United States Coast Guard
Office of Investigation and Analysis

Passenger Safety on Vessels Under 100 Gross Tons
A Review of Injuries and Fatalities
Calendar Years 1992 - 2003

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EXECUTIVE SUMMARY

Of all the U.S. flag vessels that are inspected and certificated by the Coast Guard, half are "small" passenger vessels – under 100 registered gross tons. Given the large number and capacity of the vessels in this segment of the marine transportation system, a review of passenger fatalities and injuries was undertaken. This document presents the results of that review. The accident data is presented in two parts. Information on passenger fatalities appears first, followed by passenger injury statistics.

Main Points

Fatalities:

For the twelve-year period from 1992 through 2003 there were 340 passenger fatalities, or approximately 28 per year. The fatalities occurred in 311 separate incidents, with only 9 of the incidents resulting in multiple fatalities.

Most fatalities (81.2%) were not related to operation of a vessel. And, nearly all of those non-vessel fatalities resulted from diving accidents, swimming, snorkeling or natural causes.

There is a fairly steep upward trend in natural cause fatalities, most likely due to an aging population, i.e., "baby boomers". This trend is expected to continue in the coming years.

Vessel-related fatalities are rare occurrences. The deaths are few in number with very low frequency (approximately 5 per year), and are spread across a variety of causes. When grouped by type of accident, there were no trends or patterns.

A single event, such as the *TAKI TOOO* capsizing, can be statistically significant, in part because of the historically low fatality rates.

Injuries:

Most injuries involved only one person (88.6% of the incidents and 66.7% injuries).

The two most frequent injury types were falls and contact with a fixed or moving object, covering 71% of all injuries. This distribution is very different from that of fatalities, where diving accidents and natural causes were the dominant factors.

Of the vessel-related injuries, most were caused by allision, grounding, collision and propulsion/steering failures. Further, a relatively small number of incidents led to most of the "vessel-related" injuries. This is considered significant, given that 88.6% of all incidents involved only one person. Also, it was discovered that vessel related injuries are under-reported, largely because the database does not provide an identifier for injuries from sudden vessel movements. An update to the MISLE system is proposed to identify those injuries.

Finally, it is recommended that MISLE be updated to allow for injury severity indicators. Presently, there is no practical way to discriminate between minor and serious injuries.

A. INTRODUCTION

Passenger vessels of the United States that are under 100 registered gross tons are covered by safety requirements in Title 46 of the Code of Federal Regulations, Subchapter T.[1] These vessels are sometimes known as "small" passenger vessels to distinguish them from the larger cruise ships and gaming vessels, which must comply with much more extensive safety requirements, contained in Subchapter H of Title 46. However, the term "small passenger vessel" is a misnomer, because this is the largest group of inspected and certificated vessels in the United States, with the capacity to carry millions of passengers each year.

This document presents a review of passenger fatalities and injuries on small passenger vessels for calendar years 1992 through 2003. This review was performed to:

- provide general statistics on small passenger fatalities and injuries for managers and other persons who may be interested in maritime safety.
- determine if, over time, there have been any significant changes in accident trends or causes that might signal the need for changes in safety policies or procedures.

The accident data will be presented in two parts. Information on passenger fatalities will be presented first, followed by passenger injury statistics. Each section will begin with broad-based descriptive statistics. Then, additional details will be presented, to focus on the most significant factors in passenger casualties.

The Vessel Population

At the time of this document there were 11,929 U.S. flag commercial vessels that were inspected and certificated by the U.S. Coast Guard. Of that number, half (5,962) were small passenger vessels, with a combined passenger capacity of 443,171. The vessels ranged in size from 16 to 247 feet in length. The average vessel is 57 feet in length and carries 74 passengers. By comparison, there were 153 "large" vessels, with a combined passenger capacity of 150,396, which is 1/3 the combined capacity of the smaller vessels.

The Accident Data

The data for this report was extracted from two of the Coast Guard's Marine Safety databases. From 1992 through December 13, 2001, casualty reports were recorded in the Marine Safety Information System (MSIS). Thereafter, the Marine Information for Safety and Law Enforcement (MISLE) system replaced MSIS, which is the current repository for casualty reports.

Additional details about the data sources are contained in Appendix A.

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[1] For an in-depth review of large passenger vessels, see the October-December 2003 *Proceedings of the Marine Safety Council*, Volume 60, Number 4, which can be viewed online at **www.uscg.mil/proceedings**

B. PASSENGER FATALITIES

For the twelve-year period from 1992 through 2003 there were 340 passenger fatalities, or approximately 28 per year. The fatalities occurred in 311 separate incidents, with only 9 of the incidents resulting in multiple fatalities. These figures represent all reportable passenger deaths that were investigated by the Coast Guard, as prescribed by Federal Regulations. The applicable portion of the Regulation is contained in Appendix B. The multiple fatality cases are shown in Table 1.

Multiple fatality incidents

Vessel	Date	Passenger Fatalities
Taki Tooo	14 June 2003	10 (+ 1 crew member)
Miss Majestic	1 May 1999	13
S. S. Minnow	2 January 1998	2*
Atlantis	2 July 1995	2*
El Toro II	5 December 1993	2 (+ 1 crew member)
Daniel Matheney (ferry)	17 September 1993	2
Rain Song	15 April 1993	3
Seeker	12 October 1992	2*
Virginia C (ferry)	20 April 1992	2

*** = Diving accident.** **Table 1**

Trends in passenger deaths

Figure 1 shows the trend in passenger deaths. In the first 5 years, there appears to be a fairly flat pattern, followed by much more variability. A control chart can be used to examine this trend further. Upper and lower control limits[2] have been added to the chart, based on historical values, to show the normal range of variation. The chart shows an upward trend in passenger deaths, starting in 1997, which exceeded the upper limit in 1998 and 1999, followed by a sharp drop and another peak in 2003. When compared to the first 5 years, the trend is "out of control." In other words, this trend indicates a statistically significant change in the death rate that cannot be explained by normal variation.

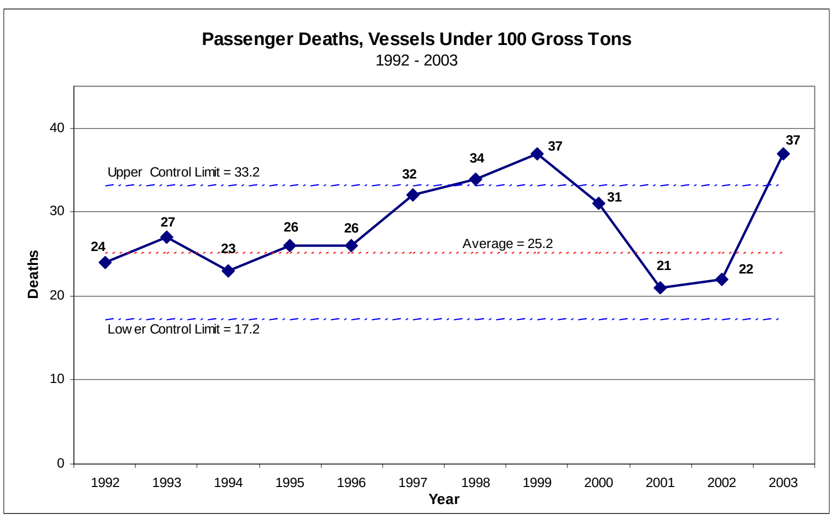

Figure 1

Deaths by accident type

Among the details reported by Coast Guard investigators is the nature, or type, of accident that resulted in a death. This information can help explain the changing fatality rates in recent years and is summarized in Figure 2.

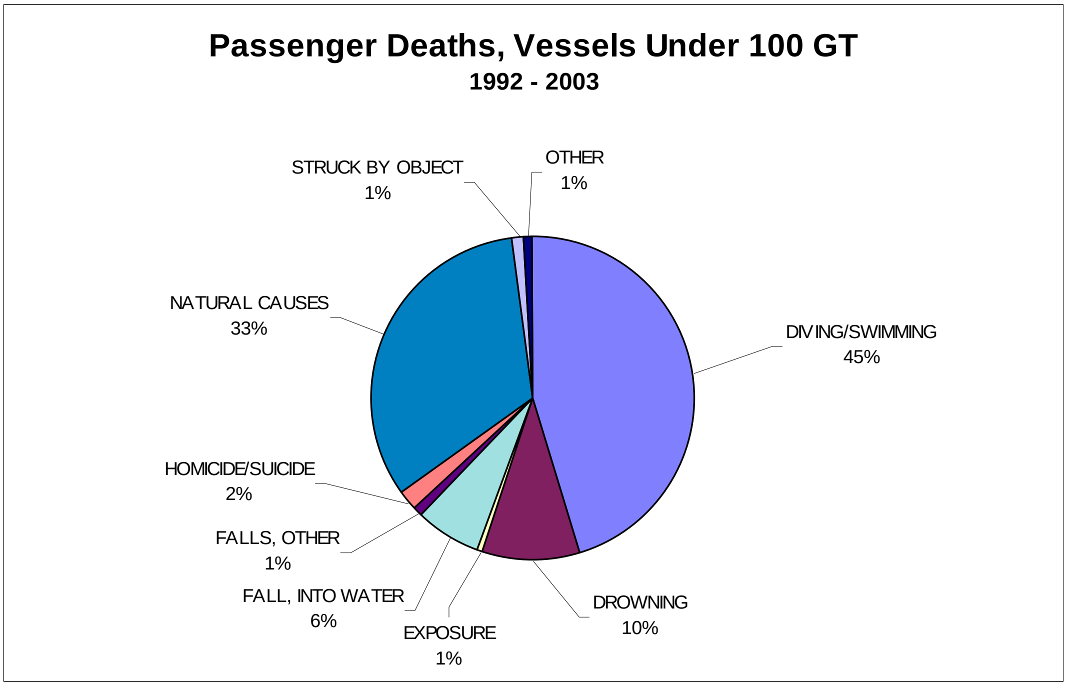

Figure 2

The graph shows that most passenger deaths were not related to the operation of a vessel. For example, deaths from natural causes include heart attacks and strokes, which could have occurred at any time or place. Similarly, diving deaths result from errors made by the diver, such as ascending too quickly, entanglement in kelp, getting lost in a wreck, and diving equipment failures. Also, some of the diver deaths were linked to pre-existing medical conditions. Collectively, all non-vessel accident types account for 81.2%, or 276 of the 340 passenger deaths, summarized as follows:

Accident Type	Fatalities
• Diving/Swimming accidents	154
• Natural causes	112
• Suicide/Homicide	7
• Drug overdose	2
• Choked on food	1

Given the high percentage of fatalities attributed to diving activities and natural causes, a review of those cases is presented next.

Fatalities from diving

As noted, diving accidents account for nearly half of all passenger fatalities. Figure 3 shows the annual fatality counts, along with a best-fit regression line. The regression line shows a nearly flat, but slightly downward trend. In other words, there is very little change in diving fatalities over time. Thus, one can expect future diver fatalities to occur an average of 12.8 times per year, within a range of approximately 6 to 20, i.e., 2 standard deviations of the average.

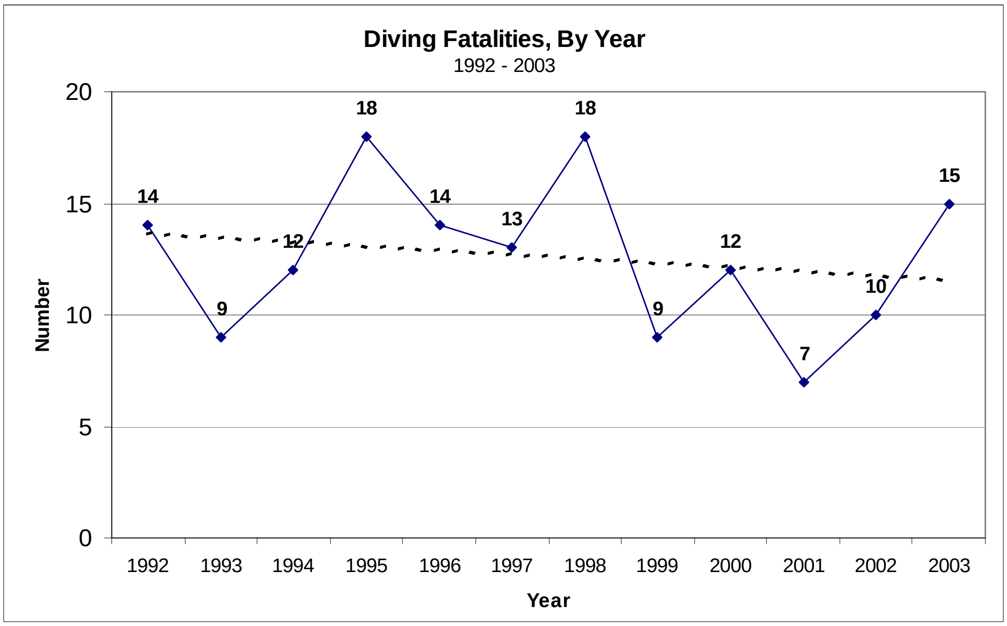

Figure 3

Natural Causes

One third of all reported deaths on small passenger vessels are attributed to natural causes. Figure 4 shows the annual counts, along with a best-fit regression line. The graph shows a clear upward trend in this data. The likely explanation for the upward trend is an aging population. According to the U.S. Census Bureau:

> "The median age of the United States was 35.3 in 2000. In 1990 the median age was 32.9. As the large generation of baby boomers (those born between 1946 and 1964) began passing their 45th birthday, the population aged 45 to 54 swelled 49 percent during the decade."[3]

Further, the Census Bureau predicts that the median age will continue to increase. By the end of 2010, the Bureau projects a population increase of 26.8 million. Most of that increase, 18.6 million, will be between 45 and 64 years of age – several times larger than any other age group.[4]

Assuming that ridership on small passenger vessels is representative of the overall population, it is likely that natural cause deaths will continue to increase.

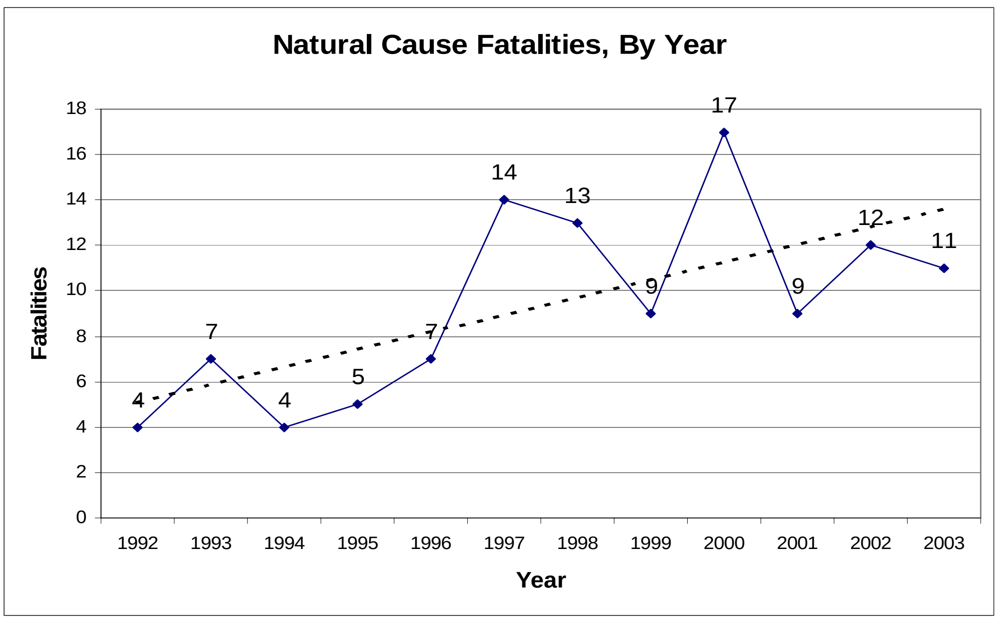

Figure 4

Vessel-Related Fatalities

If the non-vessel cases described above are set aside, 60 passenger fatalities remain from the original 340. Those 60 fatalities are the most likely to concern safety officials, because they may be related to vessel operation. Figure 5 shows a trend line for the "vessel-related" cases, which is very different from the overall trend shown previously. Generally, the number of fatalities per year has been quite low, except for spikes in 1999 and 2003. Each of the spikes resulted from a single casualty:

- 1 May 1999. The tour boat *MISS MAJESTIC* sank in Lake Hamilton, Arkansas, with 13 passenger deaths.
- 14 June 2003. The *TAKI* TOOO capsized while transiting hazardous waters in Tillamook Bay, Oregon, resulting in 10 passenger fatalities.

Further, the two recent incidents are the most serious in 23 years. Of the casualty records from 1981 to present, the incident next in severity is the broaching of the *MERRY JANE* on 8 February 1986, with 9 passenger fatalities. Without the *MISS MAJESTIC* and *TAKI TOOO* casualties, the trend line would remain relatively flat, as shown by the dashed line in Figure 5.

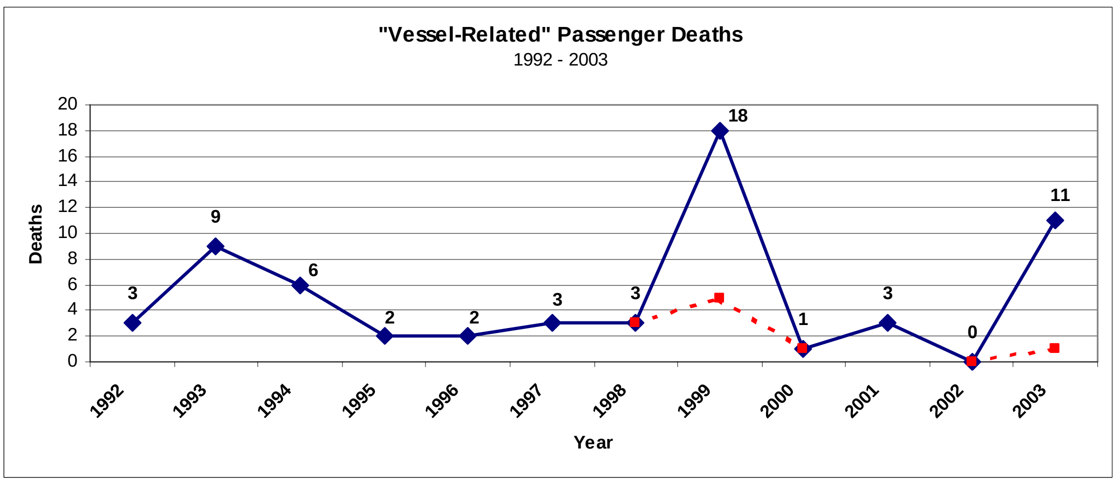

Figure 5

The 60 vessel-related fatalities occurred in 34 incidents, which is approximately 5 deaths or 3 separate incidents per year. When other factors are considered, such as the specific industry segment of the involved vessels, e.g., party fishing, excursion, diving, etc., or the nature of the fatality, these cases may be truly rare occurrences. However, as a group, the data may reveal some general "themes" or patterns, which will be explored next.

Vessel- related deaths, by accident type

A summary of vessel-related fatalities is shown in Figure 6. The graph shows that most of the deaths, 51 of 60 or 85%, resulted from just two accident types - drowning and falls into the water. The remaining 9 fatalities are distributed among 4 accident types.

Given that the deaths occurred over a period of 12 years among several different accident types, formal statistical analysis is not practical. Therefore, the individual cases are synopsized on the following pages.

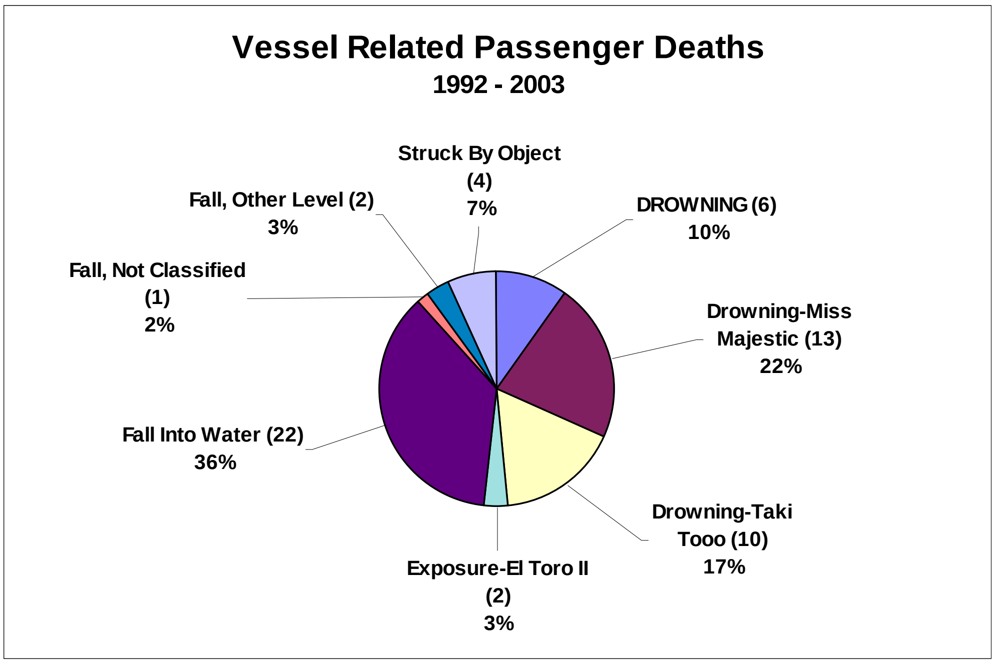

Figure 6

Drowning deaths

There were 6 incidents that resulted in 29 drowning deaths. The cases are summarized as follows:

- Capsizing of the *TAKI TOOO* while transiting hazardous waters in Tillamook Bay, Oregon, resulting in 10 passenger fatalities. An investigation of this casualty is ongoing.

- The sinking of the *MISS MAJESTIC*, with 13 fatalities. The *MISS MAJESTIC* was a World War II amphibious vessel being used for tours on Lake Hamilton, Arkansas. Shortly after entering the lake, the vessel flooded through a drive shaft housing and sank quickly. This incident was the subject of an extensive Marine Board of Investigation, which can be viewed on the internet at: http://www.uscg.mil/hq/g-m/moa/reportindexcas.htm

- *Ferry Accidents Involving Vehicles* – In each of the four other cases, a vehicle was lost from the deck of a ferry, with a total of 6 fatalities.

  - Two of the incidents were caused solely by errors made by the vehicle operators, each resulting in two fatalities. In one incident the operator was intoxicated.

  - In another incident, a ferry barge capsized and dumped a vehicle into the Missouri river, with one fatality.

  - The most recent case, which occurred on 11 November 1999, was caused by an inexperienced deckhand who removed a safety barrier and vehicle wheel chocks prematurely. A passenger car rolled into the water as the ferry approached the dock, resulting in one fatality.

At first, the ferry casualties might appear as an area of concern. However, the incidents occurred over a period of 7-1/2 years. In fact, 3 of the 4 cases occurred in 1994 and earlier. Intuitively, one knows that the potential for similar casualties exists given the number of ferries in service, their size, and the number of persons carried.[5] However, the data does not suggest anything other than random occurrences.

The most recent incident would be useful as a "lessons learned" case study, because the Coast Guard Investigating Officer noted a number of procedural errors made by a deckhand, which were attributed to lack of experience. The case report also includes an examination of personnel training, emergency procedures and company policy issues.

Falls into water

Overall, this accident type included 20 incidents, with 22 fatalities. These deaths resulted from a variety of causes, with no apparent pattern or trend, as summarized in Table 2.

Description of Incident	Total Fatalities	No. Involving Alcohol
Capsizing of the *RAIN SONG*, while crossing a hazardous bar.	3	
Stepped through a door and fell overboard.	1	
Fell from launch during transfer to another vessel.	2	
Disappeared while underway, cause unknown	4	2
Fell over rail/side.	2	1
Fell through opening in rail.	3	1
Fell from unsafe/unauthorized location.	2	1
Fell while jumping from lock wall to vessel.	1	
Jumped overboard – possible suicide.	1	
Gangway collapsed, passenger hit head & fell into water.	1	
Disappeared – foul play possible.	2	

Table 2

With the exception of the *RAIN SONG* capsizing, there was only one death per incident. In five of the fatalities, alcohol consumed by the deceased passenger was a contributing factor, as indicated in the last column of the table.

Other Accidents

In addition to incidents of drowning and falls into water, there were four other vessel-related accident types: struck by object, fall to another level, fall-not classified, and exposure. Those accident types accounted for 8 incidents and 9 fatalities. Each of the accidents was the result of unique circumstances, with the exception of two falls to another level. In both of those incidents an elderly passenger fell down a flight of stairs. The exposure fatalities occurred after the *EL TORO* II sinking in 1993.[6]

Findings

The most important factors regarding small passenger vessel deaths can be summarized as follows:

- Over a 12 year period, very few incidents have resulted in more than one fatality (9 of 311) indicating that serious cases have been rare.

- Only six of the 34 vessel related incidents resulted in more than one fatality. However, the two incidents with the most fatalities occurred in 1999 and 2003.

- When grouped by accident type, most fatalities, 276 of 340 or 81.2%, are from causes not related to the vessel.

- Nearly all non-vessel fatalities resulted from diving accidents, swimming, snorkeling or natural causes (266 of 276).

- *Fatality Trends* **–** By using a control chart, increased variability was observed in the fatality counts beginning in 1997. Most of the increase was from two factors:

  (1) An upward trend in natural cause fatalities, most likely due to an aging population; i.e. “Baby Boomers”; and
  (2) Two multiple-fatality incidents: the *MISS MAJESTIC* sinking in 1999, and the capsizing of M/V *TAKI TOOO* in 2003.

- Overall, vessel-related fatalities are rare occurrences. The deaths are few in number with very low frequency (approximately 5 per year), and are spread across a variety of causes. When grouped by accident type, there were no trends or patterns.

- There were four incidents involving vehicle ferries that were found to be random or unrelated occurrences. Given the number of ferries in service and the large number persons carried, the fatality data shows no safety issues with this industry segment.

- A single event, such as the *TAKI TOOO* capsizing, can be statistically significant, in part because of the historically low fatality rates.

C. PASSENGER INJURIES

There are many possible ways to look at passenger injury data. Rather than start with a specific question or theory, the intent of this review is to look first for the most common or significant factors in how passengers are injured. Thus, tabular and graphical summaries are used as a starting point, followed by more detailed examination, where appropriate.

For the twelve-year period from 1992 through 2003, Coast Guard investigation records show 1,238 injuries on small passenger vessels, or approximately 103 per year. The injuries occurred in 932 separate incidents, with 106 of those incidents resulting in multiple injuries.

The distribution of passenger injuries is summarized on the histogram in Figure 7, which shows the number of injuries per incident. Single-injury incidents account for 88.6% of the cases and 66.7% of the injuries.

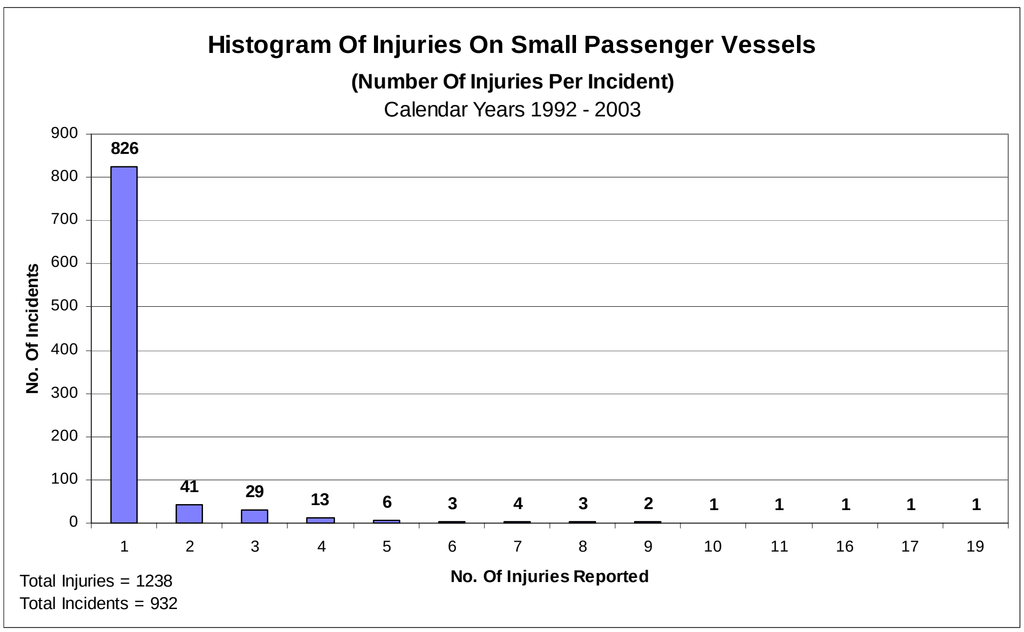

Figure 7

Trends in passenger injuries

Figure 8 shows the trend in passenger injuries. Upper and lower control limits have been added to the chart, to show the normal range of variation. Unlike the fatality trend, there are no "out of control" points. However, the number of injuries for 1996 is very close to the upper limit, making it an unusual value.[7] Also, there appears to be no relationship between

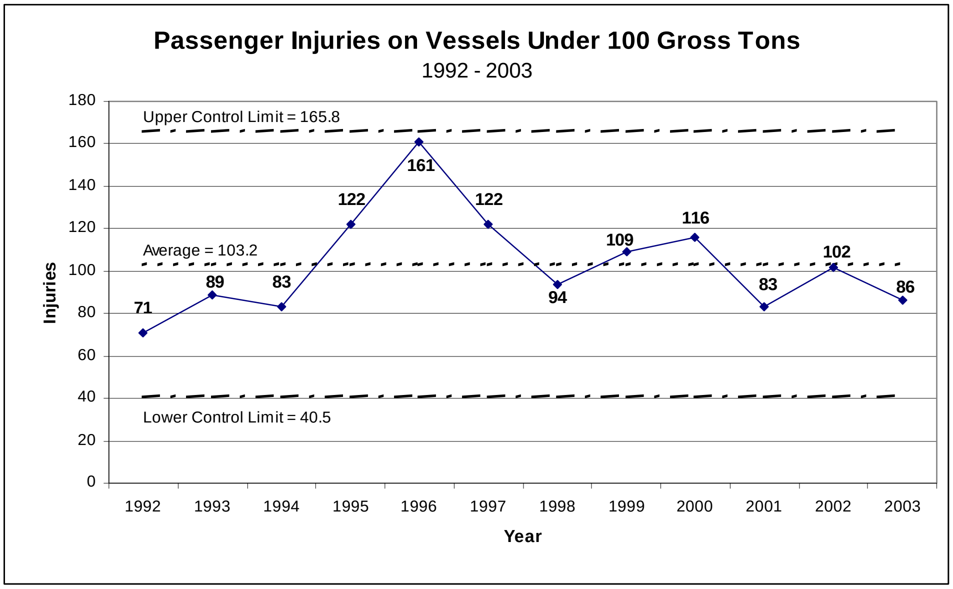

Figure 8

the unusually high number of injuries in 1996 and the number of fatalities. As shown in the preceding section, the fatality counts peaked in 1999 and 2003, with the 1996 figure being very close to the average.

The 1996 injuries were unusual in other respects. In addition to the highest injury count, 1996 showed the highest incident count, the largest number of incidents involving multiple injuries, and the highest total injuries in multi-injury incidents. Table 3 summarizes the incident and injury counts for the entire period.

In order to understand the unusual injury counts for 1996 and to identify the most significant factors in passenger injuries, the accident data will be presented in more detail on the following pages.

Injuries On Small Passenger Vessels, 1992 - 2003					
Year	All Injuries		Multiple Injury Incidents		
	Incidents	Injuries	Incidents	Total Injured	Max Injured
1992	52	71	6	25	8
1993	70	89	9	28	5
1994	65	83	6	24	7
1995	93	122	8	37	11
1996	115	161	15	61	16
1997	101	122	8	29	10
1998	69	94	9	34	8
1999	74	109	7	42	17
2000	88	116	12	40	8
2001	74	83	6	15	4
2002	68	102	11	46	19
2003	63	86	9	32	7
Totals:	**932**	**1238**	**106**	**413**	**N/A**

Table 3

Injuries by accident type

Figure 9 shows passenger injuries by accident type. Here, accident type refers to the manner in which a person was injured and is independent of other factors, such as a vessel grounding. The chart shows a distribution that is considerably different from passenger fatalities. Most casualties (71%) were attributed to "Falls" and "Contact injuries."[8] Conversely, such accident types represented less than three percent of all fatalities.

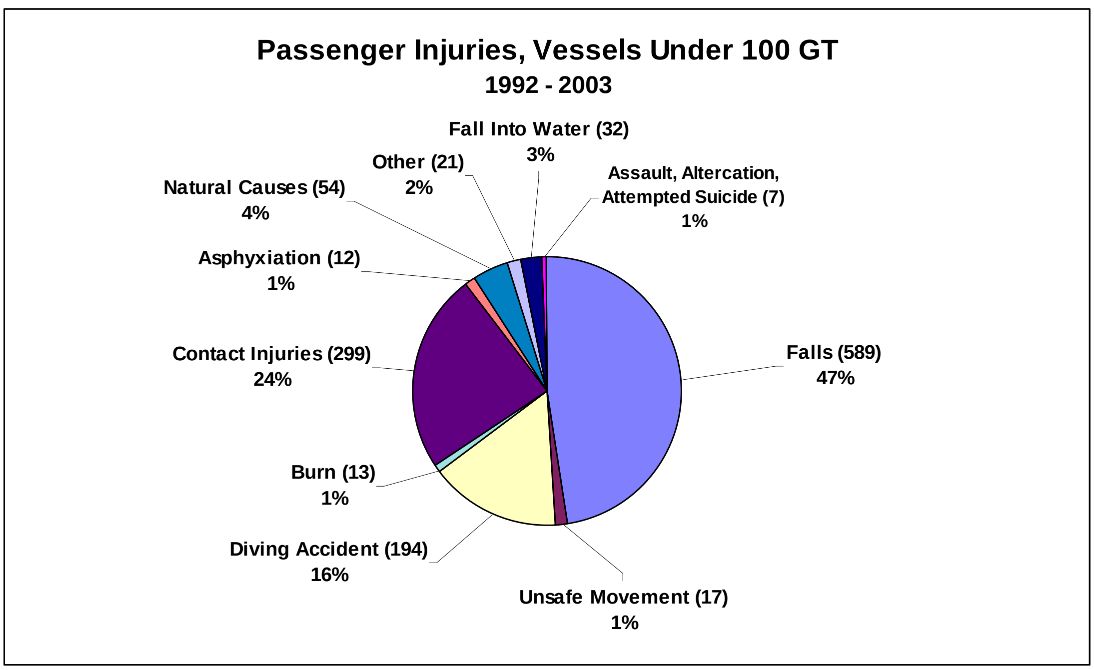

Figure 9

The data in Figure 9 does not clearly indicate which accidents are related to vessel operations. The most obvious non-vessel accident types, "Natural Causes," "Diving Accidents," and "Assault, Altercation, Attempted Suicide" were only 21% of all injuries. The most significant accident types, "Falls" and "Contact Injuries" may be caused by the person or the vessel. For example, a person could fall down stairs due to inattention or because of an abrupt vessel movement, such as a grounding.

Given the high percentage of injuries attributed to "Falls," "Contact Injuries," and "Diving Accidents," data on those accident types will be presented next.

Injuries from falls

Nearly half (589 of 1238 or 47%) of all passenger injuries were falls. Figure 10 summarizes the injuries, along with a best-fit regression line. The regression line is nearly flat, with a slightly upward trend. Also, a control chart of this data, not shown here, indicates no unusual values and relatively little variation between years. In other words, there is very little change in this type of injury over time. Injuries of this type can be expected to occur an average of 54 times per year.

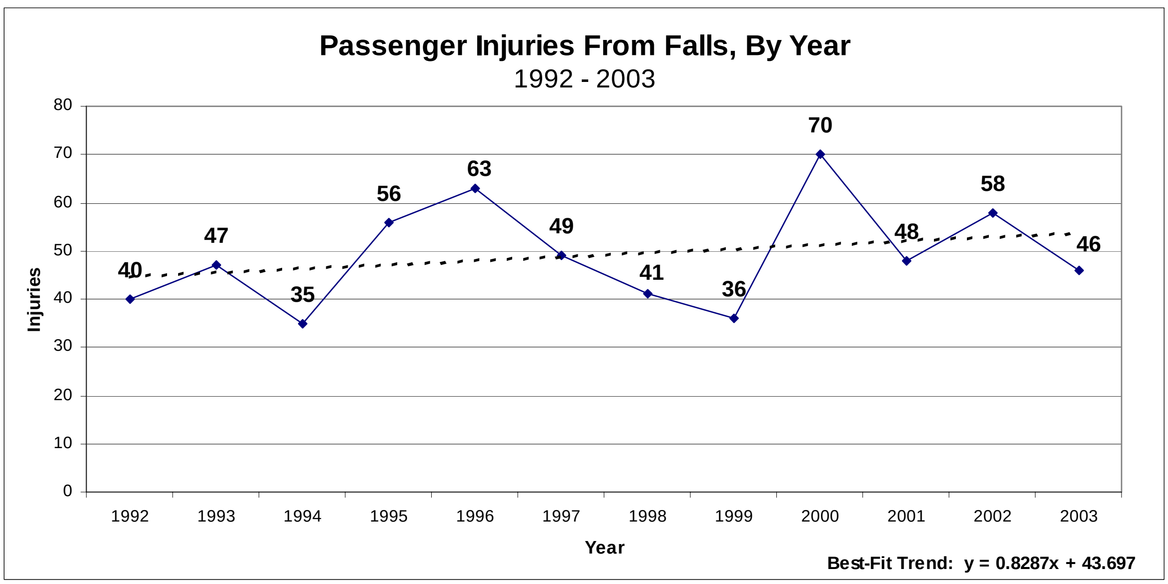

Figure 10

Contact injuries

Contact injuries are the second largest accident type, with 24% of the total, or 299 of 1,238. For this report a contact injury is defined as the striking of a person by a moving object, a person striking a fixed object, or crushing between objects, as summarized in Figure 11. The top trend line shows all contact injures. The bottom trend line shows contact injuries that were preceded by a vessel-related event. Overall, half of the injuries (148 of 297) were preceded by a vessel event. Also, most of the vessel events (95 of 148) were allisions (41), collisions (28), or groundings (26). The highest value occurs in 1996, which is the peak year for all injuries. A large portion of the 1996 contact injury count can be explained by two incidents:

- July 26, 1996: The M/V *SEE MORE* struck an iceberg in the vicinity of Tracy Arm, Alaska. A total of 16 minor injuries were reported – 10 contact injuries and 6 falls.
- October 25, 1996: The crewboat *PANTHER* grounded on a sand bar, near the Louisiana coast. Five passengers received contact injuries.

This data indicates that the trend in contact injuries is driven by vessel incidents.

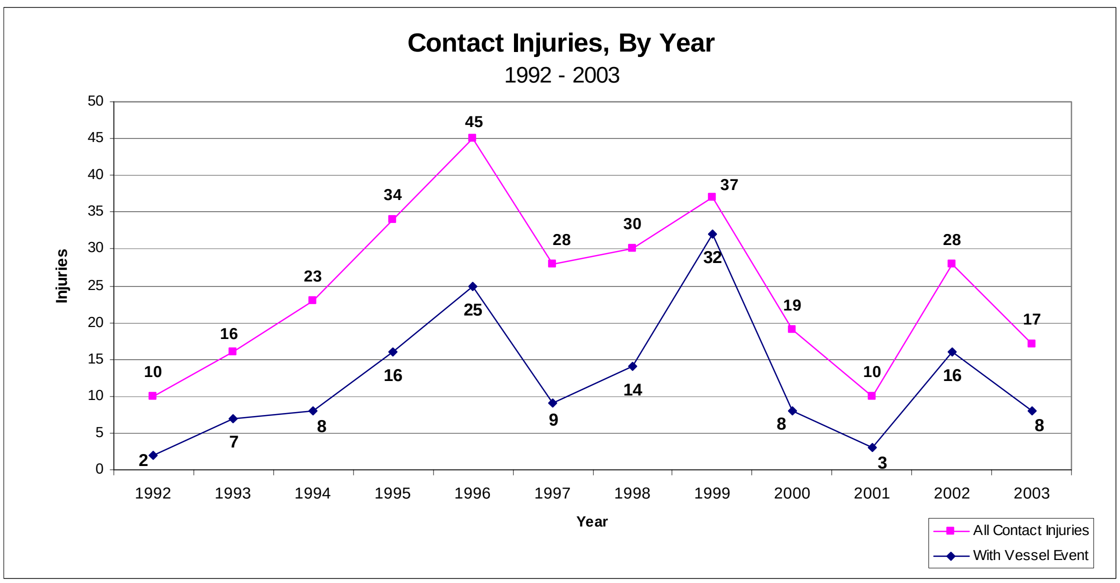

Figure 11

Diving accidents

Diving accidents are the third largest accident type, with 194 of 1,238, or 16% of the total. Those injuries fall into one of the few categories that are clearly not related to the operation of a vessel.

Figure 12 shows the annual diving injury counts, along with a best-fit regression line. The downward slope in this trend line is similar to that of diving fatalities. Again, there is a prominent spike in the injury counts for 1996, which corresponds to the peak value for all passenger injuries. Thus, diving accidents appear to be a large contributor to the unusual injury count for 1996. However, there is no apparent reason for the 1996 diving injury spike. Except for 3 incidents, (one incident with 3 injuries and two incidents with 2 injuries), all diver accidents in the data series were limited to one person at a time.

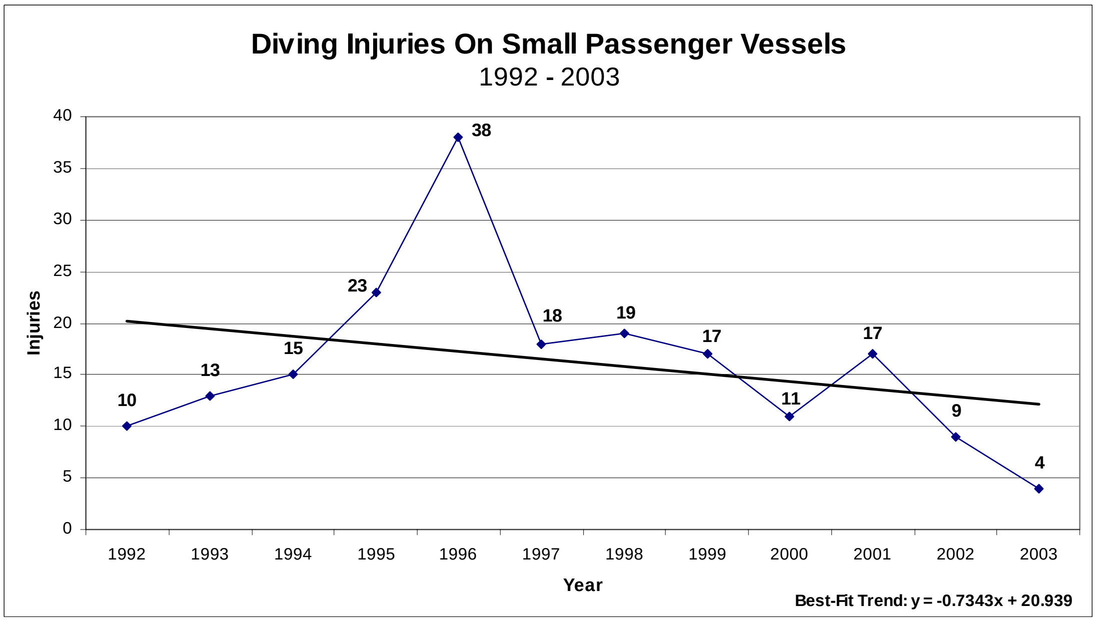

Figure 12

Injuries involving vessel events

The preceding review of injury data by accident type focused on the three most frequent types – falls, contact injuries, and diving accidents. As previously noted, the nature of falls and contact injuries is such that some, but not all, injuries may be associated with vessel casualties. To further explore the relationship between injuries and vessel operations, the sequence of events in the accident reports can be used. Specifically, the first event in the casualty sequence will be used to characterize the accidents. For example, a vessel might experience a grounding, followed by flooding and passenger injuries. In this scenario, the casualty would be counted as a grounding, which initiated the other events, including personal injury.

The database showed 299 injuries associated with vessel events, or 24.1% of the total. The injuries occurred in 106 incidents, for an average of 2.8 injuries per incident. Figure 13 shows the injuries by the first event. Four event types, related to underway operations, cover 76.9% of all injuries in this group: allision, grounding, collision, and vessel maneuverability.[9]

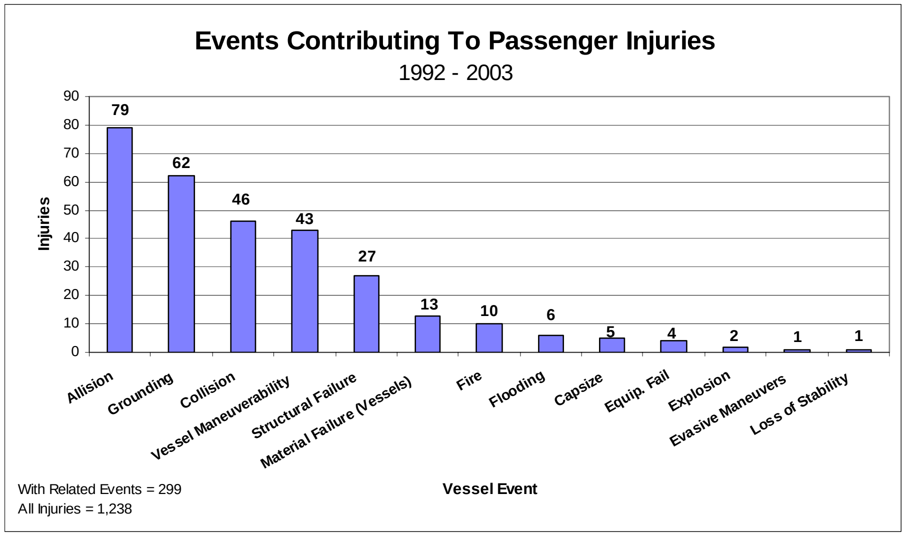

Figure 13

This group of injuries is also shown by calendar year in Figure 14. The upper trend line, injury counts, shows considerable variation between years. However, the lower trend line indicates a small and consistent number of incidents per year. In fact, 10 incidents, including the *SEE MORE* allision, accounted for 101 of the 299 injuries in this group. Thus, it appears that a relatively small number of underway incidents led to most of the "vessel-related" injuries. This is considered significant, given that 88.6% of all incidents involved only one person.

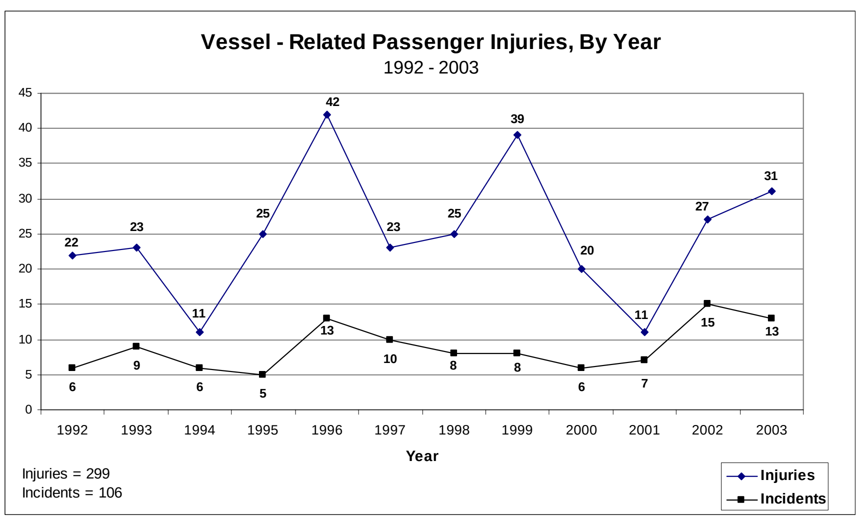

Figure 14

Not shown on the graphs above were 939 incidents where the only reported event was "personnel casualties". Of that number, 249 were clearly not related to the operation of a vessel, as follows:

- diving accidents (194).
- natural causes (48).
- assaults, altercations, and attempted suicides (7).

Of the remaining 690 injuries with no vessel events, one might assume that most of them were single-person incidents. Unfortunately, it is not possible to generalize about that group, because nearly all of them were falls (477) and contact injuries (150), which may be caused by the individual passenger or the vessel they were riding. In fact, this group includes some multiple-injury incidents, ranging from 2 to 19 injuries. A review of the multiple-injury reports showed that an abrupt or severe vessel motion preceded all incidents with 4 or more injuries. For example, a whale-watching vessel dropped several feet when it encountered a wave that was larger and steeper than all others at that locale, i.e., a "rogue wave." After the vessel dropped, 19 passengers fell and were injured.

Neither MISLE nor the older MSIS system has an event type to indicate sudden or abrupt vessel movements. Thus, there is no way for investigators to report such an event in the database. Consequently, it appears that the vessel-related injury counts, shown in figures 13 and 14, are under-reported by at least 80 injuries. If a "Sudden Vessel Movement" event type were added, the number of injuries attributed to underway operations would be <u>at least</u> 379, or 30 % of all injuries.

To properly identify the accident types and causes of all 690 non-vessel injuries, it would be necessary to review each of the casualty reports individually. A separate study would be more appropriate for such an effort.

Severity Indicators

Federal regulations require that passenger injuries be reported to the Coast Guard when professional medical treatment beyond first aid is needed.[10] Consequently, the accident data contains information on a wide range of injuries, from minor to very serious. However, the database contains no indicators of severity, which would be desirable for analysis purposes. For example, it would be useful to know the distribution of passenger injuries by severity and whether there are any trends in the more serious incidents. In the preceding pages, there was one possible "proxy", or indirect, indicator of severity – vessel-related injuries. The data showed that a small number of vessel casualties resulted in a large percentage of the injuries. While not an ideal measure, the number of vessel-related injuries does provide an indication of the severity of the incident overall.

Another possible severity indicator is the number of times injuries and fatalities occur during the same incident. However, there were only 5 such incidents. Such rare occurrences are not useful for trend analysis.

Findings

The review of passenger injuries on the preceding pages showed the following:

- Most injuries, 66.7%, involve only one person. Also, single-person accidents represent 88.6% of all incidents.
- From year to year, the number of injuries was relatively constant, except for a spike in 1996. That increase appears to be the result of two factors - a small number of vessel incidents with multiple injuries, and an unexplained spike in diving accidents.
- When grouped by accident types, most injuries (71%) were the result of falls and contact with a fixed or moving object.
- The most frequent type of injury, falls, represented 47% of the total. Throughout the 12-year period, there was a slight upward trend, with relatively little variation between years. The data does not clearly distinguish between falls from vessel incidents and those caused by the individual passenger.
- Contact injuries were the second largest accident type, with 24% of the total. The number of injuries was generally driven by a small number of vessel casualties. A few vessel casualties with multiple contact injuries contributed to the spike in 1996.
- The third most frequent injury type was diving accidents, with 16% of the total. Overall, there was a downward trend in these accidents, which corresponds with a similar trend in diving fatalities. This injury type was the largest contributor to the spike in 1996. However, there is no apparent explanation for the high numbers.
- Vessel casualty events preceded 24% of all injuries. Four event types, related to underway operations, were attributed to most of the injuries in this group: allisions, groundings, collisions or propulsion/steering problems. Further, a relatively small number of incidents led to most of the "vessel-related" injuries. This is considered significant, given that 88.6% of all incidents involved only one person. Also, it was discovered that vessel related injuries are under-reported. The information system does not provide an identifier for injuries caused by sudden vessel movements.

D. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

With nearly 6,000 vessels and the capacity to carry over 440,000 passengers, "small" passenger vessels comprise the largest segment of vessels to be inspected and certificated by the U.S. Coast Guard. However, these statistics understate the contribution of such vessels to the marine transportation system. A better indicator would be the number of passenger embarkations per year, which would allow comparisons to other modes of transportation. Even though embarkation figures are not readily available, the number is certainly in the tens of millions. For example, four vessels of the Casco Bay Ferry Line, serving Portland, Maine and several nearby islands, carry more than 977,000 passengers per year.[11] There are similar ferry operations throughout the United States, some operated by state agencies.

Given the number of vessels and their capacity, the passenger fatality and injury data shows that the existing safety regime has been quite successful. Vessel-related fatalities have been rare occurrences. The deaths were few in number (approximately 5 per year), and spread across a variety of distinct causes. When grouped by accident type, there were no trends or patterns. However, all parts of the safety regime must remain vigilant. Small lapses can have serious consequences, as evidenced by the *MISS MAJESTIC* sinking and the *TAKI TOOO* capsizing.

The data on passenger injuries is more difficult to interpret. A few minor changes to the Coast Guard's information system, as described below, should improve the data significantly. Even with the noted limitations, the injury data showed that a small number of operational incidents, such as allisions, collisions and groundings, result in a disproportionate number of injuries.

Suggestions for improving the injury data

The review of injury data revealed two places where a small change in the information system would significantly improve data analysis capabilities. The proposed changes are as follows:

Sudden vessel movement.

The most frequent accident type, falls, includes incidents that may be caused by either the person or the vessel. It was discovered that many of the injuries were preceded by a sudden or abrupt vessel motion and that the passengers did not contribute to their own injuries. However, there is no means to identify a sudden vessel motion in the event sequence. Thus, investigators generically report the occurrence of "personnel casualties." Each accident report would have to be reviewed in order to identify the vessel-related incidents. It is recommended that the MISLE system be updated to allow for this type of event on the casualty timeline.

Injury Severity Indicators.

The accident data contains information on a wide range of injuries, from minor to very serious. However, the database contains no indicators of severity, which would greatly enhance data analysis. For example, it would be useful to know the distribution of passenger injuries by severity and whether there are any trends in the more serious incidents. There are other indicators of overall incident severity. However, such indicators cannot be consistently applied to injuries. For example, a collision may result in significant property damage, but only a few minor injuries. Again, the only way to get indicators of severity from the current system would be to read the narrative comments in each of the accident reports.

It is recommended that the MISLE system be updated to record severity indicators for all injuries. The indicators should be based on standard, but easy to understand descriptors such as “minor,” “moderate,” “serious,” and “critical,” with concise definitions. Severity indicators designed for the medical community, such as the Abbreviated Injury Scale, are not appropriate for use by Coast Guard investigators, because of their complexity.

APPENDIX A: ABOUT THE DATA SOURCE

What incidents are reported to the Coast Guard?

The Coast Guard's role in investigating accidents on commercial vessels is contained in Title 46 of the Code of Federal Regulations, Part 4 (46 CFR 4). The criteria for reporting casualties is explained in 46 CFR, paragraph 4.05-1, which requires, in part, that all deaths on commercial vessels be reported to the Coast Guard at the earliest opportunity. (A portion of the regulation is provided on the next page.) It should be understood that such reports are simply the first step in a process where the Coast Guard investigates maritime casualties, primarily to determine their cause. As shown elsewhere in this report, some fatalities and injuries are the result of factors that are not related to the vessel or its operation, such as deaths from natural causes, e.g., heart attack.

The databases

The data for this report was extracted from two of the Coast Guard's Marine Safety databases. From 1 January 1992 through 13 December 2001, casualty reports were collected in the Marine Safety Information System (MSIS). The Marine Information for Safety and Law Enforcement (MISLE) system replaced MSIS, and is the current repository for casualty reports.

What passenger casualties were included?

To identify the population of small passenger vessel fatalities and injuries, the Coast Guard used the following:

- The service of the vessel, at the time of the casualty, was recorded as "PASSENGER."
- The vessel had a Coast Guard Certificate of Inspection and was less than 100 gross tons in size.
- At least one passenger was listed as dead, missing, or injured.
- Vessels classified as "Cruise Ship" were excluded.
- Only vessels of U.S. flag were included.

Quality Control

Readers should note that a large percentage of the data fields in the Marine Safety databases are optional. In fact, Investigating Officers have the discretion to provide data on only those factors they feel are relevant, depending upon the nature of the incident. Thus, each of the fatality reports was individually reviewed, in order to verify the accuracy and completeness of the items needed for this report. In particular, the investigator's narrative comments often provided the specifics for missing or incomplete data items, including:

- Crewmembers that were misclassified as passengers.
- Fatalities that did not involve a vessel.
- Missing records for passenger fatalities.
- Missing, nonspecific, or misclassified descriptions of the fatality.

All reasonable effort has been made to identify all of the fatalities and injuries for this report. However, it is possible that a small, but unquantifiable, number of incidents were not included, because of data entry errors, omissions, or incidents that were still under investigation at the time of this report. It is believed that the probability of such exclusions is rare, due to the seriousness of the incidents involved and ongoing data reviews.

APPENDIX B: CASUALTY REPORTING REQUIREMENTS

[Code of Federal Regulations]
[Title 46, Volume 1, Parts 1 to 40]
[Revised as of October 1, 2000]

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[**CITE**: **46CFR4.05-1**]

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TITLE 46--SHIPPING

CHAPTER I—COAST GUARD,
DEPARTMENT OF TRANSPORTATION

PART 4--MARINE CASUALTIES AND INVESTIGATIONS—Table of Contents

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Subpart 4.05--Notice of Marine Casualty and Voyage Records

Sec. 4.05-1 Notice of marine casualty.

(a) Immediately after the addressing of resultant safety concerns, the owner, agent, master, operator, or person in charge, shall notify the nearest Marine Safety Office, Marine Inspection Office or Coast Guard Group Office whenever a vessel is involved in a marine casualty consisting in—

(1) An unintended grounding, or an unintended strike of (allision with) a bridge;

(2) An intended grounding, or an intended strike of a bridge, that creates a hazard to navigation, the environment, or the safety of a vessel, or that meets any criterion of paragraphs (a) (3) through (7);

(3) A loss of main propulsion, primary steering, or any associated component or control system that reduces the maneuverability of the vessel;

(4) An occurrence materially and adversely affecting the vessel's seaworthiness or fitness for service or route, including but not limited to fire, flooding, or failure of or damage to fixed fire-extinguishing systems, lifesaving equipment, auxiliary power-generating equipment, or bilge-pumping systems;

(5) A loss of life;

(6) An injury that requires professional medical treatment (treatment beyond first aid) and, if the person is engaged or employed on board a vessel in commercial service, that renders the individual unfit to perform his or her routine duties; or

(7) An occurrence causing property-damage in excess of $25,000, this damage including the cost of labor and material to restore the property to its condition before the occurrence, but not including the cost of salvage, cleaning, gas-freeing, drydocking, or demurrage.

[CGD 94-030, 59 FR 39471, Aug. 3, 1994]

APPENDIX C: ABOUT CONTROL CHARTS

This review used control charts to examine variation in casualty data. A process control chart is a way to examine trends over a period of time. Upper and lower control limits are added to the chart, to show the "normal" variation (statistically, plus or minus two standard deviations from the average) from year to year. Values that cross above or below the limits are considered "out of control," meaning they are very unusual and bear further examination. When a change in a safety program or initiative is implemented, the revised statistical average, and the subsequent control limits, would give an indication of the success or failure of the program or initiative.

The methodology used in this document is contained in "*Understanding Variation: The Key to Managing Chaos*" by Donald J. Wheeler, SPC Press, Inc., Knoxville, TN, 1993. Mr. Wheeler's methodology for developing process control charts is summarized as follows:

- Use the average of the individual observations (X) for the central line.
- Calculate the average moving range, (mR). This is done by finding the difference in the individual observations, the moving ranges, then averaging those values.
- Calculate the upper control limit (UCL).:
  UCL = X + (2.66 x mR).
- Calculate the lower control limit (LCL).:
  LCL = X - (2.66 x mR).
- Display the individual values, the central line, the upper control limit, and the lower control limit on a line chart.
- The trend line of the individual observations is interpreted by comparing them to the upper and lower control limits. Values that cross one of the limits are considered "out of control". In other words, the change cannot be explained by normal variation.