12		5	

TUNA 9/89

Other than this summary, this study does not include the sinking of the TUNA. The report of this casualty was received after all of the analysis was done. It fits the pattern of most of the other losses, however, in that the vessel was wood, and 56 years old when it was holed or sprung a plank after hitting a submerged object, about one mile offshore. The operator was able to summon help by radio. All ten persons on board put on their lifejackets and as the vessel sank, jumped into the water and awaited rescue. The first boat to respond arrived just as the vessel sank. Water temperature was reported as "warm." There were no injuries to anyone resulting from the few minutes in the water. As in other casualties close to shore, an EPIRB would have made no difference in the outcome of this case. The lifejackets and buoyant apparatus were sufficient lifesaving equipment for the casualty.

DEBBY JOANN, 6/90

Other than this summary, this study also does not include the most recent case of the DEBBY JOANN, which sunk about 5 miles offshore in Cook Inlet, Alaska. This case has a number of unusual aspects which make it difficult to analyze completely until the investigation is finished. It seems to be the only case where a vessel with a fiberglass reinforced plastic (FRP) hull (13 years old) was lost taking on water from an unknown source. The owner was the only person on board. The vessel was towing a small Boston Whaler at the time, which the owner used to row to shore. There was also one immersion suit on board, which was not required to be carried. It also had a 406 MHz satellite EPIRB on board. The vessel's route was limited to 20 miles from a harbor of safe refuge, which would not require it to carry an EPIRB of any type under the present regulations. The EPIRB signal was picked up by the COSPAS/SARSAT system, and under the computer program in use at the time, identified it as being in an area where the Air Force is responsible for SAR. The Air Force assigned the case to the Civil Air Patrol, which was responding when the owner rowed ashore and turned the EPIRB off.