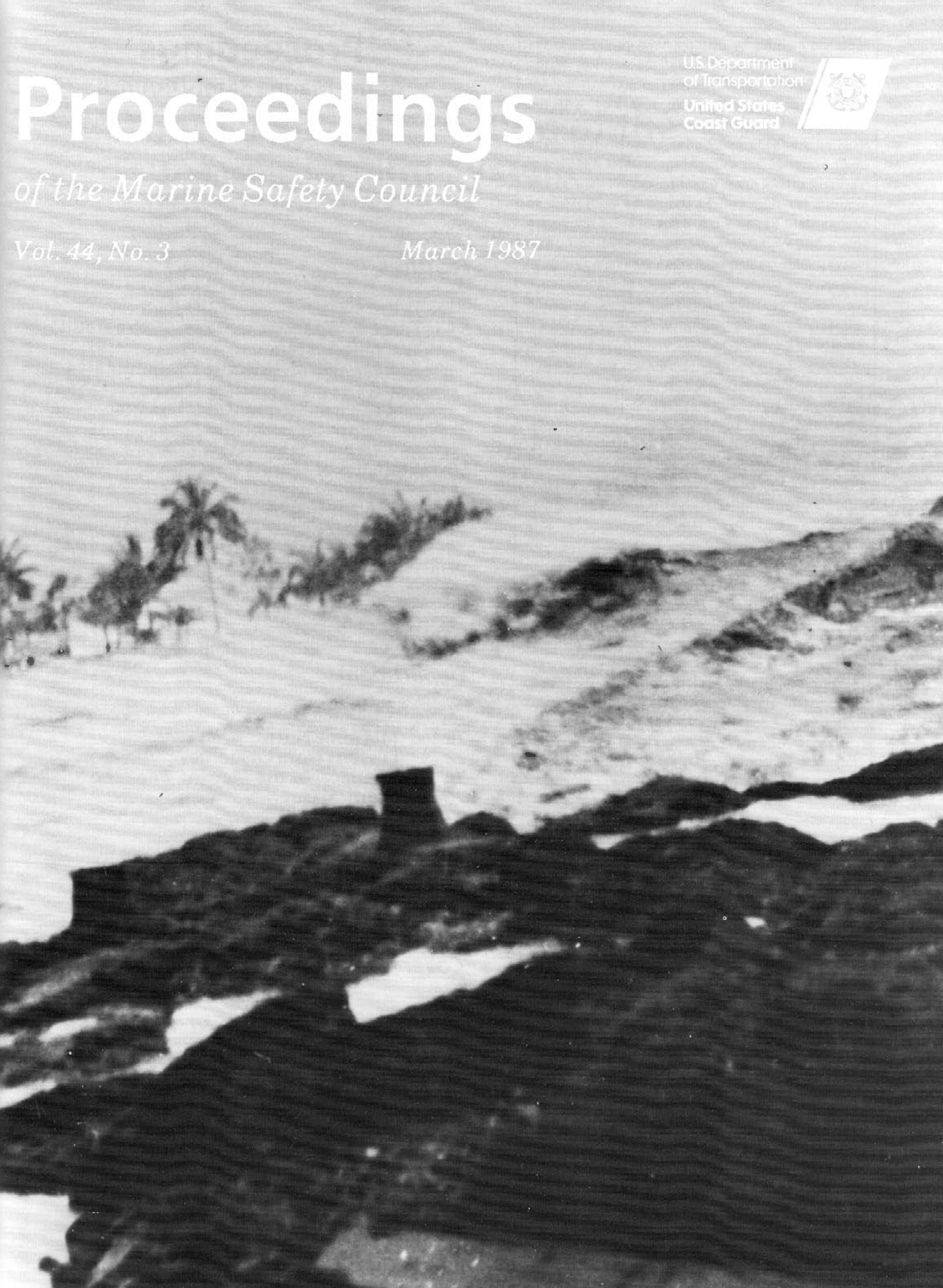
Proceedings

of the Marine Safety Council

Vol. 44, No. 3 March 1987

U.S. Department of Transportation
United States Coast Guard



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Cover

The tsunami of April 1, 1946 caused extensive damage in both Alaska and Hawaii. Here, the second wave breaks near Coconut Island inside Hilo breakwater on the island of Hawaii. Story begins on page 55. (Cover photo by Ted Lusby was provided by the National Geophysical Data Center.)

Tragedy Sparks Creation of the Tsunami Warning System

Patricia Lockridge

The beacon from landmark Scotch Cap lighthouse pierced the moonless night of April 1, 1946, in Alaska's remote Aleutian Island chain. In the reinforced concrete lighthouse, five men were engaged in various support operations connected with the maintenance of the 80,000-candlepower beam. Perched atop a building constructed 5 years earlier on a bluff 32 feet above sea level, the proud new light rose a total of 92 feet above the swirling, restless seas. On a cliff behind the lighthouse, a second building housed the Coast Guard radio direction-finding station.

Suddenly, at 1:30 a.m., a sustained earthquake rocked the buildings. About 30 minutes later, a second jolt was felt. The watchkeeper in the station behind the lighthouse dutifully noted these events in the log, even though no damage occurred in either building. Twenty-one minutes after the second shock, water began flooding the radio direction-finding station. Men off shift and asleep in their bunks awoke and ran into the operations room where they were instructed to look for higher ground. Outside and stumbling through ankle-deep water, the men noted that the beacon from the lighthouse no longer pierced the blackness of the night. "The light has gone out!" was the cry. Power failure owing to the swirling water was suspected.

Only the coming of daylight revealed the full extent of the damage. All that remained of the 60-foot structure was a concrete platform and a few pieces of broken concrete. And no trace could be found of the five men who occupied the building.

But the waves generated by a combination earthquake/submarine landslide were not through wreaking havoc. By the time that the teletype message had gone out that Scotch Cap lighthouse was totally destroyed, the waves were well on their way to a new destination: Hawaii.

The catastrophic waves engulfed the islands suddenly and unexpectedly. Two women, one of them carrying a baby, were stranded in front of their houses when they were surrounded by rising water in Haena Bay on the

Before-damage photo of the Scotch Cap lighthouse. All five occupants died in the tsunami. *(U.S. Coast Guard photo)*

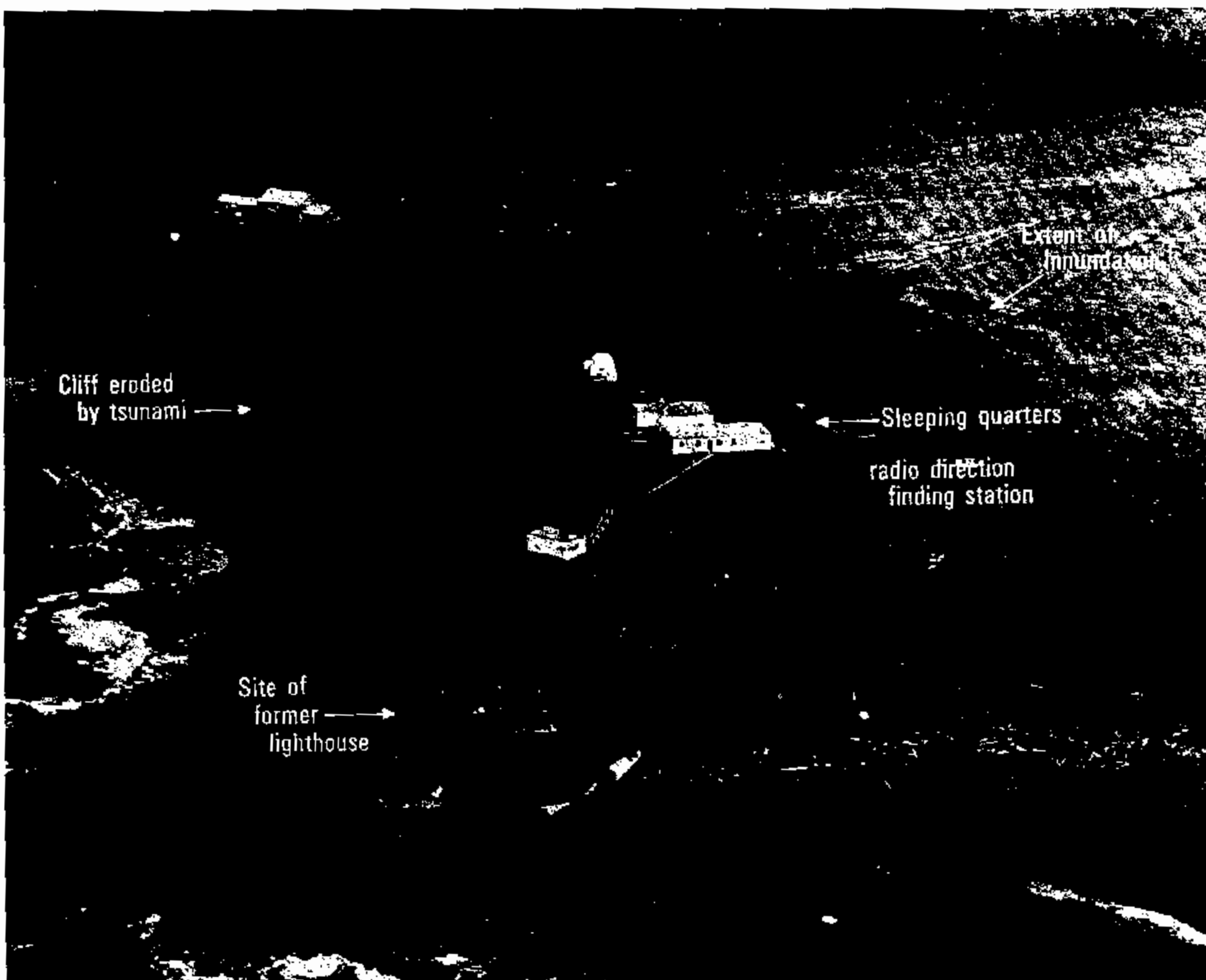
Patricia Lockridge is the data base manager for the tsunami data center at the National Geophysical Data Center in Boulder, Colorado. This center is operated by the National Oceanic and Atmospheric Administration as part of its National Environmental Satellite, Data, and Information Service.

island of Kauai. They managed to swim to nearby trees to save themselves and the infant.

Others were not so fortunate. In the town of Hilo, almost every house on the main street facing Hilo Bay was smashed against the buildings on the other side. At the Wailuku River, a steel span of the railroad bridge was torn from its foundation and tossed 300 yards upstream. Heavy masses of coral 4 feet wide were strewn on the beaches, and enormous sections of rock weighing several tons were wrenched from the bottom of the sea and thrown onto reefs. Houses were overturned, railroads ripped from their roadbeds, coastal highways buried, and beaches washed away. The waters off the island were dotted with floating houses, debris, and people. The water rose nearly 50 feet in places and cost the islands 173 lives and $26 million in property damage.

How Tsunamis Occur

The most frequent cause of tsunamis is a crustal movement along a fault: a large mass of rock drops or rises and displaces the column of water above it. This column of water -- a tsunami -- travels outward from the source at the fantastic speed of 500 mph or more. As the tsunami enters the shallow water along coastlines, the velocity of its waves diminishes, and wave heights increase. The arrival of a tsunami may be announced by a gradual recession of coastal water (if the trough precedes the first crest) or by a rise in water level of about one-half the amplitude of the subsequent recession. This is nature's warning to evacuate coastal areas -- and it should be heeded -- for tsunami waves traveling at 30 mph can crest onshore at heights of more than 100 feet.



Scotch Cap lighthouse was completely destroyed by the tsunami. This aerial views shows the extent of destruction. *(U.S. Coast Guard photo)*

Tsunamis always produce a threat near their source, but not always one at distant locations. Only if the energy produced is sufficiently great will the resulting wave cross the open ocean, reappearing as a highly destructive wave thousands of miles from its source.

Tsunami Warning System

Following the tragic 1946 tsunami, a tsunami warning system was established to minimize the effects of these waves in the Pacific. An array of seismic (earthquake) detectors established on the island of Oahu and a network of seismograph stations installed around the Pacific now contribute data that permit the Tsunami Warning Center in Honolulu to make a quick location of an earthquake's point of origin and determine its magnitude.

When an earthquake of magnitude sufficient to generate a tsunami occurs, a tsunami "watch" begins, and tide stations near the earthquake's origin are alerted to report any unusual wave action in their areas. When a confirmation of unusual wave activity is received at the Center, a tsunami "warning" is issued, and travel times of the tsunami are calculated. This gives authorities a chance to warn the shipping industry and to evacuate residents of low-lying areas.

In the last 40 years, all the coastal areas in the Pacific have experienced a rapid growth in population and industrial and harbor facilities. Many miles of coastline are exposed to tsunamis in North America, the east coast of Asia, the Pacific Islands, and South and Central America. During this time in the United States alone, tsunamis have resulted in the deaths of 355 people and $485 million in property damage. As more people are attracted to the seashores for their livelihood and for recreational and other purposes, the damage caused by a tsunami will be much greater than in the past, unless technology provides an effective and efficient warning system for those living along the shores of the Pacific.

Present techniques of tsunami prediction are severely limited. The only way to determine, with certainty, if an earthquake is accompanied by a tsunami, is to note the occurrence and epicenter of the earthquake and then detect the arrival of the tsunami at a network of tide stations. While it is possible to predict approximately when a tsunami will arrive at coastal locations, it is not yet possible to predict the wave height, number of waves, duration of hazard, or the forces to be expected from such waves at specific locations.

Studying historical tsunamis is one means of mitigating a tsunami's devastating effects. The U.S. National Geophysical Data Center/World Data Center "A" for Solid Earth Geophysics has developed data bases to further tsunami research. These sets of data include mareograms (tide gauge records), wave damage photographs, source data, descriptive material on tsunamis, tsunami wall maps, and publications on historical tsunamis. Source data and descriptive data for both Pacific Basin and non-Pacific Basin tsunamis are held in a digital file that contains information on methods of tsunami generation, location, and magnitude of generating earthquakes, tsunami size, event validity, and references. Eventually this digital data base will have real-time applications, as it can be readily searched to provide information on the effects of historical tsunamis generated in any area of the Pacific.

When an earthquake occurs in the Pacific Ocean Basin, authorities must quickly decide on a course of action. Is a tsunami likely to be generated? If so, what areas will be affected by it? How can damaged from the tsunami be kept to a minimum?

Many of these questions can be answered by examining the historical data. Although much has been accomplished toward understanding and predicting this sometimes devastating natural hazard, much remains to be understood about its unpredictable nature if we are to avoid tsunami destruction in the future.

For more information on the tsunami data available from the National Geophysical Data Center, telephone inquiries may be directed to (303) 497-6337, or write and request a copy of "Tsunami Data" from the National Geophysical Data Center, NOAA, Code E/GC1, 325 Broadway, Boulder, Colorado 80303.

Statistics of Marine Casualties -- 1984

Annually, the Coast Guard presents a statistical summary of commercial vessel casualties that were investigated by Coast Guard marine investigators during the calendar year. The public, industry, and the Coast Guard determine the need for legislation to improve the protection of safety of life and property at sea.

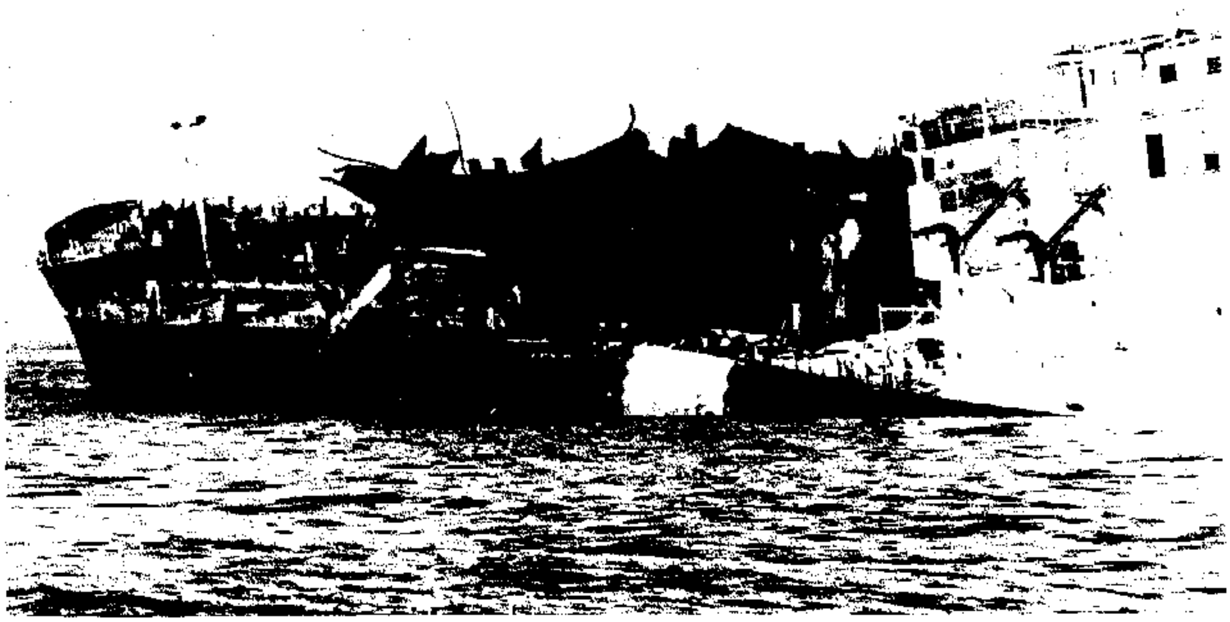
Marine Investigation Regulations, 46 CFR 4.05-10, state, "In addition to the notice required by paragraph 4.05-1, the person in charge of the vessel shall, as soon as possible, report in writing to the Officer in Charge, Marine Inspection, at the port in which the casualty occurred or nearest the port of first arrival." The following summary represents casualties for which reports were received at Coast Guard Headquarters during calendar year 1984. These casualties, involving commercial vessels, were required to be reported to the Coast Guard whenever the casualty resulted in any of the following:

- an accidental grounding or an intentional grounding which also meets any of the other reporting criteria or creates a hazard to navigation, the environment, or the safety of the vessel;

- loss of main propulsion or primary steering, or any associated component or control system, the loss of which causes a reduction of the maneuvering capabilities of the vessel. Loss means that systems, component parts, subsystems, or control systems do not perform the specified or required function;

- 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;

The Puerto Rican casualty occurred on October 31, 1984. The explosions and fire damaged the hull to the extent that it broke in two, and the stern section sank 3 days later. *(Official U.S. Coast Guard photo)*



The extensive damage to the Puerto Rican is apparent in this view, taken while the vessel was under tow on November 1, 1984. *(Official U.S. Coast Guard photo)*

- loss of life;
- injury causing a person to remain incapacitated for a period in excess of 72 hours; or
- an occurrence not meeting any of the above criteria but resulting in damage to property in excess of $25,000. Damage includes the cost of restoring the property to the service condition which existed prior to the casualty, but must exclude the cost of salvage, gas freeing, and drydocking. It also does not include such items as demurrage.

Every event involving a vessel or its personnel which meets any of the conditions of a reportable casualty is of great concern to the Coast Guard. A number of reportable casualties are not investigated by the Coast Guard simply because they are not reported. Thus, it is of the utmost importance that the masters of all vessels ensure that all casualties are reported.

The statistical tabulation presented below is intended to summarize the casualty experience for the entire commercial fleet. Because the summary is so all-encompassing, use of the statistics may lead to erroneous conclusions if the limitations of the data are not well understood. The Marine Safety Evaluation Branch of the Marine Investigation Division will gladly assist in quantifying those limitations for each specific need.

Comments and recommendations for changes or improvements in the statistics should be addressed to Commandant (G-MMI-3), U.S. Coast Guard, 2100 Second Street, SW, Washington, DC 20593-0001.

Major Casualties that Occurred in 1984

M/V Scandanavian Sea

At 1920 on March 9, 1984 (Eastern Standard Time), the ship's plumber discovered a fire aboard the **M/V Scandanavian Sea** in crew quarters, Room 414. The **Scandanavian Sea** (Bahamian registry) was underway at a position approximately 9 miles southeast of Port Canaveral, Florida, engaged in a daily "Cruise to Nowhere" which began and ended in Port

Canaveral. The passengers debarked upon arrival, and shoreside firefighters from various local and federal agencies started firefighting operations. Despite the combined efforts of the firefighters, the fire spread out of control until it was successfully extinguished during the afternoon of March 11, 1984. No lives were lost, nor were any serious injuries sustained by passengers, crew, or shoreside firefighters. The **Scandanavian Sea** was subsequently declared a total constructive loss, valued at $16 million. Although the actual cause of the fire on the **Scandanavian Sea** remains unknown, the most probable cause was the intentional or accidental ignition of combustible material in stateroom 414.

Tankship Puerto Rican

At approximately 0324, October 31, 1984, the tankship **Puerto Rican** suffered explosions and fire in number 6 center void space and the adjacent wing cargo tanks. The explosions and fire damaged the hull of the vessel to the extent that it broke in two, and the stern section sank 3 days later. The pilot and one crew member were thrown overboard by the explosions and injured; one crew member was thrown overboard by the explosions and is missing and presumed dead.

The Commandant of the Coast Guard has concurred with the investigation board that the actual cause of the casualty cannot be established with certainty, but the most probably cause was the failure to repair a gouge, later to become an opening in the stainless steel cladding in the bulkhead separating number 5 center port cargo tank and number 6 center void space, allowing caustic soda cargo to enter the void. The caustic soda reacted with the zinc coatings in the number 6 center void space, producing hydrogen gas, which ignited. This led to a sequence of explosions and fire which caused the loss of the vessel. Contributing to the casualty was the failure of the master to locate the missing caustic soda cargo which leaked from number 5 center port tank into number 6 center void space.

Tankship American Eagle

At 1045 on February 26, 1984, the American tankship **SS American Eagle** suffered a major cargo tank explosion while enroute in ballast from Savannah, Georgia, to Orange, Texas. The explosion occurred while several crew members were cleaning and gas-freeing the number 3 center cargo tank of the last cargo of gasoline. Although the **American Eagle** suffered major structural damage, the vessel remained afloat until February 27, 1984, when the vessel broke up and the master ordered the crew to abandon ship. The surviving crew members were rescued by three offshore supply vessels and a Coast Guard helicopter. As a result of the explosion, three crewmen lost their lives, and four were injured. During the abandonment and rescue efforts, two additional crew members lost their lives, and two remain missing and are presumed dead; also, five more crew members were injured. The proximate cause of the casualty was the introduction of steam into number 3 center cargo tank through an ungrounded air mover with a plastic sleeve attached. The use of steam resulted in an electrostatic discharge which ignited the hydrocarbon vapors in the number 3 center cargo tank. The Coast Guard has issued warnings regarding the use of steam and portable venturi-type blowers in non-gas-free atmospheres.

An electrostatic discharge ignited hydrocarbon vapors in the cargo tank, resulting in an explosion and the loss of the American Eagle. *(U.S. Coast Guard photo)*

Table 1

Summary of Commercial Vessel Total Losses By Nature of Casualty and Vessel Size for 1984

	FOUNDERED		FIRE/EXPLOSION		COLLISION		GROUNDING		HULL/MACHINERY DAMAGE		MISSING		OTHER		TOTAL
	No.	GT	No.	GT	No.	GT	No.	GT	No.	GT	No.	GT	No.	GT	
FREIGHTSHIP															
Less than 100 GT	1														
100-199							1	135							
200-299															
300-499															
500-1599															
1600-4999	1	1718	1	3541											
5000-9999															
10,000-19,999							1	17902							
20,000 and Above															
SUBTOTAL	2		1				2								5
TANKSHIP															
Less than 100 GT															
100-1599															
1600-4999															
5000-9999															
10,000-19,999			1	13757											
20,000-39,999			1	20295											
40,000-99,999															
100,000 and Above															
SUBTOTAL			2												2
PASSENGER VESSEL (inc. ferries)															
Less than 100 GT	7	386	7	204	1	98	2	53	1	15					
100-1599															
1600-4999			1												
5000 and Above															
SUBTOTAL	7		8		1		2		1						19
TUG/TOWBOAT															
Less than 100 GT	9	381	3	83					4	121	1	9			
100-199	11	1131													
200-299									2	589					
300-999															
1000 and Above															
SUBTOTAL	20		3						6		1				30
OFFSHORE SUPPLY															
Less than 100 GT															
100-199															
200-499							1	251							
500 bove															
SUBTOTAL							1								1
MODU															
Less than 300 GT															
300 GT and over															
SUBTOTAL															0
PLATFORM	1	49													
SUBTOTAL	1														1
FISHING VESSEL															
Less than 100 GT	72	2186	63	2666	22	1014	18	576	18	788			2	19	
100-199	16	2255	8	1050	3	337	3	395	2	315	1	199			
200-499															
500-999					1	771									
1000 and Above	1	1499													
State Numbered	9	55	9	19	4	5	4	5	3	0	2	5	2	0	
SUBTOTAL	98		80		30		25		23		3		4		265

Table 1 -- Continued

	FOUNDERED No.	FOUNDERED GT	FIRE/EXPLOSION No.	FIRE/EXPLOSION GT	COLLISION No.	COLLISION GT	GROUNDING No.	GROUNDING GT	HULL/MACHINERY DAMAGE No.	HULL/MACHINERY DAMAGE GT	MISSING No.	MISSING GT	OTHER No.	OTHER GT	TOTAL
TANK BARGE															
Less than 500 GT															
500-999															
1000 and Above	1	2293			2	5054									
SUBTOTAL	1				2										3
FREIGHT BARGE															
Less than 100 GT					1		2	11			1				
100-999	4	2682			4	3455	2	1504	2	1636					
1000 and Above					1	1024									
Unknown															
SUBTOTAL	4				6		4		2		1				17
MISCELLANEOUS															
Less than 100 GT	4	95	2	119	10	84			2	104			1	95	
100 and Above (SP)	5	1084							3	702					
100 and Above (NSP)	2	732													
SUBTOTAL	11		2		10				5				1		29
FOREIGN FLAG															
Freight	2	1718	1	3541			1	135							
Tank															
Other			1	10736	1										
SUBTOTAL	2		2		1		1								
TOTALS	144		96		49		54		57		5		5		370

Table 2A

Total Losses During 1984
Type of Vessel by Age of Vessel

Type vessel Age	0-4	5-9	10-14	15-19	20-24	25-29	30 & Above	UNKNOWN	TOTAL
FREIGHTSHIP	1		1		2			1	5
TANKSHIP			1			1			2
PASSENGER VESSEL (inc. ferries)	5	5	3	3		1	2		19
TUG/TOWBOAT	4	4	2	4	3	3	10		30
OFFSHORE SUPPLY		1							1
MODU									
PLATFORM							1		1
FISHING VESSEL	25	51	30	31	20	14	61		
STATE NUMBERED	5	8	6	1		1	4	6	263
TANK BARGE			2	1					3
FREIGHT BARGE	2	1	5	3			2	4	17
MISCELLANEOUS	7	4	5	4	2		4	3	29
TOTAL	49	74	55	47	27	20	84	14	370

Table 2B

Total Losses During 1984
Nature of Casualty by Age of Vessel

Casualty Age	0-4	5-9	10-14	15-19	20-24	25-29	30 & Above	UNKNOWN	TOTAL
FOUNDERED	19	26	15	19	11	8	39	7	144
FIRE/EXPLOSION	14	18	16	17	3	8	19	1	96
COLLISION	8	11	9	4	5	1	8	3	49
GROUNDING	2	12	7	2	1	1	9		34
HULL/MACHINERY DAMAGE	4	5	7	4	7	2	7	1	37
MISSING	2	1						2	5
OTHER		1	1	1			2		5
TOTALS	49	74	55	47	27	20	84	14	370

Table 3

Summary of Commercial Vessels Not Involved in a Total Loss
By Nature of Casualty and Vessel Size for 1984

	FLOODED	FIRE/EXPLOSION	COLLISION	GROUNDING	HULL/MACHINERY DAMAGE	WEATHER DAMAGE	OTHER	TOTAL
	No.	No.	No.	No.	No.	No.	No.	
FREIGHTSHIP								
Less than 15 GT			3		2		1	
15-99	1	1		3	2		3	
100-199	1		3		1		1	
200-299			1		1		1	
300-499			2	1			1	
500-1599	1		4	5	4		1	
1600-4999			6	4	8			
5000-9999		4	7	6	11			
10,000-19999		5	46	45	39	1	4	
20,000 and Above	3	5	30	46	34	7	5	
SUBTOTALS	6	15	102	110	102	8	17	360
TANKSHIP								
Less than 100 GT	1		1		2			
100-1599		1	5	1	1		1	
1600-4999			5		4		1	
5000-9999			1	1	2			
10,000-19,999		2	12	12	23		5	
20,000-39,999		4	15	26	16		1	
40,000-99,999		1	9	11	14	1		
100,000 and Above					1			
SUBTOTALS	1	8	48	51	63	1	8	180
PASSENGER VESSEL (inc. ferries)								
Less than 100 GT	10	12	30	27	43		16	
100-1599		4	2	2	15			
1600-4999			1		8		1	
5000 and Above		1	1	1			1	
SUBTOTALS	10	17	34	30	66		18	175

Table 3 -- Continued

	FLOODED	FIRE/EXPLOSION	COLLISION	GROUNDING	HULL/MACHINERY DAMAGE	WEATHER DAMAGE	OTHER	TOTAL
	No.	No.	No.	No.	No.	No.	No.	
TUG/TOWBOAT								
Less than 100 GT	10	7	88	99	40	1	48	
100-199	12	7	148	130	51	3	20	
200-299		3	42	48	17		8	
300-999	2	5	109	235	12		6	
1000 and Above			8	27	2		1	
SUBTOTAL	24	22	395	539	122	4	83	1189
OFFSHORE SUPPLY								
Less than 15 GT			1					
15-99	1	3	9	3				
100-199		1	7		1		1	
200-499	2	3	22	1	6	1	1	
500 and Above								
SUBTOTAL	3	7	39	4	7	1	2	63
MODU								
Less than 100 GT		1	2					
100-200			1					
300 GT and Above		3	17	1	17	2	3	
SUBTOTAL		4	20	1	17	2	3	47
PLATFORM		7	9		1			
SUBTOTAL		7	9		1			17
FISHING VESSEL								
Less than 100 GT	61	42	85	77	199		86	
100-199	14	10	24	24	65	1	22	
200-499		1	1	3	6			
500-999			2	1			1	
1000 and Above								
State Numbered	9	6	11	7	17		14	64
SUBTOTAL	84	59	123	112	287	1	123	789
TANK BARGE								
Less than 100 GT		1	12	6	2		2	
100-499			5	2	1		2	
500-999		3	54	66	10		2	
1000 and Above	3	6	147	162	33	4	8	
SUBTOTAL	3	10	218	236	46	4	14	531
FREIGHT BARGE								
Less than 100 GT	1		58	84	9		32	
100-999	8	1	288	407	36		109	
1000 and Above	1		74	106	14		20	
Unknown								
SUBTOTAL	10	1	420	597	59		161	1248
MISCELLANEOUS								
Less than 100 GT	7	4	32	8	11		18	
100 and Above (SP)	2	2	10	6	10	1	5	
100 and Above (NSP)	1		16	2	6	1	1	
SUBTOTAL	10	6	58	16	27	2	24	143
FOREIGN FLAG								
Freight	3	6	76	72	44	1	9	
Tank		2	21	24	12		5	
Other	3	5	16	13	4	1	170	
SUBTOTAL	6	13	113	109	60	2	184	
TOTALS	151	156	1466	1696	797	23	453	4742

Table 4A

Vessels Not Involved in a Total Loss During 1984
Type of Vessel by Age of Vessel

Type vessel Age	0-4	5-9	10-14	15-19	20-24	25-29	30 & Above	UNKNOWN	TOTAL
FREIGHTSHIP	73	78	89	58	24	5	31	2	360
TANKSHIP	30	44	31	19	8	20	25	3	180
PASSENGER VESSEL (inc. ferries)	43	36	22	14	16	14	27	3	175
TUG/TOWBOAT	253	257	200	157	67	82	159	14	1189
OFFSHORE SUPPLY	27	26	6	2	1	1			63
MODU	24	13	4	3	1	1		1	47
PLATFORM	1	2				1		13	17
FISHING VESSEL	91	169	104	93	27	43	177	21	725
STATE NUMBERED	11	9	5	7	6	2	16	8	64
TANK BARGE	95	128	119	83	31	17	25	33	531
FREIGHT BARGE	301	287	180	121	62	26	26	245	1248
MISCELLANEOUS	24	18	12	23	13	7	19	27	143
TOTAL	973	1067	772	580	256	219	505	370	4742

Table 4B

Vessels Not Involved in a Total Loss During 1984
Nature of Casualty by Age of Vessel

Casualty Age	0-4	5-9	10-14	15-19	20-24	25-29	30 & Above	UNKNOWN	TOTAL
FLOODED	19	31	20	20	5	5	41	10	151
FIRE/EXPLOSION	38	27	27	19	10	7	18	10	156
COLLISION	325	367	237	184	75	63	105	110	1466
GROUNDING	352	397	292	204	90	72	124	165	1696
HULL/MACHINERY DAMAGE	145	170	138	99	47	30	145	23	797
WEATHER DAMAGE	7	9	5	2					23
OTHER	87	66	53	52	29	42	72	52	453
TOTAL	973	1067	772	580	256	219	505	370	4742

Table 5A

Summary of Commercial Vessel Casualties By Cause* and Nature of Casualty -- 1984

PERSONNEL	FOUNDERED No.	FIRE/EXPLOSION No.	COLLISION No.	GROUNDING No.	HULL/MACHINERY DAMAGE No.	MISSING No.	OTHER No.	TOTAL
Inatt. to duty	3	2	12	17	4		4	42
Judgmental error	4	2	108	247	1		6	368
Carelessness	4	6	10	4	5		11	40
Lack of knowledge			6	16	1			23
Relied on floating ATON			1	2				3
Failed to								
Account wind/current	2		77	74			5	158
Use nav. equip/charts			2	10				12
Use radiotelephone			1	1				2
Ascertain position			13	56				69
Establish Pass Agreement			14					14
Keep Proper Lookout			24	3				27
Keep Right of Channel			4	1				5
Comply w/Rule, Reg, Procedure		1	25	1				27
Proceed at Safe Speed	2		13	1	1			17
Yield Right of Way			7	1				8
Stress								
Fatigue			3	10				13
Physical impair.			1	1				2
Intoxication								
Improper Loading	11	1		1	2		3	18
Improper Maintenance	15	10			41		18	84
Improper Mooring/Tow	4		7	2	2		10	25
Improper Securing/ Rigging	10		3	1	2		15	31
Improper safety Precaut		14	3	2	1		3	23
Operator Error	14	7	107	135	14		14	291
Other	9	8	26	40	16		7	106
SUBTOTAL	78	51	467	626	90		96	1408

Table 5B

Summary of Commercial Vessel Casualties By Cause* and Nature of Casualty -- 1984

ENVIRONMENT	FOUNDERED No.	FIRE/EXPLOSION No.	COLLISION No.	GROUNDING No.	HULL/MACHINERY DAMAGE No.	MISSING No.	OTHER No.	TOTAL
Adverse weather	15		13	19	6		17	70
Adverse current	14		5	12	11		17	59
Debris	2	1	2	1	16		5	27
Ice	1		3	3	3			10
Lightning					1			1
Shoaling				151				151
Submerged object	1	1	76	2				80
Channel hazard	1		7	26			1	35
Inadequate AtoN								
Other		2	15	20	7		5	49
SUBTOTAL	34	4	121	294	44		45	482

*Cause is first one listed in each record

Table 5C

Summary of Commercial Vessel Casualties By Cause* and Nature of Casualty -- 1984

MATERIAL RELATED	FOUNDERED No.	FIRE/EXPLOSION No.	COLLISION No.	GROUNDING No.	HULL/MACHINERY DAMAGE No.	MISSING No.	OTHER No.	TOTAL
Failed Materials:								
Structural	37	8	6	6	68		46	171
Mechanical	7	18	5	4	264		35	333
Electrical		26	2		73		9	110
Corrosion					7			7
Normal wear					13		2	15
Improper welding					4			4
Improper riveting								
Steering failure			1	1			1	3
Fouled propeller				1	2		37	40
Inadequate:								
Lighting								
Stability	6							6
Lifesaving equip								
Firefighting equip								
Controls								
Lubrication					6			6
Maintenance								
Insufficient fuel		1			7		11	19
Propulsion Failure		1	2	2	2		26	33
Fatigue Failure					5			5
Other	2	4	14	12	24		3	59
NEC	8	11	6	4	14		15	58
CAUSE UNKNOWN	91	132	20	14	105	6	24	392
TOTAL	263	256	644	904	728	6	350	3151

***Cause is first one listed in each record**

Table 6

Deaths/Injuries Resulting from Total Loss of Commercial Vessels During 1984

	FOUNDERED	FIRE/EXPLOSION	COLLISION	GROUNDING	HULL/MACHINERY	MISSING	OTHER	TOTAL
FREIGHTSHIP								
TANKSHIP		4/6						4/6
PASSENGER VESSEL								
TUG/TOWBOAT	36/2							
OFFSHORE SUPPLY								
FISHING VESSEL	88/1	11/4	2/2	14/0		45/0	1/1	161/8
STATE NUMBERED	3/0			0/1		9/0		12/1
MODU								
PLATFORM								
FREIGHT BARGE	6/0							6/0
TANK BARGE								
MISCELLANEOUS	121/2		13/8		2/2			136/2
LICENSED OFFICER	7/0	0/2						7/2
CREW	125/5	15/8	9/6	14/1	2/2	54/0	1/1	220/23
PASSENGER	121/0		6/4					127/4
OTHER	1/0							1/0
TOTAL	254/5	15/10	15/10	14/1	2/2	54/0	1/1	355/29

Table 7 Deaths/Injuries Resulting from a Commercial Vessel Not Involved in a Total Loss During 1984

	FLOODED	FIRE/EXPLOSION	COLLISION	GROUNDING	HULL/MACHINERY	WEATHER DAMAGE	OTHER	TOTAL
FREIGHTSHIP		3/2	0/1		0/2		1/0	4/5
TANKSHIP			2/0		0/4			2/4
PASSENGER VESSEL			0/17	0/1	0/1		5/3	5/22
TUG/TOWBOAT		0/1	2/8		0/4		4/3	6/16
OFFSHORE SUPPLY	1/1	1/0	12/12		0/1			14/14
FISHING VESSEL	1/0		1/4		1/2		16/4	19/10
STATE NUMBERED		0/2			0/2		9/0	9/4
MODU		0/4	0/3		0/2		36/45	36/54
PLATFORM		35/95	0/4		1/0			36/99
FREIGHT BARGE			2/20		0/1		2/1	4/22
TANK BARGE		9/10	1/1				0/2	10/13
MISCELLANEOUS	2/2	0/1	1/10		2/2		2/1	7/16
LICENSED OFFICER		1/1	0/4		0/2		3/0	4/7
CREW	4/3	39/108	20/62		3/17		70/59	136/249
PASSENGER			1/14	0/1			1/0	2/15
OTHER		8/6			1/2		1/0	10/8
TOTAL	4/3	48/115	21/80	0/1	4/21		75/59	152/279

Table 8 Other Deaths/Injuries Onboard Commercial Vessels During 1984 (Not Related to a Vessel Casualty)

	SLIP/ FALL ONBOARD	FALL OVER BOARD	DISAPPEAR	STRUCK BY OBJECT	PINCH OR CRUSH	BURN SCALD	ELECTRIC BURN/ SHOCK	CUT	CAUGHT IN LINES	ASPHYXIA	SPRAIN OR STRAIN	DIVING	UNKOWN OR NOC	TOTAL
FREIGHTSHIP	1/76	6/5		3/42	1/12	0/4	0/2	0/4	0/2		0/24		2/9	13/180
TANKSHIP	3/43			0/16	0/6	0/4		0/2	0/2	1/11	0/10		0/4	4/98
PASS. VSL.	0/30	0/1		1/9	0/2	1/2	0/1	0/2		1/0	0/3	5/0	0/1	8/51
TUG/TOWBOAT	0/14	12/1		1/7	0/6	0/2	0/2	0/1	0/1		0/3		0/1	13/38
OFFSHORE SPLY	0/12	2/1		1/11	1/7			0/1	0/1		0/4	1/0	0/1	5/38
FISHING VSL.	0/11	10/0	3/0	1/19	2/15	0/2		0/4	0/4	3/2			1/2	20/59
STATE NUMBERED	0/1	3/0	1/0		0/2				0/2					4/5
MODU	1/135	1/5		3/126	1/68	0/11	1/0	0/9	0/1		0/97	1/1	0/7	8/460
PLATFORM	0/151	1/4		4/110	0/50	0/24	0/2	0/11	0/4		0/85	0/3	0/16	5/460.
FREIGHT BARGE	1/0	2/0												3/0
TANK BARGE		1/0												1/0
MISCELLANEOUS	1/17	2/1		3/25	0/9	0/1		0/2			0/6	3/1	0/2	9/64
LICENSED OFFICER	0/19	2/0		0/17	1/5	0/1		0/1		0/4	0/6		0/2	3/55
CREW	5/429	34/16	3/0	16/336	4/167	0/47	1/6	0/32	0/17	4/9	0/220	2/1	3/39	72/1319
PASSENGER	0/20			0/2		1/0		0/1		1/0		5/0	0/1	7/24
OTHER	2/22	4/2	1/0	1/10	0/5	0/2	0/1	0/2			0/6	3/4	0/1	11/55
TOTAL	7/49	40/18	4/0	17/365	5/177	1/50	1/7	0/36	0/17	5/13	0/232	10/5	3/43	93/1455

This Act Is Not Hard To Follow

LTJG E. Donald Zacharias

A pilot on a downbound towboat overhears the following transmission between two others on the bridge-to-bridge radiotelephone frequency:

"Yeah, captain, I'll just stay to the side of the bend and that should give you plenty of room to pass."

"Roger that, cap, I'll let the current catch my stern here and have her lined up before we meet."

A few minutes later:

"Captain, we sizing up all right here?"

"Well, I think it's going to be close, real close, but I think you'll clear to starboard."

"Starboard?!"

This meeting situation ended up being closer than "close" -- it turned into a major collision.

The Bridge-to-Bridge Radiotelephone Act came into force on January 1, 1973. The Act applies to

- power-driven vessels 300 gross tons and over,
- vessels 100 gross tons and over carrying one or more passengers for hire,
- towing vessels 26 feet and over while navigating, and
- in certain situations, dredges and floating plants.

LTJG Zacharias is the Coast Guard Administrator for U.S. inland and international navigation rules in the Regulations and Policy Branch, Navigation Systems Safety Division, U.S. Coast Guard.

The act's purpose is to "...provide a positive means whereby the operators of approaching vessels can communicate their intentions to one another through voice radio, located convenient to the operator's navigation station."

Bridge-to-bridge radiotelephone frequencies vary. Most of the United States uses VHF-FM channel 13 (156.65 MHz). The area where the Bridge-to-Bridge Act applies is inside a line drawn 3 miles seaward of the baseline from which the territorial sea is measured. Certain areas of the lower Mississippi River use VHF-FM channel 67 (156.375 MHz). These areas are "The Mississippi River from South Pass Lighted Bell Buoy '2' and Southwest Pass Entrance (midchannel) Lighted Whistle Buoy SW to mile 242.4 AHP (Above Head of Passes) near Baton Rouge, and in addition, over the full length of the Mississippi River-Gulf Outlet Canal from entrance to its junction with the Inner Harbor Navigation Canal, and over the full length of the Inner Harbor Navigation Canal from its junction with the Mississippi River to its entry to Lake Ponchartrain at the New Seabrook vehicular bridge." On the Great Lakes, the VHF-FM channel used is 16 (156.80 MHz). However, the United States and Canada are currently considering a change to VHF-FM channel 13 (156.65 MHz).

One of the major reasons the act does not reach its maximum potential is the ambiguous language used by vessel operators when setting up passing agreements. The use of vague phrases and/or colloquialisms defeats the act's purpose by creating confusion. This can create a dangerous situation and can be worse than passing no information at all.

U.S. Inland Rule 34(h) allows for the setting up of passing agreements via the radiotelephone. If this is done in accordance with the act, the vessels are not required to sound the appropriate whistle signals. However, if no agreement is set up, or such agreement becomes confusing, then appropriate whistle signals shall be sounded and will prevail.

The Rules of the Road Advisory Committee (RORAC) looked into creating a standard phraseology to be used when setting up passing agreements via the radiotelephone. The RORAC, after in-depth discussion, concluded that a standard phraseology is already in place in Rule 34. For instance, Inland Rule 34 (a)(i) states "...one short blast to mean 'I intend to leave you on my port side'..." If an operator wished to set up a port-to-port passage with another vessel, a transmission of "I'll meet you on one whistle, port-to-port, Rule 34," would provide a clear indication of what type of passage is proposed. To ensure the message is understood and agreed upon, a confirmation by the other operator of "Roger, captain, one whistle, port-to-port, Rule 34" is all that is required. This does not mean that additional information cannot or should not be passed. In fact, in some cases it *should* be. For instance, Rule 9, Narrow Channels, requires not only the downbound vessel with the following current to propose the manner of passage, but also where it is to take place. There are no whistle signals for identifying this passage location. This can be done only via the radiotelephone.

A violation of the Bridge-to-Bridge Radiotelephone Act can result in a civil penalty of up to $5,000. Violations can range from using too much power (wattage) when transmitting to not maintaining a continuous watch. All violations should be noted and reported to the nearest Coast Guard Marine Safety Office. Violations decrease the overall effectiveness of the Bridge-to-Bridge Radiotelephone Act and are a danger to you, the operator.

The bridge-to-bridge radiotelephone is as much a piece of navigation equipment as the radar or depth finder. But it is only as good as the professionals who use it. Pass the information in a positive, decisive manner. Confirm and reconfirm if necessary. Leave no doubt in your mind or in the mind of the individual you are transmitting to about what exactly is to take place. Remember: "A collision at sea (or on the river) can ruin your whole day."

Maritime Notes

Hazardous Materials Workshop

The U.S. Coast Guard Captain of the Port, New York, with the National Cargo Bureau and the Port Authority of New York and New Jersey, is planning a series of monthly hazardous materials workshops to be held at the Port Authority Marine Administration Building in Port Newark. Workshops began in January and will continue to be held on the fourth Wednesday of every month through May 1987. These sessions will commence at 9:00 a.m. each day and will take about 3 hours. Topics to be covered include using the 49 CFR; documentation requirements; packaging, marking, labeling, placarding, stowage, and segregation; use of hazardous materials publications; and key points of contact.

The workshops will cost $10 per person per workshop to cover the cost of materials and refreshments. Registration is limited to 50 people. If you have any questions or require more information, contact the U.S. Caost Guard Hazardous Materials Office at (212) 668-7909.

Fleet Management Technology Conference

The Maritime Administration, U.S. Department of Transportation, will host the Annual Fleet Management Technology Conference (FMT '87) at the Sheraton Inner Harbor Hotel in Baltimore, Maryland, on May 5-6, 1987.

This will be the eighth annual conference of the Fleet Management Technology Program, which is administered by MARAD's Office of Advanced Ship Operations. The program was established to improve productivity, profitability, and the competitive position of U.S. water transportation companies through the application of advanced computer/communications technology. Over the years, this program has provided an opportunity for MARAD to work with industry in cooperatively funded research efforts in areas such as vessel performance monitoring, shipboard computer applications, and micro-mainframe communications.

There will be limited exhibit space (adjacent to the main conference area and available at no charge) for companies wishing to demonstrate relevant computer applications or technology. Firms or individuals interested in arranging for exhibits and demonstrations should contact the conference coordinator.

FMT '87 will include a keynote address and luncheons with distinguished speakers from the maritime community and government. There is a discount for early registration; however, registration will also be accepted at the door. For additional information, please contact the Conference Coordinator, Joedy W. Cambridge of Phillips Cartner & Co., Inc., 700 N. Fairfax Street, Suite 400, Alexandria, Virginia 22314; telephone (703) 684-2060.

Plastic Wraps Marine Wildlife

While the nation's highways have long been the target of clean-up efforts, the nation's waterways are slowly choking on trash. However, while highway trash may be an eyesore, waterborne trash can kill.

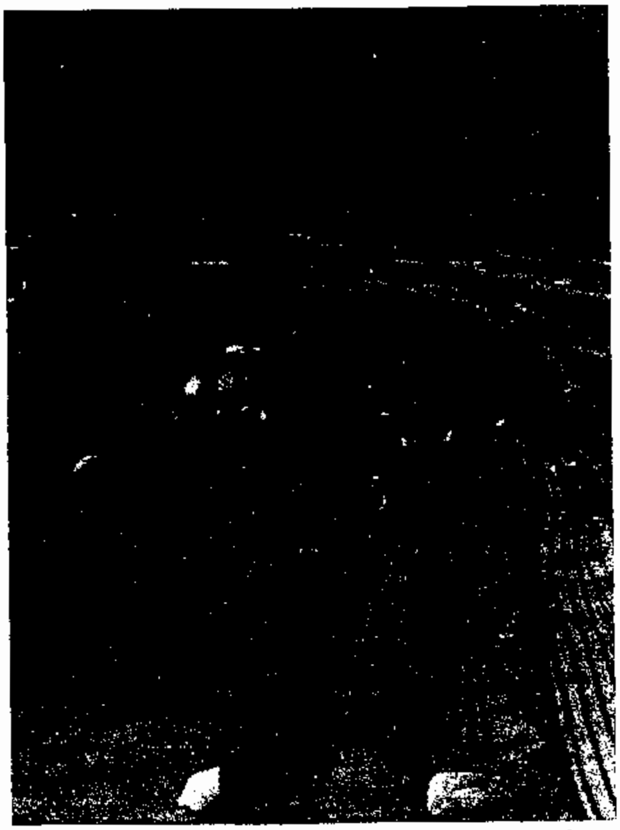
Plastic debris in the nation's rivers, lakes, and oceans is threatening the survival of numerous species of marine wildlife as it entangles and kills birds, turtles, seals, and even whales. Many creatures mistake plastic bags for their natural food and either starve to death from feeding on it or slowly die of complications from ingesting it.

For boaters, plastic litter poses a threat to marine engines by fouling propellers and clogging water intakes. Waterskiers and divers also run a risk of injury.

The three products that do much of the damage are the plastic six-pack beverage rings, monofilament fishing line, and plastic bags. Because these products are designed to be so durable, the plastics problem is continually growing -- six-pack rings are estimated to have a life-span of 450 years.

In a recent clean-up campaign of the Gulf Coast of Texas, some 2,000 volunteers collected 91 tons of trash that washed ashore, including plastic bottles, nets, food bags, and six-pack rings.

Help may be on the horizon if the manufacturers switch to a type of degradable plastic which cracks after exposure to sunlight.



This litter-strewn beach in Texas illustrates the growing problem with plastic products tossed overboard. *(Photo courtesy of Padre Island National Seashore; loaned by the Center for Environmental Studies)*

Ten states already require six-pack rings to made of degradable plastic.

A bill was introduced in Congress by Sen. John Chafee (R-RI) that would require the Environmental Protection Agency to study the problem of plastic trash, particularly six-pack rings, and prepare a list of products that should be regulated and eventually replaced by degradable plastic. Chafee drafted the bill with the aid of the Center for Environmental Education (CEE), a lobbying group for the marine environment.

To prevent further decimation of marine wildlife, boaters are advised to contain all trash, especially plastic products, on board until it can be safely disposed of on land. *(Reprinted with permission from* BOAT/US Reports, *Vol. XXII, No. 1, January/February 1987.)*

Lessons from Casualties

A Pair of 2692s

M. R. Daniels

If merchant vessels, like some battlefield missiles, could have a fly-by-wire connection to a shore-based computer for the job of keeping watch and compiling a list of their troubles, such a hookup would have logged more than just bad weather in the month of February 1986. The computer's printout of that month for U.S.-flag vessls would have included two failures of lifeboat falls -- more instances of the same things discussed before in these pages, i.e., deterioration of wire rope resulting from a lack of complete lubrication in its maintenance.

After the casualties occurred, the master of each vessel filed a "Report of Marine Accident, Injury or Death" (Form CG-2692) in accordance with the regulations, . The details given in the two reports are strikingly similar.

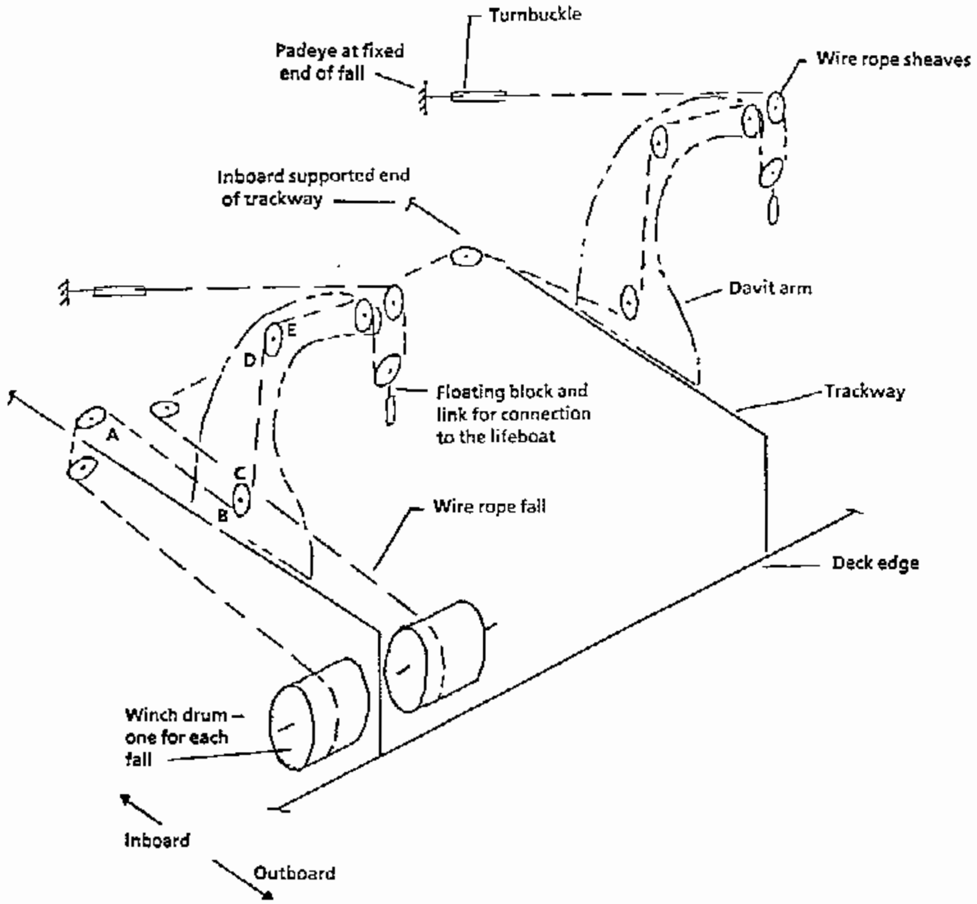
The casualty on the first vessel -- a coastwise tanker -- occurred on the 20th of February. The master noted: "During fire and boat drills, the #3 lifeboat forward falls parted, causing after falls to part, causing boat to fall into water. Boat and equipment recovered, and vessel proceeding into port. Falls to be tested more often and changed every 4 years." This casualty produced one personnel injury: blows to the head and leg of a seaman located in the "...end of the #3 lifeboat..." The Form 2692 's entry #40 (Resulting Injury) describes this as a "minor hit." The report does not explain whether this failure occurred during lowering or hoisting of the boat.

Mr. Daniels is a General Engineer (Marine Equipment) in the Coast Guard's Survival Systems Branch, Office of Marine Safety, Security, and Environmental Protection.

The second case involved another tanker and occurred on the 24th of February. The report reads: "The #1 lifeboat was being lowered to the embarkation deck during the weekly Abandon Ship Drill. While the boat was being lowered, the after fall parted. The weight of the boat pulled the starboard forward davit arm from the track. The forward fall and tricing pendants also parted, and the boat fell into the water." In this case, the vessel was unable to recover its lifeboat, but there were no personnel injuries involved.

Past writeups in this magazine about casualties to lifeboat falls have attributed them to breaks occurring at points in the wire rope cable that are inadequately lubricated in routine maintenance. An able-bodied seaman assigned to slushing down the wire rope with lubricant will do the job while the lifeboat is in its stowed position. Brushing on oil or grease along sections A-B and C-D as shown on the diagram poses no difficulty. But it is the hidden areas of B-C and D-E in way of the sheaves that can't be reached by the lubrication brush. These hidden parts along a wire become the rust spots for future points of failure. Given enough time, the process of rusting converts the flexible steel wires into pockets of iron oxide that eventually make the cable lose its flexibility and finally brittle enough for failure.

Therein lies the difficulty: the hidden areas of the wire rope can be made accessible to the seaman and his oil brush only if the fall is made to move around its sheaves by lifting or moving the boat outboard. To do the job properly -- to uncover the boat, clear its gripes, and pay out the wire by operating the winch -- requires the help of possibly four or more people, not just the one seaman who started the job. Contractors on construction jobs ashore



Reeving Diagram of Wire Rope Falls on Trackway-Gravity Davit

operating draglines, power shovels, and cranes would not stay long in business if their wire ropes became undependable; they occasionally have to "boom down" so that mechanics can have access to the entire length of each wire rope. The shipboard situation is more difficult but no less demanding of the same attention. There is no way around the difficulty: the chief mate may have to turn out the watch in order to pay out the falls and expose the hidden spots of the wire cable if the job is to be done correctly.

A pending change in the marine inspection regulations opens up the possibility for improving the above situation. In the 1983 amendments made to the International Convention for the Safety of Life at Sea, 1974, there is in Chapter III (Life-Saving Appliances and Arrangements) a regulation dealing with the "Maintenance Falls" which says

Falls used in launching shall be turned end for end at intervals of not more than 30 months and be renewed when necessary due to deterioration of the falls or at intervals of not more than 5 years, whichever is the earlier.

If nothing else, the above end-for-ending will put all sections of the falls within reach of maintenance personnel on a regular schedule. The hidden section of the wire rope, in continuous contact with the sheaves, would be available for lubrication before the falls are reeved once again on their davits. The objective of the new regulation is to eliminate an old hazard. The chances for this happening will be greater when the new rules come ito force if they are accompanied by an effort of mariners to keep each fall thorougly lubricated at all times -- along its entire length, including the hidden spots.

Chemical of the Month

Julie Mehta

Benzene

Benzene (C_6H_6), a clear, colorless, flammable liquid compound, is the simplest hydrocarbon of the aromatic group. It is given the general formula CnH_{2n-6} as the first member of the homologous series of the compound.

Benzene was once extracted from coal tar, but since 1950, it has been produced from petroleum. The separation from coal tar was a difficult process because of the presence of isomers with close boiling points. Benzene and toluene can also be separated from gas refractions. A synthetic production of benzene involves dealkylation of toluene. Additionally, benzene can be derived from the catalytic reforming of petroleum.

Benzene was discovered in 1825 in illumination gas from whale oil by the English chemist Michael Faraday. Since then, the structure of benzene has been speculated upon and developed by various chemists. Benzene has a structure of a regular hexagon: a carbon atom at each angle with hydrogen attached at each carbon atom.

Benzene is widely used in industry and is a parent substance for many chemical compounds. Styrene and cyclohexane are major products of benzene. Other compounds derived from benzene produce detergents, dyes, aniline, and insecticides. Many useful compounds are formed when benzene is combined with chlorine. Benzene contributes in the production of pharamceuticals, varnishes, and plastics. The chemical also acts as an excellent solvent. In addition, benzene can act as a starting agent for reactions. Because of its explosive mixture with air, benzene can be used as a fuel component for internal combustion.

Benzene can be potentially hazardous. Major hazards are its acute and chronic toxicity and flammability. Exposure to high concentrations of benzene vapor will lead to acute poisoning as the central nervous system is affected. As with other anesthetic gases, symptoms include a period of excitation followed by depression. Death can result through respiratory failure.

Benzene vapor can be irritating to eyes, nose, and throat. When inhaled, the chemical is known to cause headache and difficulty in breathing which may result in a loss of consciousness and/or death. The hazards for chronic toxicity are equally serious. Repeated inhalation of low concentrations of the chemical (below 100 ppm) can lead to severe or fatal anemia. Leukemia and death have been connected with contact to a concentration of benzene vapors.

When exposed to benzene, if a victim's breathing has stopped, artificial respiration and oxygen should be given. Benzene can also be absorbed through the skin. If liquid benzene is exposed to the skin, immediately flush the areas with water. A victim who has swallowed benzene and is still conscious should be given water or milk to drink.

Benzene is extremly flammable ,and a resulting fires and/or explosions are potential hazards. Benzene vapor is heavier than air and may travel to a source of ignition and flash back. Dry chemicals, foam, or carbon dioxide may be used to fight a benzene fire. Water, although ineffective to fight the chemical fire, should be used to keep fire-exposed containers cool. A self-contained breathing apparatus should be worn as well as rubber gloves, face shield, hard hat, and protective clothing. In case of a spill, water may be used to flush spills and disperse vapors. Benzene pollutes water and even in low concentrations can kill aquatic life.

The Occupational Safety and Health Administration has set the standard of no greater exposure than 10 ppm benzene during an 8-hour work day and a 25 ppm ceiling for up

Julie Mehta was a Fourth-Class Cadet at the Coast Guard Academy when this article was written. It was written under the direction of LCDR J.J. Kichner for a class in hazardous materials transportation.

to 15 minutes a day. NIOSH has changed this to 1 ppm as an exposure limit guideline.

Benzene is usually shipped in small glass containers, 1-gallon cans, 5- to 55-gallon metal drums, tank cars, tank trucks, and in bulk by tank barges and parcel tankers. Care should be taken when loading benzene. On cargo ships, restricted gauges should be used, and vents should be sufficiently high (about 12 feet above deck).

Benzene is regulated by the U.S. Coast Guard in Subchapter O of 46 CFR and by the Department of Transportation in Subchapter C of 49 CFR. Benzene is also regulated by the Environmental Protection Agency in 40 CFR.

Chemical Name
Benzene

Formula
C_6H_6

Synonyms
benzol, phenyl hydride, coal naptha, cyclohexatriene

Physical Properties
boiling point: 80.1°C (176°F)
freezing pont: 5.5°C (42°F)
vapor pressure: 20°C (68°F) 75 mmHg

Threshold Limit Values
time-weighted average: 10 ppm; 30 mg/m³
short-term exposure limit: 25 ppm; 75 mg/m³

Flammability Limits in Air
lower flammability limit: 1.3% vol.
upper flammability limit: 7.1% vol.

Combustion Properties
flash point : -11°C (12°F)
autoignition temperature: 591.6°C (1097°F)

Densities
liquid (water = 1): 0.899 at 20°C
vapor (air = 1): 2.77

U.N. Number: 1114
CHRIS Code: BNZ
Cargo Compatibility Group: 32 (Aromatic Hydrocarbons)

Nautical Queries

The following items are examples of questions included in the Third Mate through Master examinations and the Third Assistant Engineer through Chief Engineer examinations:

Engineer

1. In a coil type auxiliary water-tube forced circulation boiler _________.

A. unevaporated feed water collects in the bottom of the flash chamber
B. all generated steam is recirculated through heating coils in the boiler
C. heated water flashes to steam in the boiler heating coils
D. response to steam demand is slower than in a fire-tube boiler

Reference: Osbourne, *Modern Marine Engineer's Manual, Vol. I*

2. The diameter of a piston is usually less at the crown than at the skirt. This is done to _________.

A. facilitate the installation of piston rings
B. allow for the expansion of the piston during operation
C. prevent crankcase vapors from entering the combustion chamber
D. reduce wearing of the upper cylinder liner

Reference: Stinson, *Diesel Engineering Handbook*

3. Some R-12 refrigeration systems have chemical moisture indicators installed with the sight glass on the liquid line. If excess moisture is present in an R-12 system, the indicator will _________.

A. activate the driers
B. change color
C. secure the compressor
D. add a predetermined amount of liquid drier

Reference: Althouse, Turnquist, and Bracciano, *Modern Refrigeration and Air Conditioning*

4. A multistage centrifugal pump can be *best* described as having _________.

A. two or more impellers housed together in one casing
B. one stepped impeller mounted in a progressively staged casing
C. a large radial clearance between the impeller and casing to prevent overheating due to friction
D. an increase in the discharge velocity of the liquid with a corresponding decrease in pressure through the stages

Reference: Hubert, *Preventive Maintenance of Electrical Equipment*

5. The frequency of an operating alternator is controlled by the _________.

A. relative speed of the rotor poles
B. number of turns of wire in the armature coil
C. strength of the magnets used
D. output voltage

Reference: Hubert, *Preventive Maintenance of Electrical Equipment*

Deck

1. While using a combustible gas indicator, if the hydrocarbon content of the atmosphere exceeds the U.E.L., the needle of the indicator will

A. remain at zero without moving.
B. move to the maximum reading and stay there.
C. move half-way up the scale.
D. move to the maximum reading and immediately return to zero.

Reference: MARAD, *Marine Fire Prevention, Firefighting, and Safety*

2. The Omega navigation system is designed to provide position fixing accuracy of _________.

A. 9 miles 85 percent of the time
B. 6 miles 90 percent of the time
C. 4 miles 95 percent of the time
D. 3 miles 98 percent of the time

Reference: Bowditch, *American Practical Navigator*

3. Under the Mississippi River Buoyage System, passing daymarks on the right descending bank are

A. red diamond-shaped panels with red reflector borders.
B. red triangular-shaped panels with red reflector borders.
C. green square-shaped panels with green reflector borders.
D. green triangular-shaped panels with red reflector borders.

Reference: *Light List*

4. A tank is loaded with 7,500 barrels of gasoline. The temperature of the product is 80°F, and it has a coefficient of expansion of .0006. The net amount of cargo loaded is

A. 7,320 bbl.
B. 7,410 bbl.
C. 7,590 bbl.
D. 8,856 bbl.

Reference: Marton, *Tanker Operations*

5. You are crossing the course of another vessel which is to your starboard. You have reached an agreement by radiotelephone to pass astern of the other vessel. You are required to

A. sound one short blast.
B. sound two short blasts.
C. change course to starboard.
D. do none of the above.

Reference: COMDTINST M16672.2A

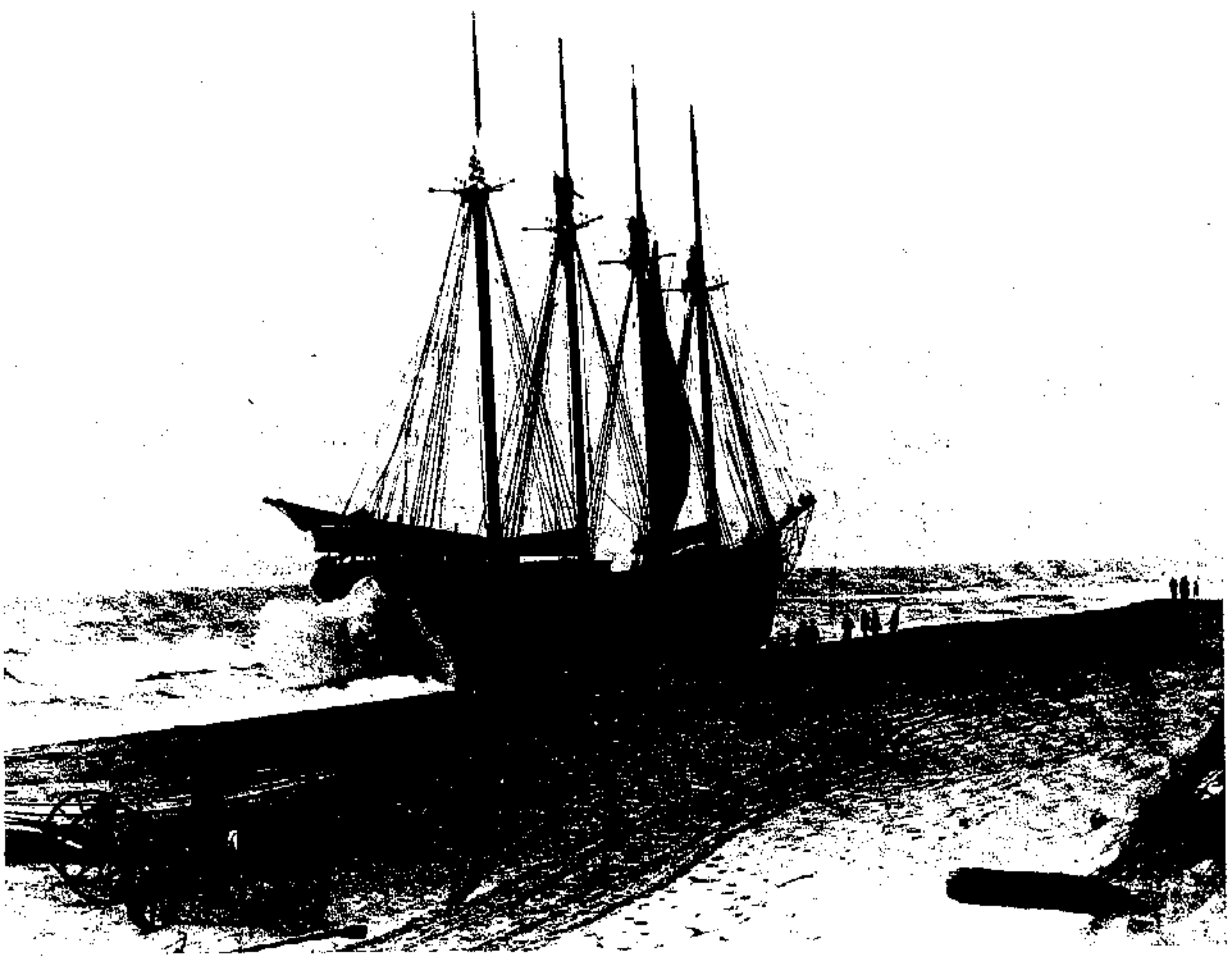
Answers

Engineer: 1-A; 2-B; 3-B; 4-A; 5-A
Deck: 1-D; 2-C; 3-C; 4-B; 5-D

Prepared by staff of the U.S. Coast Guard Institute, (mvp), P.O. Substation 18, Oklahoma City, OK 73169; telephone (405) 686-4417.

Shipwrecks!

On March 14, 1894, the 1,576-ton American schooner **Charles A. Campbell** stranded in the Pamet area of Truro, Massachusetts, at 4:00 a.m. in thick fog. The vessel lay on the beach in light surf and 2 days later was pulled off and towed to Provincetown harbor by tugs. The surfboat from the Pamet River Life-Saving Station is in the foreground. *(Photo by Henry K, Cummings, Orleans, Massachusetts, and loaned to this magazine by William P. Quinn.)*

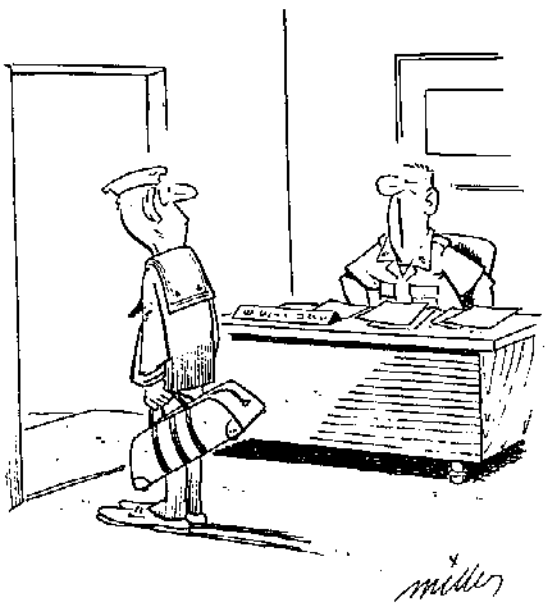


Keynotes

Final Rule

CGD 84-069a, Lifesaving Equipment; Immersion Suits (January 12)

The Coast Guard is revising the specifications for approval of exposure suits. Existing approvals for exposure suits under 46 CFR 160.071 will be terminated on the effective date of these regulations and new approvals will be issued for immersion suits under 46 CFR 160.171 after supplemental testing. Existing vessels may continue to use exposure suits approved under 46 CFR 160.071 as long as the suits remain serviceable. Ships, the construction or conversion of which started on or after July 1, 1986, will be required to have immersion suits approved under 46 CFR 160.171. The changes are needed to conform the regulations to the International Convention for Safety of Life at Sea, 1974 (SOLAS 74), as amended. The effective date of this final rule is April 13, 1987.



"I don't want to ruin your 30 day leave, so I'll give you the bad news when you get back."

First Woman Chief Engineer, Any Horsepower (USMMA)

Ms. Jeanne M. Kraus successfully completed the professional examination on her first attempt and received her license as Chief Engineer of United States Steam Vessels of Any Horsepower at the Port of Baltimore, Maryland. She received her license from Captain R. C. Pickup, U.S. Coast Guard Officer in Charge, Marine Inspection, on October 30, 1986. Captain Renick of the U.S. Merchant Marine Academy's Office of External Affairs confirmed that Ms. Kraus is the first femal graduate of the U.S. Merchant Marine Academy to obtain a Chief Engineer Any Horsepower license. She is to receive a $10,000 prize for her achievement from the widow of a Kings Point graduate.

Ms. Kraus, who currently resides in Annapolis, Maryland, graduated from the U.S. Merchant Marine Academy in 1979. She sailed for the Exxon Shipping Company of Houston, Texas, since July 1979. In May 1984, Jeanne completed her examination for First Assistant Engineer, Steam. She shipped in **Exxon Benica, Exxon Baltimore, Exxon Lexington, Exxon Washington,** and **Exxon North Slope**. She entered the U.S. Naval Reserve in 1979 and served as adjunct professor in the Department of Engineering at Kings Point and taught Introduction to Marine Engineering.

U.S. Department
of Transportation

**United States
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