

ALASKA LEGISLATURE SPECIAL COMMITTEE / SUBJECT FILE 8672
1972 SCOMM 76: HOUSE SPEC. COMM. EXXON VALDEZ OIL SPILL. 1991-92

189

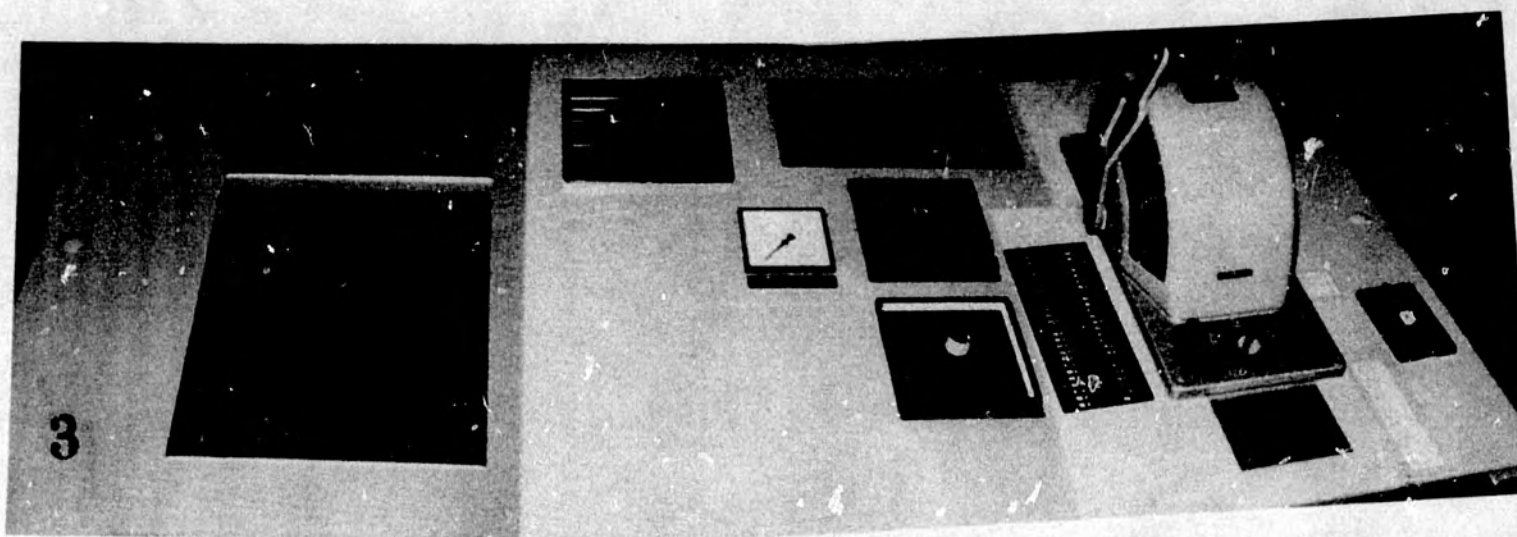


Figure 7.--Engine control console.

- o a ground track speed indicator showing ship's speed forward or reverse and vessel heading,
- o an analog rudder angle indicator,
- o a shaft rpm analog indicator,
- o a Sperry digital doppler speed log,
- o a digital fathometer with an illuminated display and audible alarm (with the transducer located in the forepeak tank bottom plating),
- o a rate of turn indicator showing degrees per second,
- o a wind indicator showing wind direction and velocity.

The ship was propelled by an eight-cylinder, reversible, slow-speed Sulzer marine diesel engine, model 8-RTA-84. The main engine was rated at 31,650 brake horsepower (bhp), which sustained a sea speed of 16.25 knots at the engine's maximum continuous rating of 79 rpm. The main engine was designed to operate on No. 2 diesel oil or heavy fuel oil with a viscosity of 6,000 Redwood at 100° F. The main engine crankshaft was directly coupled to the propeller shaft driving a single, five-blade propeller.

The propulsion control system was designed for remote starting, controlling, and stopping of the main engine from the control console in the machinery control room located in the engine room or from the propulsion control console on the bridge. The control system also provided for emergency operation of the main diesel engine from a local control station at the main engine. In the case of an emergency, the main engine could be stopped remotely by pushing the EMERGENCY STOP button either at the bridge engine control console or at the machinery control room console, or it could be stopped manually at the engine emergency local control station.

Normally, the main engine was started, controlled, and stopped from the control console on the bridge. Provision was made on the bridge control console for automatic acceleration from the maneuvering speed (55 rpm) to sea speed (79 rpm) and for automatic deceleration from sea speed to maneuvering speed. The full-ahead order was programmed so that the engine would slowly increase its speed to the preselected sea speed when the automatic "load program up" button was pushed. The acceleration time, normally about 43 minutes, could be varied between 30 and 120 minutes. The engine speed could be similarly reduced by pushing the automatic "load program down" button, which would cause the engine speed to slowly drop back to the maneuvering speed. By pushing the automatic "load program off" button, the automatic acceleration/deceleration could be stopped at any time. The engine speed reached when the "load program off" button was pushed would then be kept constant.

The steering system, which consisted of steering equipment and a control system, was located in the steering gear room on the 68.5-foot flat between frames 101 and 107. The steering gear consisted of two (one port and one starboard) independent electrohydraulic pumping units with associated piping and valves, two sets of hydraulic rams (pistons, rods, and cylinders) positioned athwartship, and a tiller and rudder installed on the centerline. When energized, the selected hydraulic pump supplied pressurized hydraulic oil to the rams for left and right movement of the rudder. Limit switches prevented the rudder from moving more than 35° right or left from the midships position.

A Sperry SRP-2000 steering control system was installed in the vessel. According to a description in the Sperry manual:

The [control] system permits route planning and continuous readout of the tankship's position based on inputs from the ship's gyrocompass, speed log (dead reckoning) and position fixes from satellite navigation (SatNav), global positioning satellite system (GPS), shore-based Loran C and Omega units. The ship [SRP-2000] steering control system provides precise changes in original heading with minimal rudder movement, thus allowing maneuvers with minimal loss of speed and the most economical operation. Course keeping adaptive capability evaluates ship's yaw and rudder motion and automatically alters values to optimize rudder activity.

The SRP-2000 was a centralized, multicomputer, integrated steering control system that furnished communication between the electronics in the bridge steering control console and the electronics in either the port or starboard rudder control unit (depending on which unit was selected) that energized the solenoid control valve of its associated hydraulic pumping unit in the steering gear room. The selected rudder control unit, upon receiving an electrical command from the computer located in the SRP-2000 console on the bridge, energized the solenoid control valve associated with the selected hydraulic steering pump to direct pressurized hydraulic oil to the rams to move the rudder.

The SRP-2000 console had the following four steering modes:

- (a) Helm, or hand steering--This was the mode normally used to steer the vessel when it was entering and leaving port. In this mode, the steering wheel was turned by a helmsman to the desired rudder angle, as indicated by a mechanical indicator on the vertical front of the SRP-2000 console, and the rudder quickly moved to the angle set by the wheel. About 1 3/4 turns of the wheel would cause the rudder to move from 0° (midships) to 35° (hard right). The helm mode was selected by pressing the HELM button on the console.

Turning the wheel caused an electrical command to be transmitted to the rudder control unit, which in turn energized the solenoid on the selected pump to direct oil to the rams to move the rudder. When the rudder reached the angle set by the steering wheel, the unit deenergized the solenoid control valve and the valve closed, hydraulically locking the rudder at the desired angle. The automatic matching of the rudder and the angle set by the steering wheel is referred to as a followup system.

- (b) Gyro, or automatic pilot--In this mode, the SRP-2000 received input from the gyrocompass and then generated commands to the rudder control unit to keep the vessel on the selected course. The gyro mode was normally selected by steadying the vessel on the desired course and then pressing the GYRO button. While in the gyro mode, the course could be changed by pressing the left or right arrow switches to select a new heading order, followed by pressing the ACCEPT switch. The vessel would then turn to the new course. The amount of rudder that would be used to keep the vessel on course or to make a turn could be selected. According to the vessel's second mate, the maximum rudder setting was normally 7 to 10 degrees. The steering wheel is electrically disconnected during gyro mode operation and may be turned without affecting the steering or causing any alarms to sound.
- (c) NAV mode--In this mode, an integral computer calculated the course to steer from one preselected geographical location or waypoint to the next one and kept the vessel on course until that waypoint was reached. The SRP-2000 normally received position information from passing satellites (SatNav) or from shore-based Loran stations. The SRP-2000 computer determined any needed course corrections to keep the vessel headed toward the next waypoint. As the vessel approached the waypoint, the SRP-2000 console would sound an alarm to alert the navigation watch. Also, it could be programmed to make a course change to head the vessel toward a subsequent waypoint. As many as nine waypoints could be entered in the SRP-2000.

- (d) Rate-of-turn mode--This mode enabled a turn to be made at a constant rate. The SRP-2000 monitored the rate of turn and transmitted command signals to the rudder control unit to keep the vessel turning at the selected rate despite any external forces, such as seas and winds.

The SRP-2000 also provided emergency control of the rudder by means of a hand-operated rocker-switch on the front of the console. Pressing either the port or starboard side of the rocker-switch resulted in electrically energizing the solenoid valve of the hydraulic steering pump to direct oil to the rams. The rams moved as long as the rocker-switch was pressed. Releasing the rocker-switch deenergized the solenoid control valve, stopping the rudder. Thus, to move the rudder to the desired angle, the rocker-switch had to be depressed until the rudder, as indicated by the rudder angle indicator, reached the desired angle. This system was referred to as a nonfollowup system.

The console, rudder control unit, and steering pump were activated when the system (pump selector) switch, located on the upper right front of the steering console, was moved from the center, OFF position to either the left (port) or right (starboard) steering system rudder control unit and pump unit. The bridge steering control console received inputs of the following data: heading from the ship's gyrocompass, speed from the speed log or manual speed input, position from SatNav or Global Positioning System (GPS) (not installed) or Loran C or Omega (not installed) units, rudder angle order signals from the rudder angle transmitter, and feedback signals from the rudder repeat back units, the rudder control unit, and keypad entries.

The SRP-2000 control console provided ship steering control and position information on a cathode ray tube (CRT) display. The information included rudder angle and rate of turn. Also, the steering control mode selected (HELM, GYRO, NAV, etc.) was automatically shown, as were the operating instructions for that mode. The lower portion of the CRT displayed operating instructions for operator-selected parameters of speed, navigation source, turn rate, heading, load, weather adjustment, system status, and ship parameter information.

The pilot stated that all navigation and steering equipment had operated satisfactorily while he was piloting the vessel.

Vessel Damage

An inspection of the vessel in drydock at the National Steel and Shipbuilding Company shipyard in San Diego was conducted on August 29, 30, and 31 and September 1, 1989. The inspection revealed that the forepeak tank was severely holed and that center cargo tanks Nos. 1, 2, 3, and 4 were ripped open over almost their entire lengths. Although holed, center cargo tank No. 5 sustained the least damage. Starboard cargo tanks Nos. 1, 3, and 5 also were severely holed, as was starboard ballast tank No. 2. Starboard ballast tank No. 4 sustained minor damage, resulting in a small opening at

the bottom of the forward bulkhead near the turn of the bilge caused by a separation of the bulkhead from the bottom plating. The void (double bottom) below the starboard slop tank was also ripped open. (See figure 8.)

The greatest loss of plating occurred in the forward starboard side of center tank No. 3 and in the forward half of starboard cargo tank No. 3 and the after one-quarter of starboard ballast tank No. 2. The frames¹⁰ and longitudinals¹¹ that were exposed by the loss of bottom plating in cargo tanks Nos. 3 (center and starboard) were bent upward about 4 to 6 feet. The turn of the bilge and lower side of the hull at starboard cargo tank No. 3 were compressed upward.

The Safety Board found that the maximum vertical damage was 10.9 feet above the bottom of the vessel at two locations in the after half of starboard cargo tank No. 1. The most forward of the two locations was between frames Nos. 10 and 11, where a large boulder had lodged in the ship's hull structure, causing a longitudinal to break loose at frame No. 11 and curve upward to a height of 10.9 feet. The highest point of the boulder was about 8 feet. Upward bending and breaking of longitudinals near the after end of the tank between frames Nos. 12 and 13 resulted in the second 10.9 feet of vertical damage. In starboard ballast tank No. 2, frames Nos. 15 and 17 near the middle of the tank sustained deformation up to about 15 feet. There were two locations in the forward part of starboard cargo tank No. 3, between frames Nos. 23 and 24 and Nos. 24 and 25, where the vertical damage reached 9.9 feet. The maximum vertical damage in center cargo tank No. 3 was 9 feet in the forward part of the tank between frames Nos. 23 and 24 and Nos. 24 and 25. The vertical damage in the other cargo tanks ranged from less than 1 foot to 8 feet in a few locations.

The center vertical keel had broken loose from the after bulkhead of center cargo tank No. 2 from the tank bottom to a height of about 9 feet, and a small crack in the weld extended to a height of about 11 feet. On the other side of this bulkhead, which was the forward bulkhead of center cargo tank No. 3, the center vertical keel had broken loose from the bulkhead from the tank bottom to a height of about 9 feet.

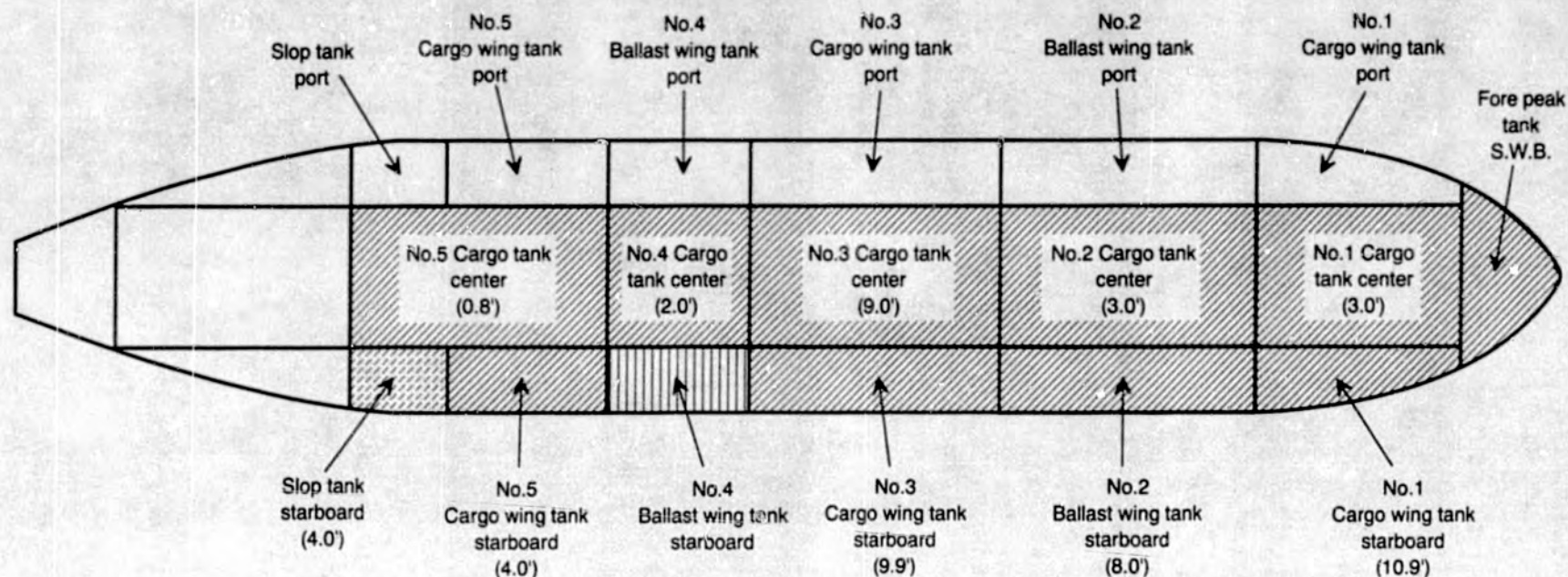
There was no damage to the port tanks and except for the after part of the void under the starboard slop tank, which is outboard of the pumproom, all damage occurred forward of the pumproom.

Other Damage

Most of the loss of cargo from the EXXON VALDEZ occurred during the first 8 hours. Initial measurements by the chief mate about 30 minutes after

¹⁰Ribs or girders extending transversely from side to side of the hull and from the keel to the highest continuous deck.

¹¹Structural members, or girders, running fore and aft.



26

Not to scale

- ☐ Breached tanks (Max. vertical damage)
- ☐ Flooded due to internal damage
- ☐ Only void below (slop tank was breached)

Figure 8.--Plan view showing damaged tanks.

the grounding indicated that 115,000 barrels of the 1,263,000 barrels loaded had been lost. These calculations were based on gauge readings made in the cargo control room. By 0600, gauge readings indicated about 215,000 barrels had been lost.

On the morning of March 25, ullage measurements¹² were taken of all cargo tanks, the forepeak tank, and the ballast tanks. The ullages showed that considerable cargo had been lost from all center cargo tanks and from starboard cargo tanks Nos. 1 and 3. The ullage readings also revealed that there was a substantial amount of water in the bottom of these tanks. In addition, three previously empty ballast tanks, the forepeak tank, starboard tank No. 2, and starboard tank No. 4, were found to contain oil as well as water. The changes in the cargo and ballast tanks by the morning of March 25 are shown in the following tables:

Table 1.--Barrels of cargo lost from damaged cargo tanks.

<u>Tank No.</u>	<u>Cargo departing Valdez</u>	<u>Cargo after grounding</u>	<u>Cargo lost from tanks</u>
1 Center	136,061	82,870	53,191
1 Starboard	60,257	36,552	23,705
2 Center	172,095	111,092	61,003
3 Center	189,441	124,200	65,241
3 Starboard	107,107	62,397	44,710
4 Center	79,051	70,910	8,141
5 Center	173,132	124,490	48,642
5 Starboard	61,978	44,790	17,188
Total			321,821

Table 2.--Barrels of cargo gained in damaged ballast tanks.

<u>Tanks</u>	<u>Cargo gained</u>
Forepeak	30,428
No. 2 Starboard	65,645
No. 4 Starboard	935
Total	97,008

Net Loss 224,813 (by March 25, 1989)

A rupture in the forward bulkhead of center cargo tank No. 1 allowed oil from that tank to enter the forepeak tank. Ruptures in the after bulkhead of starboard cargo tank No. 1 and forward bulkhead of starboard cargo tank No. 3, together with the separation of the starboard longitudinal bulkhead from the bottom plating in tanks Nos. 1, 2, and 3, permitted oil to enter No. 2 starboard ballast tank. The holes in the bottoms of the center cargo tanks also may have contributed to the oil gained in the forepeak tanks and

¹²Measurements from the deck or top of the cargo hatch down to the level of the cargo. Also called outages.

starboard ballast tank No. 2. There was some loss of cargo after the ullage measurements on March 25. Exxon calculated that the total cargo lost was about 258,000 barrels. The value of the lost cargo was estimated at \$3.4 million. Exxon expended approximately \$1.85 billion on cleanup operations in 1989.

Crew Information

Master.--Personnel records provided by Exxon show that the master of the EXXON VALDEZ, age 42, received a Bachelor of Science degree in Marine Transportation from the State University of New York Maritime College in May 1968. At that time he also received a Federal license, which qualified him to serve as a third mate of steam and motor vessels of any tonnage upon oceans.

He was employed by Humble Oil and Refining Co. (the predecessor company of Exxon Shipping Company) as a third mate on June 10, 1968. During his career with Humble/Exxon, he took numerous marine courses sponsored by Exxon. He upgraded his license to second mate in 1971, to chief mate in 1973, and to master in 1977, making him eligible for promotion to the level of the respective licenses. He obtained a Federal pilotage endorsement to his master's license for Prince William Sound between Cape Hinchinbrook and Rocky Point in Alaska in 1987. He was promoted to second mate in 1978, to chief mate in 1979, to relieving master in early 1979, and to master in 1980.

Since his promotion to master, he had served on nine tankships with no breaks in service except for authorized leave periods. He had served as the alternate master on the EXXON VALDEZ since 1987 and had worked in the Alaskan trade for about 10 years (during this period, the master made well over 100 round trips through Prince William Sound).

Submissions by Exxon provided a seriatim ranking of the master in comparison with other Exxon masters from 1981 to 1988. These rankings are as follows:

Year	Rating/group size	Percentile (100 equals the highest possible ranking)
1988	23/38	39
1987	24/29	17
1986	35/37	5
1985	35/37	5
1984	24/34	26
1983	29/33	12
1982	35/39	10
1981	25/36	36

Each year's ranking was for the performance period of the previous year. The EXXON VALDEZ in the West Coast Fleet and the EXXON GALVESTON in the Gulf Coast Fleet were selected as the best performing vessels in 1987. In 1988 the EXXON VALDEZ was the sole winner of this award. The master was one of

two masters of the EXXON VALDEZ when the vessel was judged to be the best performer in the fleet in 1987 and 1988.

In addition to the employment history shown in Exxon and Coast Guard records, the master told Safety Board investigators that he had served as a lightering superintendent in the Gulf of Mexico for about 3 1/2 months and had acquired additional seagoing experience in the Esso foreign flag fleet.

Additional employment information on the master is contained in appendix C.

About 13 hours before the accident, the master, accompanied by the chief engineer and the radio electronics officer, went ashore while the EXXON VALDEZ was loading cargo at the Alyeska Marine Terminal. The Alyeska security logbook shows that they departed the terminal gate at 1059. They were met by the ship's agent, who drove them to the agent's office at Alaska Maritime Agencies, Inc., in Valdez. The agent's supervisor recalled that the three men arrived shortly after 1100 and that the master and chief engineer conducted routine ship's business in a meeting that lasted about 45 minutes. The agent informed investigators that the master seemed "more relaxed" than when she had seen him on previous trips. She explained by saying that she had worked with the master for 8 to 10 years. After the meeting, the pilot who had conducted the inbound transit of the vessel to Valdez picked up the three men at the agent's office in his automobile and drove them to a nearby restaurant, where the four had lunch together. The chief engineer said that they spent about 1 1/2 hours at the restaurant. The chief engineer and the radio electronics officer told investigators that the master and pilot had nonalcoholic beverages with their lunch. However, the master told the Coast Guard investigating officer that he had had a beer at lunch.

After lunch, the pilot drove the three men to a small shopping center, and the three separated to run personal errands. The three men had agreed to meet again at a town bar later in the afternoon. Safety Board investigators located a gift store where the master had ordered flowers sent to his family. The owner of the gift shop recalled having a pleasant conversation with the master and stated that he did not appear to have been drinking. The chief engineer recalled walking to several newsstands, looking unsuccessfully for a newspaper, and then going to the bar, arriving alone about 1600. He said that the master arrived about a half hour after he did. However, the master told the Coast Guard investigator that he arrived at the bar about 1500. The radio electronics officer said that when he arrived at the bar about 1630, the master and chief engineer were already there. According to the radio electronics officer, they played darts with local residents and otherwise enjoyed themselves while each purchased one or more rounds of drinks. The radio electronics officer said that he drank beer while the master was drinking a "clear" beverage and the chief engineer was drinking gin and tonic. The chief engineer told Safety Board investigators that he had three gin and tonics and that he did not recall how much the master had.

The chief engineer said the three men left the bar about 1900 and returned to the restaurant where they had had lunch. They ordered two pizzas to take back to the ship and then went next door to an adjacent bar to await

the preparation of the pizza. The chief engineer and the radio electronics officer in separate interviews agreed that each man, including the master, had one drink while they waited. The radio electronics officer stated that he believed the master had a vodka while they waited. The chief engineer said that about 1930 their pizza order was ready and they called a cab to return to the ship.

According to the cab driver who transported them back to the Alyeska terminal, a fourth person from an ARCO tanker joined them in the cab for the trip to the terminal. He said that no one in the group appeared to be "under the influence of alcohol." The security log at the terminal gate showed that the cab arrived there at 2024. Terminal security officers stated that all persons arriving in cabs were required to check in to the office and walk through a metal detector and that they did not believe any of the men arriving at that time were intoxicated. The cab was permitted to proceed to the dock without delay.

The chief engineer said that they had expected the vessel to depart later in the evening and were surprised that it was ready to get under way. He also said that during the afternoon, the master had discussed the presence of ice in the traffic lanes and was considering delaying departure until daylight.

According to the radio electronics officer, the three men boarded the ship together. The ship's agent was aboard the vessel in the wheelhouse when the master arrived. She said that she met with him there to discuss cargo and ship's fuel. She said that he was in a good mood and did not appear to be intoxicated, although his eyes were watery. The agent and the master agreed that they would talk further on the VHF/FM radio to confirm cargo quantities after the vessel got under way.

The pilot conducting the outbound transit from the Alyeska terminal told Safety Board investigators that he smelled alcohol on the master's breath when the master returned to the ship from Valdez. However, it was his impression that the master's behavior and speech were unimpaired. The pilot said that the master left the bridge after they had gotten under way and remained away until the pilot called him shortly before disembarking at Rocky Point. The pilot said that the master returned to the wheelhouse soon after the call, and he estimated that the master had been gone for about 1 1/2 hours. The pilot stated that he again smelled alcohol on the master's breath, but the master's speech and behavior gave no indication of impairment.

Both the XO and the SIO of the MSO who boarded the vessel after the accident about 0335, smelled alcohol on the master's breath when they met with him on the bridge. The investigating officer described the odor as the very strong smell of "stale" alcohol. In response to a question about the smell of alcohol, the master explained to the investigating officer that he drank two Moussy beers (.05 percent alcohol) after returning to the vessel from Valdez. The investigating officer reported finding two empty Moussy beer bottles in a wastebasket in the master's stateroom.

The XO reported to the Commanding Officer (CO) of the MSO that the master smelled of alcohol, and he requested that someone be sent to the vessel to conduct toxicological testing. The CO then contacted an Alaska State trooper by telephone and requested him to proceed to the vessel to conduct the testing. However, when the trooper arrived about 0630, he had no equipment to conduct any testing or to collect urine specimens for subsequent testing. The XO again called the CO to request someone to conduct the testing. During a later telephone conversation, the CO suggested that the XO check with the master to ascertain if the vessel carried any equipment for collecting toxicological samples. About 1000, the Coast Guard officers learned that kits for obtaining toxicological samples were on board the vessel, and urine specimens were obtained soon thereafter from the third mate and the two ABs on watch when the grounding occurred. The master also was asked to provide a urine specimen at this time, but he said he was unable to urinate.

Meanwhile, ashore, a Coast Guard medical technician from Anchorage, Alaska, who had been conducting an inspection of health records of the MSO, was located at the airport about 0830 and instructed to proceed to the vessel to take blood and urine samples. About 1030, the Coast Guard medical technician boarded the vessel to obtain blood samples for toxicological testing. The master was selected to provide the first blood sample. At this time the master also provided a urine specimen. Blood samples also were taken from the third mate and the two ABs. At this time it was discovered that the urine specimen earlier provided by the AB on lookout was not sealed correctly, and she provided a second specimen.

The results of the toxicological testing by Chem West Laboratories, Inc., of Sacramento, California, of the samples collected on March 24, 1989, are shown in the following table:

Table 3.--Toxicological testing results

<u>Position</u>	<u>Blood</u>		<u>Urine</u>	
	<u>Time</u>	<u>% Ethanol</u>	<u>Time</u>	<u>% Ethanol</u>
Master	1050	0.061	1000 ¹³	0.094
Third Mate	1100	0	1000	0
Lookout	1140	0	1145	0
Helmsman	1115	0	1000	0

Portions of the blood and urine specimens provided by the master were sent to the Center for Human Toxicology (CHT) for an independent ethanol analysis. The CHT measurement showed the blood contained 0.06 percent ethanol and the urine contained 0.1 percent.

¹³Although the sample container was marked 1000, the urine specimen probably was taken about 1050.

The president of Exxon Shipping Company testified that the master, while on leave, had entered a hospital for treatment of an alcohol problem and that the company learned about the master's hospitalization when a shoreside manager attempted to contact the master. Exxon provided investigators limited medical records for the master's treatment. An Exxon Individual Disability Report, signed by the attending physician and dated April 16, 1985, showed that the master was admitted to a hospital on April 2, 1985, and "remains in residence at the present time." The report stated: "He is a 38 yo W/M who has been depressed and demoralized; he's been drinking excessively, episodically, which resulted in familial and vocational dysfunction." A treatment program was suggested that included a recommendation that he be given a leave of absence to get involved in Alcoholics Anonymous (AA), psychotherapy, and aftercare. The report indicates his first day of disability was April 1, 1985. Further documents show that the master was on sick leave from April 1, 1985, through May 15, 1985, and that disability was terminated on May 16, 1985, at which time he was placed on leave of absence for 90 days starting on May 16, 1985. Exxon did not provide documentation to indicate when he was granted sick leave or what followup monitoring was provided.

The master had made no claims for medical care or health services with the Exxon health care contractor during the last year of his employment before the accident.

The president of the Exxon Shipping Company testified that a fleet manager and a ship group coordinator were given the responsibility to follow up on the master after he was returned to duty following his hospitalization in 1985. According to this testimony, the followup consisted of visits by the ship group coordinator to the master's vessel in the west coast ports of San Francisco and Long Beach about every 2 weeks. The president testified, "I think he [the master] felt he was the most scrutinized employee in our company. I think he felt a little uncomfortable with it."

Early in the investigation, an Exxon representative said the company could find no documents covering this followup period. Exxon later provided documents that included a memorandum dated June 27, 1988, initialed by the master's shoreside supervisor at the time, regarding the master's performance. In this memorandum, the master was complimented for his professional expertise, leadership, and interdepartmental cooperation. Exxon also provided an unsigned and undated document that discussed the supervision of the master during his rehabilitation from October 1985 to April 1987. This document was developed from memory, after the accident, by a former shoreside supervisor of the master. The frequency of the visits and the outcome of these visits were not detailed in the document, except for a statement that no evidence of alcohol use by the master could be found and that it was concluded that he was "clean."

The Safety Board made a 50-State search of the National Driver Register (NDR) to investigate the master's driving record. This check revealed that the master had one "driving while intoxicated" (DWI) conviction in Huntington, New York, in 1985, and a second DWI conviction in Conway, New Hampshire, in 1988. The police report for the first DWI conviction showed

that on September 21, 1984, he ran a red light, struck another vehicle, and left the scene without providing information to the driver of the other vehicle. The investigating police officer subsequently met the master in the driveway of his residence and reported that the master smelled strongly of alcoholic beverage, was unsteady on his feet, and that his speech was slurred. The master refused to take a Breathalyzer test. The master's second DWI conviction, on September 15, 1988, resulted from his being stopped for driving 44 mph in a 30 mph zone. The reporting officer reported that he smelled strongly of alcoholic beverage, had difficulty getting his driver's license out of his wallet, and was unsteady on his feet. The master submitted to a Breathalyzer test that gave a blood alcohol level of 0.19 percent.

The chief engineer and the radio electronics officer stated that the master was going through divorce proceedings at the time of the accident. The radio electronics officer on the EXXON VALDEZ stated that the master appeared to undergo noticeable changes in mood.

The radio electronics officer said that he witnessed the master drinking alcohol on board the EXXON VALDEZ during the last voyage of the vessel at the end of February 1989. The master had called him about a design for a ship's T-shirt, and in the course of the conversation, the master asked him to come to the lounge to "destroy a bottle." When the radio electronics officer arrived, the third mate was already there and the master removed a bottle or a flask from his jacket. Soon thereafter, the master sent the third mate to the galley for some ice, and the radio electronics officer went to bring some orange juice to the lounge. He said that the chief mate came into the lounge while the drinking was going on but did not participate. According to the radio electronics officer's recollection, the incident took place in the morning or early afternoon. The radio electronics officer said that one or two other persons were in the lounge watching a concert video, but he could not recall who they were. He said that the bottle was placed on the deck while he, the master, and the third mate watched the video. He did not recall tasting alcohol in any beverage he drank during the incident. He said the contents of the bottle were clear. It was his impression that the master had been drinking before he was called to the lounge, but no one appeared to be intoxicated during or after the incident.

Third Mate.--The third mate told Safety Board investigators that he had begun sailing in 1977 on National Oceanic and Atmospheric Administration (NOAA) vessels as an ordinary seaman after having worked several years as a shipfitter and a hull inspector. He said that he had served 3 years on NOAA vessels and in 1980 had begun sailing with Exxon as an AB. Coast Guard records for his sea duty with Exxon show that he worked as an unlicensed seaman from December 1980 to January 1987, principally as an AB. The third mate said he had attended a Page Navigation School course in New Orleans to prepare for the third mate's license examination. He obtained a third mate's license in March 1986. Since January 1987, he had served as third mate on five Exxon vessels with no breaks in service of more than 3 1/2 months. He told investigators that he had made six round trips to the port of Valdez with the current master and had served one previous tour on the EXXON VALDEZ. Company records show that he joined the vessel on February 20, 1989. He

obtained a second mate's license on January 12, 1989. Information provided by the company showed that the third mate had made 18 voyages through Prince William Sound, but the information did not indicate how many were as an AB and how many were as an officer.

Exxon provided four performance appraisals for the third mate to the Safety Board. The lowest rating given to the third mate was in 1986 while he was serving as an AB on the EXXON JAMESTOWN; it was "above normal" in the rating category of "Steers In Confined Waters." The same rating category was "outstanding" on two earlier appraisals of his service on the EXXON NORTH SLOPE. The third mate's overall performance as an AB was rated as "outstanding" on three of the Exxon performance appraisals.

In one performance appraisal as a third mate, his "overall effectiveness" had been evaluated as "high," one rating below "outstanding." The two lowest ratings he received as a third mate were given to him while he was on the EXXON JAMESTOWN in 1987 and contained the following comments: "performs adequately" in the rating categories of "seeks advice or guidance at the appropriate time and informs supervisor when appropriate" and "demonstrates thorough knowledge of ship and its handling characteristics." In a summary of employee weaknesses, the evaluator wrote, "He [third mate] seems reluctant or uncomfortable in keeping his superior posted on his progress and/or problems in assigned tasks."

During the third mate's initial interview by the Coast Guard investigating officer, he stated that he began work on March 23, 1989, at 0800, had a "cat nap" at 1330, relieved the chief mate for supper and worked thereafter until the grounding. He testified that he had been on watch when the EXXON VALDEZ approached the terminal dock on the day preceding the accident. The third mate said that after his watch ended, he had a brief conversation with the chief mate about how he [the chief mate] "starts up the cargo." He also testified that he had gotten to sleep at 0100 and was called at 0720 for his watch on the morning of March 23.

The crew on the EXXON VALDEZ did not normally break sea watches while they were transferring cargo or ballast. Since the chief mate oversaw cargo handling operations, the second mate and the third mate stood watch extra hours to enable the chief mate to rest. The second mate said that in addition to relieving the chief mate, the two mates tried to "cover one another when needed." The second mate told Safety Board investigators that on this trip to Valdez, the two mates began their extended watches at midnight on March 23. He indicated to Safety Board investigators on board the vessel on March 26, 1989, that he and the third mate essentially stood watches 6 hours on and 6 hours off during cargo operations.

The third mate testified that he went to the engineroom to conduct a "salinity test" after lunch on March 23 and then went to his room for a nap between 1300 and 1350. According to the testimony of an Exxon Seaman's Union officer, it was "common practice for the mates off watch to assist in the cargo operations." The pumpman told Safety Board investigators that he had seen the third mate walking forward on the main deck early during the afternoon watch on the day preceding the accident.

At 1700 on March 23, the third mate relieved the chief mate for the evening meal, and about 1730, he was in turn relieved by the chief mate. About 1800, he assisted the chief mate with completing the cargo loading. The third mate checked navigation gear on the bridge about 1848 and remained on the bridge until he was relieved by the chief mate, probably sometime prior to 1900. The third mate was next reported by an AB as standing by at his usual location at the aft mooring lines during undocking about 2100. The third mate then returned to the pilot house about 2150 to relieve the chief mate. He said that he relieved the chief mate early because the chief mate had been up for a long time and needed rest. The pumpman who met and talked briefly with the third mate immediately before he returned to the bridge stated that the third mate appeared to be fatigued. Another AB also told Safety Board investigators that he had heard on the night of the grounding that the second mate was tired and this explained why the third mate had remained on watch after midnight. The third mate remained on duty until sometime after the Coast Guard boarding officers arrived about 0335.

Helmsman.--Coast Guard records show that the AB serving as helmsman when the grounding occurred had obtained his first seaman's document in 1965. Between 1965 and 1970, he had acquired only 25 days of documented marine work, all of which was in the steward's department for Boatel, Inc., an offshore catering company. The helmsman had no further documented shipping time until he began working for Exxon in April 1975. He initially worked in the steward's department on Exxon vessels for about 1 year and then began working regularly as an ordinary seaman. He obtained a lifeboatman endorsement in April 1980 and an unlimited AB rating in October 1981. Coast Guard records indicated that he had worked each year without remarkable breaks in service except in 1978 and 1987, when he sailed 1 month and 1 1/2 months, respectively. Since joining Exxon, he had served on 19 vessels, including the EXXON VALDEZ.

Since acquiring his AB rating, the helmsman had acquired about 7 1/2 months of documented time as an AB, according to Coast Guard records. Those records show that the helmsman had worked primarily as an ordinary seaman and in other unrated positions. On January 18, 1989, he was assigned to the EXXON VALDEZ as an AB.

Exxon provided seven performance appraisals for the helmsman from February 1986 to August 1988. No performance appraisal for the helmsman referred to an AB-specific job classification, and for the corresponding periods in Coast Guard records he was shown as an ordinary seaman. Five performance appraisals were for the position of maintenance seaman,¹⁴ one was

¹⁴Maintenance seaman is a designation for a crewman having cross responsibilities in deck, engine, and steward's departments.

for ordinary seaman corrected to read "MS," and one was for wiper.¹⁵ Safety Board investigators could not locate any Coast Guard record for the periods during which the helmsman was evaluated as wiper.

The performance appraisals for the helmsman included at least one evaluation from the deck, engine, and steward's departments. In May 1986, he received ratings from a chief mate with whom he had worked on two vessels successively. This evaluator indicated a "cannot rate" for the "steers in confined waters" category and commented that the helmsman "needs to practice [helmsmanship] before sailing AB." The chief mate listed the helmsman's strengths as "a hard worker who was thorough in cleanup operations" but stated "[the helmsman] must prove himself capable [of an AB's position] by steering in confined waters ... and other skills required of an AB." A chief mate on the EXXON NEW ORLEANS rated the helmsman as a "normal" overall performer but commented that "[he] must concentrate more on the task at hand." In 1987, the helmsman's performance appraisal on the EXXON CHARLESTON included an "above normal" for the category "steers in confined waters" with the comment, "steers well to pilot's orders." The chief mate commented that "[he] is not ready at this time to sail as AB." In January 1988, the first assistant engineer on the EXXON BALTIMORE rated him less than the midpoint for overall performance, "needs improvement." The helmsman noted on the same performance appraisal that his ambition was to "sail on my AB's papers and/or obtain my oiler's endorsement and sail in the engine department." The helmsman also received a performance appraisal for his duties in the steward's department on the EXXON BALTIMORE and was given an overall assessment of "generally meets requirements," a midpoint rating. In August 1988, the helmsman received a performance appraisal for his maintenance duties in the engine department on the EXXON BALTIMORE and was rated with an overall assessment of "generally meets requirements."

The helmsman indicated that from March 17 through March 23 he had experienced a normal routine at sea, adhering to 4-hour watches with the customary 8 hours off. The helmsman indicated that he usually slept from about 0400 until called some time after 1100 in time for lunch before his afternoon watch. After the watch, he remained awake to eat supper about 1700 and then returned to his room to sleep about 1800 until called at 2320 for the next morning watch. He indicated that on March 23, he obtained his usual sleep between the morning watch and an unusually early call for lunch at about 1030. He then worked from noon to about 1600 loading cargo, ate supper, and went to bed. The helmsman indicated that he assisted during the undocking from the terminal from about 2000 until 2200. He indicated that he returned to his room for a nap until called for watch at 2320. The helmsman declined most voluntary opportunities to work in excess of 8 hours a day.

¹⁵An entry-level position in the engineering department on board a merchant ship. A wiper assists in the performance of general work in the engineroom and is so named because he is commonly occupied in cleaning machinery, etc.

Operations Information

The EXXON VALDEZ was one of two very large crude carriers designed for transporting Alaska North Slope crude oil from Valdez, Alaska, to Panama for transshipment by pipeline to other tankships on the Atlantic side of Panama. Beginning in 1988, the vessel was used primarily for carrying reduced loads of North Slope crude oil to the West Coast ports of Long Beach and San Francisco, California.

Minimum manning for the EXXON VALDEZ, according to the vessel's Certificate of Inspection issued by the Coast Guard, was 15 persons as follows:

Master	1	Chief Engineer	1
Chief Mate	1	First Assistant Engineer	1
Second Mate	1	Second Assistant Engineer	1
Third Mate	1	Third Assistant Engineer	1
Radio Officer/Operator	1		
Able Seaman	3		
Maintenance Persons ¹⁶	3		

The Coast Guard allowed the vessel's operator or owner to determine the number of persons comprising the steward's department.

The normal complement on the EXXON VALDEZ was 19 persons, including the master. In addition to the crewmembers listed in the Certificate of Inspection, the crew normally included two cooks and two qualified members of the engineering department (QMEDs). One QMED was assigned as the pumpman. At the time of the grounding, there was an additional QMED on board, for a total of 20 persons. A relieving QMED had reported on board, but the QMED who was to be relieved desired to remain on board for one more trip and was allowed to do so.

The chief mate was assigned to the 4-to-8 watches, the second mate to the 12-to-4 watches, and the third mate was assigned to the 8-to-12 watches. Two ABs were assigned to each watch. In addition to their navigation watchstanding duties, each mate was responsible for supervising cargo/ballast operations during his watches in port. The chief mate had overall responsibility for loading and discharging cargo and ballast and was

¹⁶Maintenance persons are designations for positions in a "Maintenance Department" that had not been fully implemented in the Exxon fleet. The department, when implemented on the EXXON VALDEZ, was to consist of three able seamen, although two ordinary seamen could be substituted for two ABs, provided the ordinary seamen were specially trained. The department had not been implemented, according to Exxon, because concurrence of the unlicensed employees labor union (Exxon Seamen's Union) had not been negotiated. The Coast Guard, pending implementation of the Maintenance Department, had directed that ABs would be required in lieu of the specially trained ordinary seamen. Special training for the ordinary seamen was to consist of a period of vessel indoctrination.

present during starts and stops. He was also responsible for the maintenance of the vessel, including directing the deck maintenance work of the ABs during the working day at sea from 0800 to 1700. The second mate was responsible for ensuring that the vessel's navigation equipment was operating satisfactorily, that all necessary charts and navigation publications were on board, and for correcting the navigation charts. The second mate was also responsible for ordering food and supplies for the ship. The third mate was responsible for all emergency equipment, including lifesaving and lifeboat equipment and firefighting equipment.

The engineroom was approved by the Coast Guard for periodic unmanned operation. Thus, watches were not normally stood in the engineroom while the vessel was under way at sea. From 0800 to 1700 at sea, engineering department personnel were in the engineroom, except on Sundays, performing maintenance work. After 1700, one engineer was assigned as the duty engineer and responded to any equipment malfunction alarms that might sound between 1700 and 0800. Another engineer was assigned as the alternate duty engineer and was responsible for tank soundings, checkoff lists, and logs, as well as for assisting the duty engineer as needed. Watches were stationed, however, while the vessel was operating in confined waters, such as entering and leaving port.

An engineering watch consisting of the first assistant engineer was stationed in the engineroom before the vessel's departure from the Alyeska Marine Terminal on March 23. The chief engineer also was in the engineroom. The chief engineer stated that he was not on watch and that his presence in the engineroom was not required, but that it was his custom to be there when the vessel was entering and leaving port. The first assistant engineer was being relieved by the third assistant engineer at the time of the grounding.

Two Federal statutes, one pertaining to rest for the navigation watch officer and one pertaining to watchstanding, applied to the EXXON VALDEZ crew. Title 46 U.S.C. 8104(a) identifies an interval of off-duty time required for deck officers before leaving port:

(a) An owner, charterer, managing operator, master, individual in charge, or other person having authority may permit an officer to take charge of the deck watch on a vessel when leaving or immediately after leaving port only if the officer has been off duty for at least six hours within the 12 hours immediately before the time of leaving

Title 46 U.S.C. 8104(d) identifies conditions for work in excess of 8 hours in 1 day for licensed personnel or seamen:

(d) On a merchant vessel of more than 100 gross tons ...the licensed individuals, sailors, coalpassers, firemen, oilers, and water tenders shall be divided, when at sea, into at least three watches, and shall be kept on duty successively to perform ordinary work incident to the operation and management of the vessel.... A licensed individual or seamen in the deck or engine department may not be required to work more than eight hours in one day.

A Coast Guard representative from the Merchant Vessel Personnel Division of Coast Guard Headquarters testified that this statute is intended to "ensure that the individual has adequate rest or at least has the opportunity for adequate rest." He attributed responsibility for compliance with the statute to a vessel's operating management. A spokesperson, who had previously sailed as a master of Exxon tanks, testified that the company does not have any program to give 6 hours of rest to a deck officer before getting under way. He stated that it was the vessel's responsibility to ensure that the officers obtained appropriate rest. He also said that on vessels under his personal command, he would stand a bridge watch after departure until someone had had "enough rest" to assume the watch.

Safety Board investigators obtained information about procedures for reducing traditional crew complements on U.S. merchant vessels from interviews with several Coast Guard officers working in supervisory positions in the offices of the Merchant Vessel Personnel Division at the Coast Guard's Washington, D.C., headquarters. Similar information was obtained in testimony from the Coast Guard civilian witness from the Merchant Vessel Personnel Division during the Safety Board's public hearing into the accident. According to these sources, the manning levels on reduced crew vessels in the Valdez trade were typical of manning levels on tankships throughout the U.S. fleet. They stated that the current crew levels were the result of a gradual reduction in crew size since World War II, coinciding with the increase in reliability of automated monitoring and controlling systems.

The Coast Guard officers said that the Coast Guard has responsibility for balancing minimum manning levels between the realities of commercial maritime economics and the need for vessel safety. They defined "minimum crew level" for any given vessel as a crew complement that cannot be further reduced and still provide for the safe operation of the vessel, and it is this level that is indicated on each vessel's Certificate of Inspection. The officers explained that there is no standard for determining the manning of merchant vessels and described their conception of reduced crew levels as complements that are "appropriate to the vessels" rather than as "reduced manning" levels. The civilian witness referred to the term "reduced manning" as a misnomer. Instead, he said that the Coast Guard is trying to set "designed manning" or "proper manning."

The Coast Guard officers referred to eight factors that are considered in setting minimum manning requirements:

- (1) emergency situations (used more frequently for passenger vessels, where the crew is required to assist passengers with abandon ship duties),
- (2) size and type of vessel,
- (3) equipment installed on the vessel,

- (4) proposed routes of operation, including frequency of port calls (longer trips permit more maintenance and crew rest after peak workload times during cargo handling),
- (5) type of service in which vessel is employed,
- (6) degree of automation,
- (7) use of labor-saving devices, and
- (8) organizational structure of the vessel, such as whether there is a maintenance department of persons that could be assigned to duties in the deck or engineroom spaces at the discretion of the master.

According to the Coast Guard Officers, the Coast Guard reviews of minimum crew levels have not been limited to these factors, and no single factor must be considered, according to statute. The Coast Guard officers said that although each vessel must be evaluated individually when several vessels are similarly equipped with automation, evidence of successful operation for one ship can be used in support of minimum crew complements for the newer vessels of the same class. According to the Coast Guard officers, the most important factor used for determining minimum manning levels is the type of equipment installed on board the vessel and its operational reliability. They said that as a general rule, the greater the automation of installed equipment on vessels, the lower the crew complements are for operation of those vessels.

In addition, the Coast Guard officers said that minimum manning for any vessel should always be based on the minimum number of persons required to accomplish essential work tasks under the most difficult conditions that could reasonably be encountered, i.e., a "worst case" scenario. The civilian witness elaborated on this factor as follows:

[Coast Guard concern is for] the ability of the ship ... to react to emergencies that we can anticipate. Are there enough people to fight a fire within the limits that we feel a crew should be able to fight. Are there enough people to set watches, [and] additional people in the watches so that if we are in reduced visibility for an extended period of time, [we can] have an augmented bridge watch.... If the automation in the engine room failed, can we set up engineroom watches.

According to the civilian witness, the Coast Guard does not consider adequate maintenance of shipboard equipment as a criterion for determining manning levels. Similarly, in his view, inadequate maintenance is not necessarily indicative of an undersized crew. He explained that maintenance on reduced crew vessels may be the responsibility of temporary riding crews or contractors who are hired by the ship operators and are aboard the vessels only to perform required maintenance tasks.

Coast Guard officers indicated that a review to determine the minimum crew complement for any given vessel normally begins with a shipowner's request in writing submitted to the Officer in Charge of Marine Inspection (OCMI) in the local MSO. The request letter serves as a formal proposal indicating the shipowner's preference for the minimum crew complement on the vessel under consideration. The OCMI is required to refer the review process to Coast Guard headquarters. Normally, when the OCMI makes his referral, he includes his own recommendations for the change in manning and forwards the requested recommendations and supporting documents with his recommendation via the District Commander to the Vessel Manning Branch of the Merchant Vessel Personnel Division at Coast Guard headquarters.

Coast Guard officers in the Vessel Manning Branch typically begin their review of requests for reduced manning with a determination of whether the requested manning is consistent with existing Federal statutes (46 U.S.C. 8104), Coast Guard regulations, the Marine Safety Manual Chapter 23, and Coast Guard policy. Then they consider supporting documentation submitted with the shipowner's request, including identification of equipment installed on the ship, maintenance records, and overtime information about the crew. If the vessel is new, it is initially manned with a traditional complement regardless of the reduced-crew manning that was intended when the vessel was designed. The traditional complement, excluding the steward's department, includes six ABs, three QMEDs, and eight licensed officers. Next, a Coast Guard officer is assigned to ride the vessel for one trip to evaluate the performance of the new vessel with the traditional crew complement. After the new ship has completed one or more voyages, the Coast Guard tentatively implements the shipowner's proposals for crew reductions or crew adjustments. A distinction is made between reductions and adjustments. A reduction takes place when the total complement of crew is reduced in number, and an adjustment occurs when the descriptions of crew duties and crew qualifications are changed, such as the creation of a maintenance department consisting of ordinary seamen in place of able seamen. When the new vessel has been operating with a reduced crew for several trips, a Coast Guard officer rides the vessel again, evaluating the crew's activities and the reliability of the automated systems that were intended to enable the reduction. When this evaluation is complete and indicates that the reduced crew is sufficient, the Vessel Manning Branch transmits its approval through the District Commander to the OCMI who initiated the review. The OCMI then implements the approval for the intended minimum manning requirement in the Certificate of Inspection issued for the vessel. During the public hearing, the civilian witness said that Coast Guard followup for monitoring reduced crews is accomplished during a reconsideration of the Certificate of Inspection every 2 years and by the midyear (off-year) inspection to ensure that all automation is operating correctly.

The Coast Guard officers were asked about the value of crew overtime records as an accurate and meaningful measure of crewmember workload. They

stated only that it was necessary to distinguish between penalty time¹⁷ and overtime paid for work in excess of 8 hours for this information to be used effectively in the evaluation process. Safety Board investigators asked the officers about Exxon's alleged manipulation of records that supported its reduced manning requests (i.e., minimizing overtime and deferring maintenance during the evaluation period). The officers said that evidence of these practices was provided to the Coast Guard by the Exxon Seamen's Union after the grounding of the EXXON VALDEZ. (The evidence consisted of three Exxon memoranda from a ship group coordinator (a shoreside manager) to the masters of four tankships directing that overtime be curtailed until after the Coast Guard had completed a review of the workload on certain vessels to determine whether reduced manning in the engine rooms of those vessels was justified. These memoranda were marked for distribution to other Exxon managers.) As a result, the Vessel Manning Branch is now requiring masters and chief engineers to include an additional letter with their documentation of overtime certifying that the records are "representative."

The Coast Guard officers interviewed by Safety Board investigators said that both the EXXON VALDEZ and her sister ship, the EXXON LONG BEACH, were designed to operate with smaller crew complements than ships of earlier vintage. The officers explained that the crew reductions were possible primarily due to the installation of "automated systems" in the engine room and "labor-saving devices" for the deck department. The officers said that after the EXXON VALDEZ had been placed in regular service, a revised Certificate of Inspection was issued by the San Diego OCMI at Exxon's request. This revision eliminated the three QMEDs included in the original Certificate of Inspection as part of the required "traditional" crew complement. The Coast Guard officers did not discuss personnel in the steward's department.

According to the Coast Guard officers and an official of the Exxon Seamen's Union, this deletion of the QMEDs from the Certificate of Inspection involved two departures from procedures required for reducing crew complements. First, the review for the deletion of QMEDs should have been referred to the Vessel Manning Branch at Coast Guard headquarters. Second, according to the Exxon Seamen's Union official, the deletions were linked to the company's request to obtain periodically unmanned status for the engine room. According to the union official, the company's rationale for the deletions was that since watches were no longer required for operation of the machinery spaces and all engine department personnel were placed on day work, QMEDs were unnecessary crewmembers and should be deleted from the Certificate of Inspection. Correspondence provided to Safety Board investigators by the Coast Guard and the Exxon Seamen's Union indicated that the Vessel Manning Branch had upheld the original decision of the OCMI to delete the QMEDs from the Certificate of Inspection. The union official

¹⁷Penalty time is a rate of extra pay for watchstanding during weekends and holidays or for performing certain duties determined to justify an overtime rate. Hence, penalty time has little impact on the Coast Guard evaluation process to assess proper tasking of crewmembers.

said that to his knowledge, the EXXON VALDEZ continued operating with QMEDs on board regardless of the approval for their deletion.

The chief engineer on the EXXON VALDEZ testified that he was assigned to the vessel when it was delivered to the company. He said that before the present COI was issued, the EXXON VALDEZ was manned with two additional oilers [QMEDs] in the engineroom and an additional third engineer. The chief engineer testified that the crew complement was, in fact, reduced after the certification for periodically unmanned status for the engineroom was granted by the Coast Guard. He recalled that one oiler was initially removed after the certification for periodically unmanned status was obtained and that some months later, a second oiler was removed, leaving one oiler aboard. He said that a third engineer was removed from the ship 1 year after the periodically unmanned status certification. The chief engineer also testified that he had not been instructed to reduce overtime and that the Exxon management memoranda obtained by the Safety Board directing ships' officers to reduce overtime was not written by his vessel's supervisor.

The president of the Exxon Shipping Company testified that he was "comfortable" with the manning scales aboard vessels in the Exxon fleet. He identified a "national standard" for crew size on U.S. ships as 21 persons and later substantiated the assertion with a manning summary document sent to the Safety Board. He stated that newer Exxon vessels were being built with "full automation" in order to attain engineroom personnel reductions on more vessels. He characterized the Exxon policy of updating its fleet with the reductions of crew size as consistent with trends in the rest of the shipping industry. He noted that the chemical specialty vessels operated by Exxon carry an additional mate and an additional pumpman.

The president of the Exxon Shipping Company testified that the mates were considered part of management and that the management status enabled Exxon to eliminate payment of overtime for officers on Exxon vessels. He said that instead of receiving overtime pay, the mates and masters received higher base salaries to offset the loss of direct payment for overtime. He explained that the exemption of officers from overtime pay was done to put them "more on a total supervisory footing."

Exxon submitted two graphics to the Safety Board as evidence of safer operation of Exxon vessels using reduced crews. One figure showed "average manning per vessel" and "number of oil spills per vessel" plotted over time from 1974 through 1988. The second figure showed "average manning per vessel" and "injuries per million workhours" plotted over time from 1973 through 1989. No breakdown of information pertaining to training or crew composition, duty/tour length, crew overtime, age or models of shipboard equipment, or indications of specific types of casualties was indicated. (See appendix D.)

Three Exxon Seamen's Union officers expressed concern for maintenance that was being regularly deferred on Exxon vessels. One union officer said that he had great concern about work on the older ships that "just isn't being done." He explained that the deferring of work on the ships was a result of two factors: insufficient manning levels on Exxon vessels and

Exxon's intent to demonstrate to the Coast Guard by not authorizing overtime that existing manning levels include unnecessary crewmembers.

Exxon union officials testified that fatigue was reported frequently to the union by licensed and unlicensed crewmembers and that the company regularly used incentives to get crewmembers to work more than 8 hours a day. The senior union official testified that two factors were contributing to the fatigue reported by crewmembers on Exxon vessels. The first was the lengthening of the tours for crewmembers from the usual 60 days to 90 and 100 days because the company could not obtain relief seamen. He said that daily work for seamen on the reduced crew vessels often includes overtime.¹⁸ Statements from ABs on the EXXON VALDEZ and the EXXON BATON ROUGE, which lightered the stranded EXXON VALDEZ, indicated that crewmembers worked 20 or more hours daily during routine cargo handling operations.

The senior union official identified the second major factor causing fatigue as the shortness of the trade routes, which require peak workloads for loading or discharging cargo every 4 to 5 days. He said that the current minimum crew requirements for the EXXON VALDEZ and EXXON LONG BEACH were intended for the Panamanian run from Valdez and that the length of the run to Panama provided more time for the crew to rest and perform maintenance between ports. It was his understanding that some time after the crew reductions were granted by the Coast Guard, the EXXON VALDEZ was removed from the Panamanian run and assigned to the Long Beach/San Francisco run, a run that is several days shorter.

Two research efforts were identified by Coast Guard officers for the study of reduced crews and safety, both of which were receiving Coast Guard sponsorship and partial funding. A joint U.S. Maritime Administration (MARAD) and Coast Guard study, Shipboard Crew, Fatigue, Safety, and Reduced Manning, is intended primarily to be an assessment of fatigue on merchant vessels with practical recommendations for shipping company management on how to assess crew fatigue. The work is being carried out with the Transportation Systems Center at Cambridge, Massachusetts, the principal research facility for DOT. The first of two phases has been completed and an interim report has been published in draft form, Shipboard Crew Fatigue, Safety and Reduced Manning - Draft Report: Fatigue. The next phase will involve direct assessments of crew fatigue on operating vessels.

The second study is being conducted by the Marine Board of the National Research Council and is entitled Effect of Smaller Crews on Maritime Safety. The purpose of the project is to provide the Coast Guard with guidelines for determining minimum crew complements and crew composition for merchant vessels. The advisory board or study group for the project included the president of Exxon Shipping Company, representatives from major maritime unions, and other participants. According to the director of the project,

¹⁸All reference to overtime is for hours worked in excess of 8 hours per day. Payment for certain kinds of work performed on watch after normal working hours or on holidays is not included.

interim results of the study have not been made public at the time of this report.

Waterway Information

The Gulf of Alaska is located along the southern coast of Alaska and is bordered by the Alaskan Peninsula on the west and Canada on the east. Prince William Sound, which is entered through the Cape Hinchinbrook entrance, is a main artery leading northward to the port of Valdez.¹⁹ The distance from the entrance at Cape Hinchinbrook to the terminal in Valdez is about 67 miles. Prince William Sound has a traffic separation scheme (TSS) with inbound and outbound traffic lanes from Cape Hinchinbrook to within about 6 miles of Valdez Narrows (the entrance to Port Valdez). The traffic lanes are each 1,500 yards wide from Hinchinbrook Entrance to the vicinity of Bligh Reef at the southeast end of Valdez Arm, then gradually decrease to a width of 1,000 yards at the terminus located at Rocky Point. The separation zone between the two traffic lanes is 2,000 yards wide between Cape Hinchinbrook and Bligh Reef and then gradually decreases in width to 1,000 yards and terminates at Rocky Point. The eastern perimeter of the TSS passes within 1 mile of Bligh Reef buoy.

The most restrictive section of the passage is Valdez Narrows, which is about 0.8 mile wide and about 2 miles long. Potato Point Light on the west bank and Entrance Point on the east bank mark the southern entrance to Valdez Narrows. At Middle Rock, a shoal near the north end of the Narrows, Valdez Narrows accesses Port Valdez. Valdez Narrows is restricted to one-way traffic by tank vessels of 20,000 deadweight tons or more²⁰ and loaded tank vessels are restricted to a maximum speed of 6 knots.²¹

Prince William Sound and Port Valdez have a diurnal range of tide of 12 feet; however, tidal currents in Valdez Arm are too weak and variable to be predictable. Depths in Prince William Sound within the TSS range from 125 to 250 fathoms (750 to 1,500 feet) from Cape Hinchinbrook to Valdez Narrows. In the Narrows, the navigable waters are less than 100 fathoms (600 feet). Depths then increase to more than 125 fathoms (750 feet) in the Port Valdez area. Alongside the Alyeska Oil Terminal berths in Port Valdez, depths range from 85 to 150 feet.

Vessels proceeding outbound from the Alyeska Marine Terminal in Port Valdez steer about 270° for about 6 miles to the northern entrance to Valdez Narrows, which is marked by a navigation light on Entrance Island. The course is then in a southerly direction into the Valdez Narrows. Upon transiting Valdez Narrows, the outbound vessel enters the wider Valdez Arm and steers 219°. The waterway through Valdez Arm is marked with navigation aids, and the land masses provide good radar returns for accurate radar

¹⁹U. S. Coast Pilot 9.

²⁰Title 33 Code of Federal Regulations (CFR) 161.370(a).

²¹Title 33 CFR 161.376(b).

navigation. Valdez Arm is about 2.5 miles wide at the start of the traffic lanes about 6 miles southwest of Potato Point and increases to about 5 miles wide adjacent to Bligh Reef buoy. Until April 12, 1989, the pilot station was located west of Rocky Point.

Busby Island Light, about 3 1/2 miles south-southwest of Rocky Point, is the next prominent fixed navigation light. Busby Island Light shows a white and red sector; the red sector shows across the area of Bligh Reef. Columbia Bay is west of the traffic lanes. Icebergs and smaller ice pieces that calve from the Columbia Glacier flow into the Valdez Arm. Bligh Reef is east of the traffic lanes opposite Columbia Bay. Bligh Reef lighted bell buoy No. 6 marks the shoals, which are east of the buoy. (The Coast Guard plans to install a tower with a navigation light, radar reflector, and a day marker to mark Bligh Reef.) Bligh Reef, a shoal area of 10 fathoms or less, extends northeast 1.8 miles and southeast 1 mile from the buoy. Upon reaching a point about 60°50'N latitude and 147°02.5'W longitude with Bligh Reef buoy bearing 083°, distance 4 miles, the outbound vessel steers 186° to remain in the traffic lane. About 1 mile south of this juncture is the new pilot station, about 3.6 miles 246° true from Bligh Reef Buoy at position 60°49'N latitude and 147°01'W longitude.²² This location is about 9 miles seaward of the previous pilot station.

Though ice calves from the Columbia Glacier into Columbia Bay throughout the year, the Coast Guard stated that the greatest number of and the largest icebergs generally appear during the late summer and early fall. Testimony and statements by pilots, traffic watchstanders, and Coast Guard correspondence indicated that the number of vessels reporting ice in the traffic lanes in the vicinity of Bligh Reef has steadily increased since the VTS was first established in 1977. The ice, consisting mainly of brash,²³ bergie bits,²⁴ growlers,²⁵ and icebergs,²⁶ is propelled by wind and current out of Columbia Bay and moves across the open waters of Valdez Arm toward

²²Title 12 AAC 56.120. Pilot Stations.

²³A collection of small fragments and rounded nodules of ice frozen together, which a ship can easily force its way through.

²⁴Medium-size pieces of ice that are detached and rounded on the top. May originate either from a glacier or from disrupted hummocky ice.

²⁵A low-lying mass of field ice that is not easily seen by approaching vessels owing to its dark indigo color. It is therefore a menace to shipping. It is usually caused by the capsizing and disintegration of an iceberg.

²⁶A large floating mass of ice detached from a glacier at sea level. The movement of a glacier downward causes it to protrude into the sea, by which it is in part supported until the weight becomes so great that more or less of it breaks off (calving) from the glacier.

Bligh Reef. According to the U.S. Coast Pilot,²⁷ "Large bergs may be found at any time along the north shore from Point Freemantle to Glacier Island." The Coast Guard has reported that vessels en route to and from Port Valdez often have been forced to take action such as reducing speed, deviating from one traffic lane to another, deviating from the TSS altogether, or awaiting daylight before transiting on account of the ice choking the traffic lanes.

The VTC watchstanders monitor the ice situation in the Valdez Arm by requesting that participating vessels make ice reports to the VTC. Ice reports, however, are not mandatory. As a result, not all vessels participating in the VTS provide ice reports. According to the Prince William Sound Vessel Traffic Center Manual (November 1988):

(Section 4.9.4.a.) Ice conditions change rapidly and there is a continuing need to have up-to-the-minute information. Ice reports should be requested from any vessel transiting the area where ice conditions may exist. Ice reports should be received from any vessel if the latest ice report is over 2 hours old.

The VTC Manual states that the VTC shall pass along ice reports to vessels entering the system. According to the VTC Manual:

(Section 4.9.4.c.) Ice reports shall be passed to vessels upon request and when an inbound vessel reports at Naked Island, and when an outbound vessel reports underway from Valdez.

The VTC watchstanders were required to log all ice reports onto the Vessel Data Sheets. They were also required to list the area congested by ice, as well as the concentrations and approximate size of ice reported, and to note all actions taken by vessels to alter course, speed, or depart from the normal traffic routes on account of the ice.

During the morning of March 23, the tankship BROOKLYN transited the Valdez Arm outbound. (See figure 9.) During that time, the BROOKLYN departed from the TSS to avoid ice and passed within 1.4 miles west of the portion of Bligh Reef where the EXXON VALDEZ later grounded. Shortly thereafter, the vessel passed within 0.35 mile (about 2,100 feet) west of Bligh Reef buoy before returning to the TSS.

About 1904, during the evening before the accident, the ARCO JUNEAU altered course to about 180° and departed from the traffic lanes to avoid the ice. During this time, the vessel passed within 3,900 feet (about 4.5 ship lengths) west of the portion of Bligh Reef where the EXXON VALDEZ later grounded. Shortly thereafter, the vessel passed within 0.4 mile

²⁷Volume 9 - Pacific and Arctic Coasts of Alaska: Cape Spencer to Beaufort Sea, 1987. Published by the U.S. Department of Commerce (National Oceanic and Atmospheric Administration).

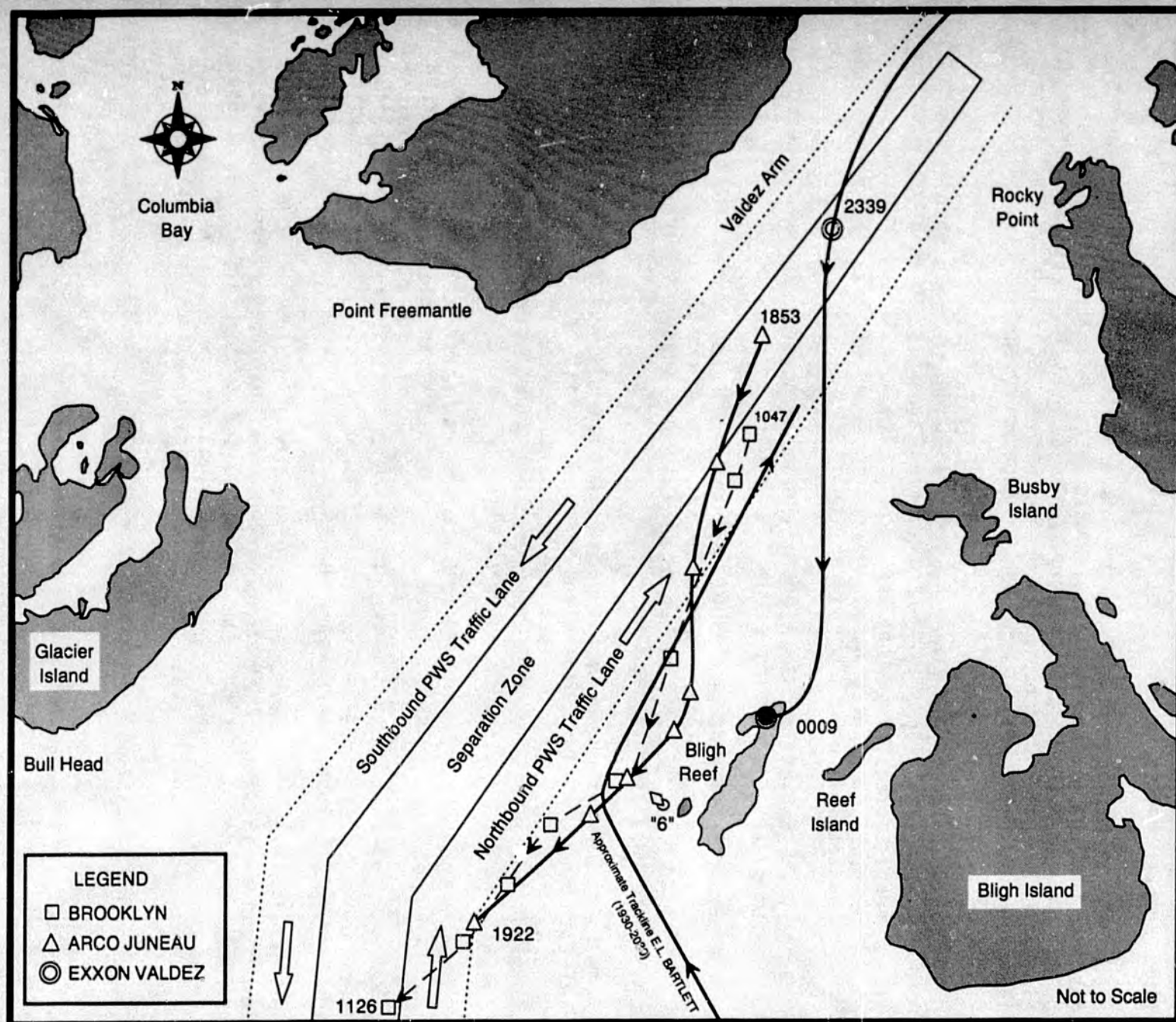


Figure 9.--Vessels departing the TSS.

(about 2,400 feet) west of Bligh Reef buoy before returning to the TSS about 1922.

About 1930 on March 23, 1989, the passenger vessel E.L. BARTLETT,²⁸ which was en route to Valdez, was approaching the TSS in the vicinity of Bligh Reef. According to the chief mate of the E. L. BARTLETT, who was on watch at the time, visibility was very poor because of snow squalls. As the vessel approached Bligh Island, he stated that the radar indicated an "extremely heavy concentration of ice all across Valdez Arm from Point Freemantle to Bligh Reef buoy and extending north to south from Busby Island to the south end of Glacier Island." The master was called to the bridge, and the speed of the vessel was reduced. Between 2000 and 2025, with the aid of radar and searchlights, the vessel worked its way through the ice in the vicinity of Bligh Reef until it was clear of the ice (in the vicinity of Busby Island). According to the chief mate, "It was some of the thickest ice I have seen in that area in the years I've worked the BARTLETT." The E.L. BARTLETT was required to participate in the VTS. On the night of the accident, however, the vessel did not transmit an ice report to the VTC, nor was it requested to do so. The vessel later made a stop at Ellamar, Alaska, (located east of Busby Island) to pick up passengers and then continued on toward Port Valdez where it arrived without incident about 2230.

As early as September 1, 1975, ice in Valdez Arm was recognized as a potential hazard to navigation. At that time, the CO of the Marine Safety Detachment²⁹ reported to the Commander, Seventeenth Coast Guard District, that the tug POLAR MERCHANT had sighted considerable ice in the shipping lanes west of Bligh Reef buoy and that some of the icebergs were reported to be as large as the 115-foot long tug. Records kept by the Coast Guard following the commencement of oil shipments in 1977 indicate that ice did affect the ability of vessels to navigate in the TSS in Valdez Arm. For example, from July to October 1981, a total of 634 transits by tankships were monitored by the VTC. Of these transits, 72 tankships reported sizable ice, 12 had to reduce speed because of ice, and 18 tankships departed the TSS to avoid ice. Because of the ice, two oil companies (Exxon and Mobil) for a period of time limited their vessels to daylight transits of Valdez Arm. Another oil company, SOHIO, for some time restricted the speed of its vessels to 6 knots when ice was present.

From July 23 to October 31, 1984, there were at least 403 vessel transits of Valdez Arm, and records indicate that in 131 of these transits the vessels (38 percent) were forced to reduce speed and/or maneuver around ice in the TSS. Of the 131 vessels affected by ice, 76 were forced to depart the TSS. One such vessel, the GLACIER BAY, reported on July 24, 1984, that

²⁸The E.L. BARTLETT was a passenger vessel owned and operated by the State of Alaska (Department of Transportation). The 168-foot vessel, which was constructed as a RO/RO combination cargo/ferry and was capable of carrying up to 236 passengers, provided regular ferry service between Cordova, Ellamar, and Port Valdez, Alaska.

²⁹The activity became a Marine Safety Office in 1977.

ice extending across the traffic lanes to within 0.5 mile of Bligh Reef buoy forced the vessel to depart the TSS and to pass within about 500 yards of the buoy.

The CO of MSO Valdez, on December 1, 1984, in correspondence with the Commandant, proposed the installation of a radar site either on Glacier Island or Bligh Island to monitor the glacial ice flowing out of Columbia Bay. The CO cited the U.S. Geological Survey prediction at the time, which reported that calving of ice from the Columbia Glacier was expected to increase over the next 10 to 30 years. Further justification, according to the CO, was that the radar could assist vessel traffic control during the adverse weather extremes experienced during the winter months. The proposed radar site, however, was not approved by Coast Guard headquarters.

The 1984 ice conditions resulted in a meeting on August 22, 1984, between the CO of MSO Valdez and representatives of the oil companies, Southwest Alaska Pilots, and U.S. Geological Survey personnel. The meeting addressed the need of tankship masters for better reports on ice conditions and the potential impact of the retreat of the Columbia Glacier, which, according to the U.S. Geological Survey, would result in increased ice floes. The oil companies expressed their belief that the masters of their vessels could be relied on to avoid the ice. The Coast Guard and the industry generally agreed that operations would continue as before.

The CO (at the time of the grounding) stated that although he was aware of vessels being forced out of the lanes because of ice during the summer of 1984, he was unaware of the exact number of incidents or the number of vessels involved. He also admitted that he had not been aware that some oil companies had previously decided that ice in the Valdez Arm posed a sufficient threat to their vessels, cargoes, and crews that they had, on occasion, ordered their vessels to operate at reduced speeds or to transit Valdez Arm only during daylight. As far as the CO was concerned, there was not sufficient concern on the part of the Coast Guard to take steps other than requesting that vessels provide regular ice reports to the VTC. When asked whether he considered the presence of ice in the traffic lanes a hazard, he stated that "any ice is a hazard to navigation." See appendix E for further information on the effects of ice on vessel operations.

Meteorological Information

At 2300 on March 23, there was a low pressure area over the southern Yukon Territory with a stationary front extending west-northwest from the low into Alaska and passing about 200 miles north of Valdez. There was a weak high-pressure area over Ketchikan with a ridge extending west-northwest through Valdez.

In the vicinity of Valdez the skies were overcast, visibility was restricted by light snow and fog, and winds were calm. For surface weather observations at Valdez from 2100, March 23, through 1200, March 24, see appendix F.

Columbia Bay, which contains the terminus of the Columbia Glacier and is the source of icebergs in the Valdez Arm and Prince William Sound, is immediately to the west of the Valdez Arm. The Columbia Glacier has been stable throughout recorded history with the terminus at a terminal moraine³⁰ in the bay. During the 1970s, the glacier began to retreat from the terminal moraine into the deeper waters of the fjord.³¹ At that time, it was predicted that once the terminus retreated into deeper water, it would begin a rapid or catastrophic retreat, a phenomenon that had already been observed in several other Alaskan glaciers.

When the Port of Valdez first opened as an oil terminal, the Columbia Glacier was being closely monitored by the U.S. Geological Survey, but since that time the level of effort has been reduced to a periodic aerial observation of the glacier terminus.

Based upon recent observations, the Columbia Glacier is receding as predicted. Since 1982, it has receded at a rate of 500 to 1,000 meters per year, and the terminus is now about 4 kilometers (2.5 statute miles) from the terminal moraine. It is expected to retreat about 30 kilometers (19 statute miles) in 30 to 50 years and then to stabilize. As the glacier recedes, it expels a large number of icebergs. About 5 cubic kilometers (1.2 cubic miles) of ice currently calves from the glacier each year, a significantly larger amount than was calved from the glacier when crude oil shipments from Port Valdez commenced in 1977. The iceberg discharge is expected to continue at about the current rate until the glacier stabilizes in 3 to 5 decades. The size of the icebergs from the glacier that can exit the fjord is limited by the depth of the terminal moraine, which is about 27 meters (89 feet).

Once icebergs depart the fjord, their movement is controlled by the currents and the wind. The majority move to the west of Glacier Island away from the Valdez Arm, but a significant number move into Valdez Arm. Although ice calves from the glacier throughout the year, the greatest activity is in the late summer and early fall, when both the greatest number and the largest icebergs are formed.

Icebergs emanating from the Columbia Glacier frequently occur in groups or plumes of icebergs. Based upon a study conducted in 1983,³² it was estimated that approximately 121 plumes occur in Columbia Bay per year and of these, 43 enter the Valdez Arm. Normally, less than 3 plumes cross

³⁰A shoal or bar across the front of the glacier built up by earth and stone deposited from the glacier.

³¹A narrow steep walled inlet of the sea formed either by the submergence of a mountainous coast or by entrance of the sea into a deeply evacuated glacial trough after the melting away of the glacier. A fjord (fiord) may be several hundred fathoms deep and often has a relatively shallow sill (terminal moraine) of rock or gravel across its entrance.

³²A. R. Klinge, U.S. Department of Interior, Geological Survey, October 20, 1989.

Valdez Arm each year, but it was estimated that with the glacier in full retreat, about 21 plumes could be expected to cross the Valdez Arm every year. A plume might consist of 10,000 icebergs, of which, according to the 1983 study, 1,000 might have a mass greater than 3,000 tons, 153 a mass greater than 24,000 tons, and 25 a mass greater than 50,000 tons.

The life span of icebergs was considered during the 1983 study. About one-half of the icebergs lasted less than 12 hours and two-thirds lasted less than 24 hours. Most icebergs were gone after 48 hours, although some larger ones moved out of the Valdez Arm into Prince William Sound and could not be tracked throughout their life spans. The life span varied, in decreasing order of importance, with water temperature, iceberg type (essentially the density), and iceberg mass.

Tests and Research

Computer Simulation.--The Computer Aided Operations Research Facility (CAORF),³³ National Maritime Research Center, at Kings Point, New York, conducted a study of the preaccident maneuvers of the EXXON VALDEZ using the facility's ship simulator. The computer for the simulator was programmed to replicate the hydrodynamic characteristics³⁴ of the EXXON VALDEZ so that the simulator would duplicate graphically the maneuvers of the EXXON VALDEZ in response to rudder and engine speeds. Once programmed, the computer was used to develop a graphic presentation of the trackline probably followed by the EXXON VALDEZ from Middle Rock in Valdez Narrows to the site of the grounding.

Fine tuning and iteration resulted in generating a trackline that passed within about 1 ship width (165 feet) of positions plotted by the VTC near Entrance Island at 2220 and near Potato Point at 2253, as well as the 2339 position in the separation zone plotted by the third mate. The trackline passed slightly less than 0.9 mile from Busby Island Light, as the third mate had indicated. Although the simulated trackline did not pass through the fixes plotted by the third mate at 2306 and 2312, it passed within 0.1 and 0.14 mile, respectively, of these two fixes. The simulated trackline, based on a turn using 4° of right rudder, placed the vessel within 2 1/2 ship widths of the grounding site on Bligh Reef as determined by the Coast Guard (latitude 60° 51.3' N; Longitude 146° 52.37' W).

The simulator study resulted in following findings:

- (a) The EXXON VALDEZ passed abeam of Busby Island Light at 2355 on March 23 at a distance of about 0.9 mile.

³³Operated for the MARAD by Marine Safety International, Inc.

³⁴Such information included the advance and transfer for the vessel. The advance is the distance the vessel travels ahead until its heading changes 90° (about 0.6 mile). Transfer is the lateral distance the vessel travels right or left of its original trackline by the time its heading has changed 90° (about 0.3 mile for a right turn).

- (b) The turn from 180° toward Bligh Reef began at 0001.5 on March 24 about 1.4 miles past Busby Island Light.
- (c) Right 10° rudder was used for about 1/2 minute at the start of the turn, and then the rudder was eased one or more times to produce a slow turn. A change in the rate of swing at time 0006 indicates that little right rudder, or possibly counter rudder, was being applied. The rudder changes resulted in a turn that could have been made using about 4° to 5° of rudder. There was no evidence that right 20° or hard right rudder was applied between the start of the turn and the time that the vessel's heading reached 245° .
- (d) The vessel passed over the 50-fathom oval-shaped depth contour centered at latitude $60^{\circ} 51.5' N$, longitude $146^{\circ} 51.3' W$. (This was also confirmed by the vessel's fathometer trace.)
- (e) A reduction in rate of turn occurred at 0007 that could have been caused by a reduction in rudder angle or counter rudder, or possibly by the ship coming under the influence of external forces such as shallow water effect, bank cushion, or impact with the reef.

Trial turns conducted on the simulator yielded the following information:

- (a) If 10° of right rudder had been used continuously throughout the turn, the vessel probably would have passed safely north of Bligh Reef about 0.1 to 0.2 mile from the 10-fathom curve.
- (b) Using 4° of right rudder when Busby Island Light was abeam would have resulted in a gentle turn, causing the vessel to pass approximately 0.9 mile north (20-fathom curve) of Bligh Reef. Other turns, begun at the same time, with increased rudder were run to determine what additional clearance from the reef would result. The results of these trials are shown in the following table:

<u>Rudder (degrees)</u>	<u>Distance from Bligh Reef (miles)</u>
4	0.90
5	1.00
10	1.20
20	1.36
35	1.40
10-20-25	1.25

The course recorder trace showed that the vessel was on course 180° for about 18 minutes. The 180° portion of the course recorder trace was very straight until 0001.5, when the vessel commenced a right swing. After the vessel steadied briefly on a heading of 247° at 0007, it resumed a slow right swing, which continued until about 0009, when the vessel's rate of swing increased significantly between 280° and 290°.

Other Information

Alcohol and Drug Policies.--The Exxon Shipping Company had a written policy on alcoholism at the time that the master was undergoing treatment for alcohol dependency in 1985. This policy, dated September 28, 1984, recognized that alcoholism is a treatable illness and that alcoholism does not, by itself, represent grounds for dismissal. However, failure to perform owing to alcohol use was sufficient cause for termination. The policy instructed supervisors to refer to the medical department those employees whose unsatisfactory job performance was owing to the perceived use of alcohol. However, no records were provided that indicated the medical department was involved in the oversight or supervision of the master. The report from the substance abuse treatment program in which the master participated during his hospitalization in 1985 was part of Exxon records on the master. The report, which was on Exxon Shipping Company forms, included a recommended treatment program. However, no documents were provided that discussed his progress or the degree to which he was following the suggested treatment program.

A more recent written policy, dated March 11, 1987, on the use of alcohol and drugs by Exxon employees was provided to the Safety Board. This policy basically prohibits the use, possession, distribution, or sale of drugs and alcohol on company premises. Furthermore, being unfit for duty because of the use of drugs or alcohol is forbidden. The program provides for:

1. preemployment drug and alcohol testing;
2. drug and alcohol testing for cause;
3. unannounced searches on Exxon-owned and -controlled property;
4. substance abuse treatment and rehabilitation through an Employee Health Advisory Program (EHAP);
5. no termination for voluntarily seeking help for a dependency problem; and
6. disciplinary action that may include termination if an employee's use of alcohol or drugs is discovered before voluntary action is taken.

Based on testimony of EXXON VALDEZ crewmembers, crewmembers were clearly aware of the Exxon policy on alcohol and drug use and knew that their employment was subject to termination for possession and use of alcohol while on the job or for reporting for duty while under the influence of alcohol. The president of the Exxon Shipping Company testified that the company did not have any procedures, such as a hot line, for crewmembers to report infractions.

The applicable DOT Coast Guard regulation for the control of intoxicant(s) in commercial vessel operation in effect at the time of the grounding is contained in 33 CFR Part 95 and is entitled "Operating a Vessel While Intoxicated." The regulation authorizes the marine employer or law enforcement officer, including a Coast Guard official, to direct a person operating a vessel to undergo a chemical test when a reasonable cause exists (Section 95.035). Reasonable cause exists when: the person was directly involved in the occurrence of a marine casualty as defined in Chapter 61 of Title 46, United States Code, or is suspected of being in violation of the "Standards of Intoxication" as defined in Section 95.020. Section 95.020 states that a person operating a vessel other than a recreational vessel is intoxicated when (1) the person has a blood alcohol concentration of 0.04 percent or (2) the person is operating any vessel and the effect of the intoxicant(s) on the person's manner, disposition, speech, muscular movement, general appearance or behavior is apparent by observation. Section 95.040 states: "A crewmember (including a licensed individual), pilot, or watchstander not a regular member of the crew: (a) shall not perform or attempt to perform any scheduled duties within 4 hours of consuming any alcohol." The marine employer is responsible for ensuring compliance with this rule.

A new final rule³⁵ on drug and alcohol testing for commercial vessel personnel was published on November 21, 1988, in the Federal Register. This rule also calls for toxicological testing after a marine casualty or accident involving death, injury, property damage, or loss and discharge of oil and hazardous substance in navigable waters of the United States. This regulation includes testing for alcohol and drugs in urine and blood and for alcohol on the breath. Urine specimens must be tested according to U.S. Department of Health and Human Services (DHHS) guidelines in 49 CFR Part 40. The prohibition against assuming duties within 4 hours of consuming alcohol has been retained. The date for implementation of the new drug testing program depends on the number of employees in the company. Testing after serious incident and reasonable cause testing had to be implemented by December 21, 1989, by all employers who employ 11 or more employees. The drug testing program must be implemented by December 21, 1990, by employers who employ 10 or fewer employees.

The new regulation states that the urine must be tested according to guidelines in 49 CFR Part 40, which does not address alcohol testing.

³⁵"Programs for Chemical Drug and Alcohol Testing of Commercial Vessel Personnel," 46 CFR Parts 4, 5 and 16, Federal Register, Vol. 53, No.224, Monday, November 21, 1988, FR 47064.

However, breath analysis for alcohol and the collection of blood is permitted. This regulation does not contain guidelines concerning how the blood is to be tested or for what drugs.

Both regulations state that in the case of postincident/accident investigations the marine employer has the responsibility to implement the regulation (46 CFR Part 40) by determining who is to be sampled and to ensure the specimens are collected in a timely manner.

The Coast Guard drug testing program as it applies to DOT civilian employees was established and set forth in the DOT directive entitled, "Drug Free Departmental Workplace" (DOT Order 3910.1), dated June 29, 1987. As an implementation resource for supervisors, the DOT issued a "Drug Testing Guide" in March 1988. A revision to the Guide concerning postaccident testing procedures was issued on July 1, 1988. The DOT's drug testing program is based on Executive Order 12564, "Drug-free Federal Workforce" signed by President Reagan on September 15, 1986. This order applies only to Federal civilian employees. The DOT drug testing program, including laboratory testing, as outlined in this document and as explained in testimony by the DOT Deputy Assistant Secretary for Administration, is to be executed in strict accordance with procedures contained in the DHHS "Scientific and Technical Guidelines for Drug Testing Programs." According to these guidelines (49 CFR Part 40), only urine specimens are tested, and the testing is generally limited to five specific drugs or their metabolites. Alcohol is not included. The five specific drugs or drug classes are: (1) opiate metabolites; (2) cocaine metabolites; (3) marijuana metabolites; (4) phencyclidine (PCP); and (5) amphetamines. The DHHS guidelines specify lower threshold cut-off values for reporting the presence of each of these five drugs or their metabolites.

The DOT employees covered in the policy are those in safety- and security-sensitive positions, including vessel traffic controllers. The policy specifies that testing is to be done when an accident or unsafe practice occurs or when reasonable suspicion exists. The decision to test DOT employees after an accident or incident is a three-step process. First, the determination must be made that a qualifying event has occurred. Second, employees whose work performance may have been a contributing factor are identified. Third, it must be determined that the employee's actions cannot be eliminated as a contributing factor from a review of known facts. The determination that a qualifying event has occurred is made by the operating administration. Once the determination has been made that testing is necessary, the employee must be notified. This decision to test, who to test, and notification of individuals to be tested must be made within 8 hours after the operating administration has received notice that an accident has occurred.

The DOT Deputy Assistant Secretary for Administration testified that postaccident testing has two objectives: deterrence and identification of employees who use illegal drugs. She said, "It is not meant as part of postaccident investigation in the sense that the Board does an investigation" to determine probable cause. However, later in her testimony she stated that the "second objective is to assess the employees' performance at or about

the time of the accident for simple employer/employee relationship, i.e., to determine if it is necessary to take disciplinary action against an employee."

In the EXXON VALDEZ grounding, the determination that a qualifying event had occurred was made, according to the Deputy Assistant Secretary for Administration, by the Coast Guard Pacific Area office in Alameda, California, which ordered that the two VTC watchstanders who were on duty just before and at the time of the grounding be tested for drug use. The order partially was carried out by a Coast Guard officer, who obtained a urine sample from the VTC watchstander on duty at the time of the grounding about 1400 on March 24, about 14 hours after the accident. The VTC watchstander on duty just before the grounding did not provide a urine specimen on March 24.

The first urine specimen obtained from the VTC watchstander on duty at the time of the grounding was tested for alcohol and revealed a blood alcohol concentration (BAC) of 0.2. Statements and testimony indicated that the watchstander was not impaired and had performed properly during his 0000-to-0800 watch, as well as during 4 hours of overtime from 0800 to 1200. He stated that after departing the VTC, he had consumed about three strong drinks at home during lunch and had then gone to bed. He gave the urine specimen about 2 hours after consuming these drinks.

The DOT Deputy Assistant Secretary for Administration testified that the toxicology testing procedures initiated by the DOT resulted in urine being collected from the two VTC watchstanders some time after 2030 on March 26, shortly after the time the collector designated by the DOT toxicology testing contract arrived in Valdez. However, DOT documents do not have the time of collection written on them. The deputy assistant secretary testified that the specimen provided on March 24 by the VTC watchstander on duty at the time of the grounding was not considered to have been collected under the DOT procedures for the employee program since the specimen was not collected by the DOT contractor (Upjohn Health Care Services Incorporated) but was collected by the Coast Guard. The DOT contractual agreement with Upjohn provided that the contractor had 24 hours in which to arrive at the collection site after being notified. Upjohn was notified at 1530 on March 24. The collector who obtained the two specimens in this case came from Atlanta, Georgia, because, as the DOT Deputy Assistant Secretary for Administration stated, "He was available and because he was one of their better collectors."

The urine specimens collected on March 26 were tested according to DOT drug procedures. According to Public Law 101-71 (101 Stat. 391,468-471, July 11, 1987), toxicological results obtained on Federal employees pursuant to Executive Order 12564 (September 15, 1989) can be released only (1) to the employee's medical review official, (2) to the administrator of any Employee Assistance Program in which the employee is receiving counseling, (3) to any supervisory or management official within the employee's agency who has authority to take adverse personnel action against such employee, or, (4) pursuant to the order of a court of competent jurisdiction where required by the U.S. Government, to defend against any challenge against adverse

personnel action. Release of test results to anyone else requires written consent from the employee. Based on this law, the DOT refused to release the urine test findings from the VTC watchstanders to the Safety Board without written authorization from the employees. Written consent to disclose the results of these tests to the Safety Board was received from the employees on May 17, 1989. Both tests were negative for the five drugs or drug classes as tested according to DHHS guidelines. The specimens were not tested for alcohol.

After the urine specimens were tested according to DHHS guidelines, the specimens were obtained by the Safety Board and tested by Chem West Laboratories, Inc., of Sacramento, California, under a broader drug screen that included alcohol and at lower cut-off levels for drugs. Under these conditions, both individuals tested positive for drugs, and the results were inadvertently released. These results are shown in the following table.

Table 4.--Urine toxicology on VTS personnel.

Position	Date	Time	Drug	Concentration
0000-0800 VTC Watchstander	3/26	1500	morphine*	230 ng/ml
1600-2400 VTC Watchstander	3/26	1500	THC-COOH**	7.5 ng/ml

* eating poppy seeds will result in positive urine morphine; the controller stated that he had eaten bread with poppy seeds before the test.

** 11-nor-delta-9-tetrahydrocannabinol-9-carboxylic acid: metabolite of marihuana.

The DHHS guidelines³⁶ for drug testing in the workplace set a urine screening cutoff for opiates, which include morphine, of 300 ng/ml and for marihuana metabolites of 100 ng/ml. The DHHS confirmation test cutoffs for these two drugs are 300 ng/ml for opiates and 15 ng/ml for marihuana (carboxylic and acid metabolite of THC).

Vessel Traffic Service.--The VTS operated from the VTC that was located in the MSO in Valdez. MSO Valdez performed COTP and OCMI functions for all of Prince William Sound. The CO of MSO Valdez acted as COTP and OCMI and was directly responsible to the Commander, Seventeenth Coast Guard District, Juneau, Alaska, for the operation of the Prince William Sound VTS. MSO Valdez had four departments: Marine Safety, Operations, Administrative, and Public Works. The VTS was part of the Operations Department. Unlike the VTSs in Puget Sound, San Francisco, and Houston/Galveston, Prince William Sound VTS was not a separate command unit. As a result, VTS personnel were utilized to perform collateral duties unrelated to the operation of the VTS. See appendix G for a description of the geographical limits and operational

³⁶Federal Register, DHHS. Alcohol, Drug Abuse, and Mental Health Administration; Mandatory Guideline for Federal Workplace Drug Testing Programs; Final Guidelines; pp. 11972-11989, April 11, 1988.

regulations, and for a history pertinent to the Prince William Sound VTS, see appendix H.

The CO of MSO Valdez, as COTP, was assisted in the operation of the Prince William Sound VTS by an XO, an Operations Officer, an Assistant Operations Officer, and a Senior Watchstander.

According to the Coast Guard Marine Safety Manual, COTP responsibilities include the supervision and control of vessel movement and mooring within the port, including vessel traffic control; the supervision and control of anchorages within the COTP zone; and the protection of the navigable waters and resources therein from environmental harm resulting from damage, destruction, or loss of any vessel, facility, or structure. According to 46 CFR 160.111, the COTP has the authority to restrict the movement of vessels through Prince William Sound when he has determined that:

such order is justified in the interest of safety by reason of weather, visibility, sea conditions, temporary port congestion, other temporary hazardous circumstances, or the condition of the vessel.

The CO of MSO Valdez stated:

the main reason why the system was designed for the location, is for Valdez Narrows, to protect Valdez Narrows, and I would think that if the folks that envisioned the system wanted coverage all the way out, we would have radars all the way out.

During the evening of March 23, the VTC was manned by a civilian traffic watchstander and an adjoining communications center was manned by an enlisted Coast Guard radioman. (See figure 10.) The VTC watchstander was responsible for communicating with and monitoring all vessels participating in the VTS. The radioman, who was standing the 2000-0800 watch, was responsible for monitoring non-VTS radio traffic on the radiotelephone, single-sideband (HF-SSB), and teletype communications for the unit.

The VTC watchstander reported for duty about 1600. About 1930, the master of the outbound ARCO JUNEAU³⁷ reported to the VTC that he had detected ice in the TSS. According to the report, the perimeter of the ice extended from Point Freemantle southward to Glacier Island (in the vicinity of Bulls Head at the southeastern part of Glacier Island) and extended eastward across the TSS to Bligh Reef Buoy. The master of the ARCO JUNEAU informed the VTC that he would maneuver the vessel through the ice, and the master also reported that he would head his vessel toward an area of open water

³⁷The ARCO JUNEAU was the last tank vessel to successfully transit the Valdez Arm on the night of March 23. The ARCO JUNEAU was an 850 foot-long tankship capable of carrying a cargo of about 800,000 barrels of North Slope crude oil.



Figure 10.--Vessel Traffic Center.

about 0.9 mile wide near Bligh Reef. The VTC watchstander observed on radar the ARCO JUNEAU deviate from the southbound lane into the northbound lane shortly before losing radar contact with the vessel in the vicinity of Busby Island about 10 to 12 miles southwest of Potato Point.

The VTC watchstander stated that he was concerned about the ice encountered by the ARCO JUNEAU. However, his concern did not prompt him to require the ARCO JUNEAU to make more frequent position reports. According to the watchstander, ice in the traffic lanes is common, and vessels transiting the Valdez Arm often are forced to reduce their speed as they maneuver around the ice. He also stated that because of the ice, most of the masters are granted permission by the VTC to deviate from the southbound traffic lane into the northbound traffic lane if there is no opposing traffic. He said that many tankship masters transiting the Valdez Arm are aware that there is an ice-free stretch of water about 0.5 to 1.0 mile wide to the west of Bligh Reef Buoy. He said that these masters regularly head their vessels into this stretch of water to remain clear of the ice. The watchstander stated that he observed the ARCO JUNEAU alter course toward Bligh Reef and that the master of the ARCO JUNEAU called the VTC, stating that he intended to head toward a small area of open water about 0.9 mile wide near Bligh Reef to remain clear of the ice. The watchstander said that he did not give the master of the ARCO JUNEAU permission to deviate from the TSS; however, he did not tell him that he could not deviate. However, the master stated that he believed his vessel was being tracked on radar by the VTC. The master of the ARCO JUNEAU, like the master of the BROOKLYN, was on the bridge conning his vessel and supervising the navigation watch.

The chart³⁸ used aboard the ARCO JUNEAU during the evening of March 23 showed that about 1904, the ARCO JUNEAU altered course to 180°, then departed from the TSS, and followed a track that took the vessel through an area about 1.0 mile wide between the Bligh Reef buoy and the traffic lanes.

Coast Guard records indicate that during the transit of the EXXON VALDEZ through the Narrows, the No. 3 (slave)³⁹ radar console was set on the 3-mile range scale and the range and bearing of the vessel from Potato Point was recorded by the data logger⁴⁰ every 3 minutes. The VTC watchstander stated that during the transit of the EXXON VALDEZ between Potato Point and the pilot station at Rocky Point, the No. 1 master radar was set on a 3-mile

³⁸The chart used aboard the ARCO JUNEAU shows the track of the vessel passing within three ship lengths of the location where the EXXON VALDEZ grounded about 4 hours later.

³⁹The slave radar received its video display from the No. 1 (master) radar.

⁴⁰The data logger is a device that automatically records vessel positions.

range scale and the No. 3 radar was set on the 6-mile range scale (in offset).⁴¹

The watchstander stated that he began to lose radar contact with the EXXON VALDEZ shortly after the vessel disembarked the pilot near Rocky Point about 2324. In an effort to maintain radar contact, he switched the range scale of the No. 3 (slave) radar to the 12-mile range scale. He could not recall, however, whether he adjusted the range scale of the No. 1 (master) radar at that time. After failing to detect the target on the 12-mile range scale after three or four sweeps, the watchstander switched the No. 3 (slave) radar back to the 6-mile range scale. He stated that with the No. 3 radar (slave) on the 6-mile range scale, he was able to resume monitoring the movement of the EXXON VALDEZ. When asked why he thought the No. 3 radar was capable of picking up the EXXON VALDEZ on the 6-mile range scale but not on the 12-mile range scale, he replied:

I don't know why. I just thought it was because the radars weren't working as well as they should have been at the time. That was my theory. It just didn't work so I went back to the 6-mile scale.

At 2326, the VTC watchstander observed the EXXON VALDEZ abeam of Rocky Point on a course of about 219°. The watchstander recalled being informed by the master that the vessel was coming to 200° and reducing speed to 12 knots, but he did not consider the course change to 200°, by itself, unusual. He then left the radar console and walked over to the VTC status board,⁴² where he estimated without the use of plotting instruments that the VALDEZ, on a course of 200° from its last known position, would pass within 1 mile of the Bligh Reef buoy.

The watchstander stated, however, that by 2330, the VTC had lost all radar contact with the EXXON VALDEZ. The watchstander stated that the VTC radar system was often unable to track vessels transiting the TSS beyond the vicinity of Busby Island because of adverse weather and sea conditions. Neither Bligh Island nor Bligh Reef buoy were visible on radar at that time. The eastern boundary of the TSS passes within 1.1 miles (to the northwest) of Bligh Reef buoy. Shortly after returning from the status board to the radar console (about 2332), he began making preparations for the changing of the watch, which was scheduled to take place about 2345. These preparations

⁴¹Offset is a feature built into the Raytheon VTS radar that allows the traffic watchstander to offset the origin position on the radar PPI scope to monitor a greater distance in one direction using the same range scale, thus producing a larger scale presentation than would be obtained by increasing the radar range setting.

⁴²The VTS status board is an enlarged chart of Prince William Sound that measures about 8-feet wide and 7-feet tall and is mounted on the wall of the VTC. Magnets in the shape of vessels are moved around the board so that the watchstander can keep track of the approximate location of participating vessels that are not under radar surveillance by the VTC.

included updating the status board and ensuring that all necessary logbooks were up to date.

The VTC manual required the VTC watchstander to "advise the OOD when a vessel deviates due to ice in the lanes." However, during the evening of March 23, the 1600-2400 traffic watchstander did not notify the Officer of the Day (OOD) that the EXXON VALDEZ had deviated from the outbound traffic lane to avoid ice and that the master had reported he would depart the TSS.

The OOD on duty on the day of the accident stated that ice was reported in the traffic lanes earlier in the day (March 23) and that tankships were told by the VTC that "they could maneuver around the ice if need be." The OOD also stated that he frequently checked on the status of those tankers in the system and observed that "they were maneuvering around the ice with no problem."

About 2333, the 0000-0800 VTC watchstander arrived at the VTC and prepared to take over the watch. Neither of the two VTC watchstanders was aware that by 2339, the EXXON VALDEZ had altered course from 200° to 180°. About 2345, the VTC radar watch was relieved.

When the relieving watchstander first arrived in the VTC, he observed that the No. 1. (master) radar was set on the 3-mile range scale and the No. 3 (slave) radar was set on the 6-mile range scale. He did not observe any contacts on the radarscope, nor did he make any changes to the radar such as using a higher range scale to determine whether there were any contacts in the area. Between 2333 and 2345, the off-going traffic watchstander briefed his relief on the events that had occurred during the previous watch. During the briefing, the 0000-0800 traffic watchstander was informed that:

- (1) Ice had been reported in the TSS;
- (2, The EXXON VALDEZ had disembarked its pilot, was currently maneuvering through ice, and that it was likely that the vessel had deviated from the southbound traffic lane into the northbound lane to avoid the ice;
- (3) The VALDEZ was no longer on radar;
- (4) The last vessel to go through the Valdez Arm (ARCO JUNEAU) had left the southbound traffic lane and crossed over the separation zone into the northbound lane because of the existence of "a lot of ice" in the TSS;
- (5) The remote radio sites located at Naked Island and Cape Hinchinbrook were inoperative and as a result, communications with vessels south of Naked Island (i.e., communications to vessels at anchor or proceeding to and from Knowles Head anchorage) were more difficult; and,

- (6) The VTC had requested that the EXXON VALDEZ provide an ice report when it reached the Naked Island check point.⁴³

According to 0000-0800 VTC traffic watchstander, the previous watchstander did not relay any information to him that indicated that anything out of the ordinary was taking place as far as the EXXON VALDEZ was concerned. The 0000-0800 traffic watchstander stated that a few minutes after taking over the watch he left the VTC (located on the second floor of MSO VALDEZ) and went to the galley (located on the first floor of the MSO) to obtain a cup of coffee, leaving the Coast Guard radioman, who was standing the communication watch, to also monitor the VTS communications. He stated that as far as he was concerned, "There wasn't anything going on at the moment."

On the way back to the VTC, the VTC watchstander stopped at the National Weather Service office (also located on the second floor) to examine the weather map. About 2355, he returned to the VTC to perform several routine administrative tasks. About midnight, he rewound, removed, and replaced the 24-hour multichannel recording tape for March 23.⁴⁴ After the tape was changed, the watchstander spent the next several minutes updating the status board, making log entries, and tallying the vessel data sheets from the previous day. The watchstander stated that it was about 0015 when he first sat down in front of the radar console and proceeded to check the calibration of the radar. To calibrate the radar, it was necessary to set the range scale of the No. 1 (master) radar at the 3-mile range scale and to set the No. 3 (slave) radar at the 1.5-mile range scale. They remained on these range settings until 0027, when the master of the EXXON VALDEZ called the VTC and notified the watchstander that his vessel had grounded in the vicinity of Bligh Reef. The watchstander immediately switched the range scale of the No. 1 (master) radar and the No. 3 (slave) radar (in offset) to the 12-mile range scale and observed the EXXON VALDEZ stationary in the water at Bligh Reef about 13.2 miles southwest of Potato Point.

The VTS radar surveillance system⁴⁵ consisted of radar transceivers installed at two remote radar sites. The information from the transceivers was transmitted by microwave back to radar consoles in the VTC. One of the sites was located at Valdez Spit, a short distance from MSO Valdez. The second site was located at Potato Point, about 12 miles southwest of the MSO,

⁴³The Naked Island check point is about 10 miles south of Bligh Reef.

⁴⁴The MSO, through the use of a Motorola Magnasync multichannel tape recorder, taped all incoming VHF-FM and telephone traffic that was routed through the VTC. The tape in the recorder was capable of operating for 24 hours before it needed to be replaced with another tape.

⁴⁵The Raytheon ANL/FPS-121 radar is a modified version of the Raytheon ANS/SPS-64V shipboard surface radar currently employed aboard many Coast Guard cutters. The primary difference between the shipboard version (ANS/SPS-64V) and the land-based VTS version is that the VTS radar uses a larger antenna and is fitted with a microwave video link.

near the southern entrance to the Valdez Narrows. For the purpose of providing system reliability, each site was fitted with two radar transceivers⁴⁶ and a backup power supply.

The radar system was controlled by a traffic watchstander monitoring three radar consoles in the VTC. Because the consoles were virtually identical, they could be used interchangeably to control and receive data from either the Potato Point or Valdez Spit remote radar sites. According to the VTC watchstanders, the No. 1 and No. 3 radar consoles were normally used to monitor the transits of vessels through the Valdez Narrows and the Valdez Arm utilizing the Potato Point remote radar site. The No. 2 radar console normally was used to monitor the transits of vessels through Port Valdez utilizing the Valdez Spit remote radar site.

Each radar console was capable of tracking up to 20 targets automatically. The offset feature on the consoles permitted the use of a smaller range scale for better resolution and enabled a slightly greater portion of Valdez Arm to be monitored on the No. 3 (slave) radar console when the No. 1 (master) radar console was on the 3-mile or 1 1/2-mile scale to monitor Valdez Narrows. The optimum trackline and the TSS normally could be displayed on both radar consoles (No. 1 and No. 3, respectively) used with the Potato Point radar site. However, the TSS circuit card for the No. 1 (master) radar, which synthetically displayed the TSS boundary lines, had burned out; hence, only the No. 3 radar console was capable of displaying the TSS overlay at the time of the accident.

A data logger, capable of automatically recording the time, range and bearing, course and speed of vessel out to the range of the radar, was connected to the No. 3 (slave) radar console. The data logger was used only to record data on vessels transiting Valdez Narrows; thus, it was not used to record the movement of the EXXON VALDEZ after it exited the Narrows and proceeded toward the grounding site.

Shipboard radars operate on either an X-Band (3 cm) or S-Band (10 cm) carrier frequency.⁴⁷ The Raytheon VTS radar in Valdez used an X-Band carrier frequency. The minimum and maximum ranges at which echoes (targets)

⁴⁶At the time of the accident, however, only one of the transceivers at each of the remote sights could be operated at a time. A modification, known as Field Change No. 2, had been designed to enable both radars at a site to be operated simultaneously. However, this modification, intended for the Potato Point radar site, had not been installed because the electronic technicians at MSO Valdez did not know how to do so.

⁴⁷Carrier frequency is the frequency at which the radio-frequency energy is generated. The principal factors influencing the selection of carrier frequency are expected range of targets and weather conditions.

can be detected depend on the pulse length⁴⁸ and the pulse repetition rate (PRR)⁴⁹ selected by the VTC watchstander. The Raytheon VTS radar was designed to operate using the following pulse lengths and PRRs:

Table 5.--VTS radar characteristics.

<u>Range Scale</u>	<u>Pulse Length</u>	<u>Pulse Repetition Rate (PRR)</u>
3 miles or under	160 Nanoseconds	3600 Hz
6 and 12 miles	500 Nanoseconds	1800 Hz
24 miles or more	1,000 Nanoseconds	900 Hz

The longer the pulse length, the greater the range capabilities of the radar. For the shorter pulse lengths the range capability is less, but the higher PRR facilitates accurate radar tracking.

According to the Coast Guard project officer who supervised the installation of the Raytheon VTS radar, in order to ensure maximum performance of the VTS radar, the slave radar had to be set on a range scale that employed the same pulse length that was used by the master radar console. If a mismatch occurred, the slave radar would pick up only a portion of the returning echoes from the remote radar site and the radar presentation on the slave radar console would be degraded. A degraded radar presentation means that targets may not be detected and/or targets previously detected and tracked could be lost.

The 1600-2400 VTC watchstander stated that he often had to turn the gain control⁵⁰ on the VTS radar all the way up in order to maintain radar contact with vessels being monitored. He believed that the radar was not working properly on the day of the accident.

The Operations Officer also stated that, overall, he did not believe that the VTS radar was operating as well as it should have been. He said that when he first arrived in Valdez during the summer of 1987, the VTC

⁴⁸The pulse length, which is measured in microseconds (nanoseconds), is the transmission time of a single pulse of radio-frequency energy. The higher the range scale in use, the longer the pulse length. The lower the range scale becomes, the shorter the pulse length.

⁴⁹PRR is the number of pulses transmitted per second. Assuming sufficient power is available, the higher the range scale in use, the lower the PRR. On the other hand, the lower the range scale in use, the higher the PRR.

⁵⁰Gain control is the feature that controls the strength of the video and noise shown on the radar scope. With too little gain, some weak echoes are missed and there is a decrease in the range at which some targets can be detected. With excessive gain, additional echoes might not be seen because the difference between echoes and the background noise signals is reduced, making observation more difficult.

watchstanders were often able to view the top of Naked Island⁵¹ on the radar scope. He stated that during the past 2 years, however, he had observed a marked deterioration in the range performance of the radar. He believed that the age and condition of the microwave video link between the Potato Point remote radar site and the VTC might have been one reason that the VTC lost radar contact with the EXXON VALDEZ before it grounded.

According to testimony received from the VTC watchstanders, the performance of the VTS radar was affected by the wide variety of weather and sea conditions in Prince William Sound. Several traffic watchstanders indicated that weather fronts, accompanied by heavy precipitation and high winds, frequently swept through the VTS area, causing radar interference that interrupted radar surveillance. When this interference occurred, targets being tracked or monitored by radar were frequently lost and the system became temporarily disabled. The 1600-2400 VTC watchstander stated that weather and sea conditions within the radar surveillance area needed to be "ideal," i.e., clear weather, little wind, and calm seas, in order for the VTS radar to be capable of acquiring and tracking vessels transiting the Valdez Arm south of Busby Island. (The VTC, at the Safety Board's request, plotted all outbound tankships during April 1989 and found that 53 of 71 transits, or about 74.6 percent, could be monitored on radar out to 13 miles or more.

The VTC and the communications center were linked to seven remote communication sites located throughout Prince William Sound: Potato Point, Naked Island, Naked Island Tertiary, two at Cordova, Point Peugeot, and Cape Hinchinbrook. (See figure 11.) There was an additional HF-SSB site at Cape Yakataga outside Prince William Sound that was used in the event that the Cape Hinchinbrook remote site became inoperative. According to the VTS Users Manual, VHF-FM Channel 13 (156.65 MHz), the bridge-to-bridge navigation safety frequency, was designated as the radiotelephone frequency for the entire VTS area. The VTC maintained a continuous guard on Channel 13 and used this frequency to transmit and receive vessel movement data and other marine safety information.

On the day of the accident, the remote communication sites at Naked Island⁵² and Cape Hinchinbrook were inoperative. According to the Coast Guard, the Naked Island site was inoperative.

⁵¹Naked Island is about 29 miles south-southwest of the Potato Point remote radar site.

⁵²The Naked Island site was used by VTC watchstanders to establish VHF-FM radiotelephone (primarily VHF-FM Channel 13-16) communications with inbound vessels approaching Cape Hinchinbrook and with vessels transiting that part of Prince William Sound south of Naked Island (particularly those tankships proceeding to and from the Knowles head anchorage area).

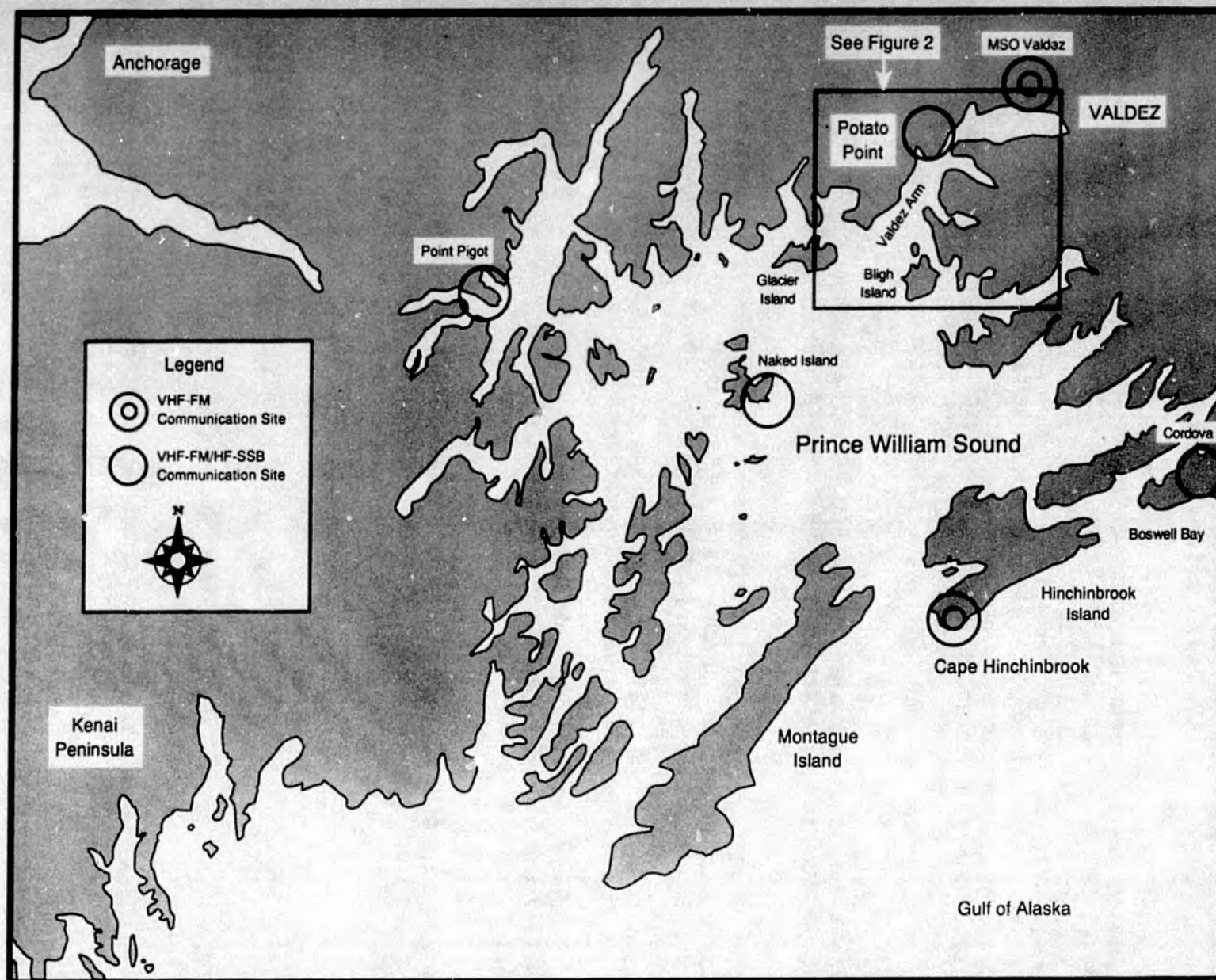


Figure 11.--Communication sites.

According to the 1600-2400 VTC watchstander, because the Naked Island site was inoperative during the evening of March 23, the VTC had difficulty establishing VHF-FM communications between the VTC and vessels south of Naked Island. To maintain communication with those vessels, VHF-FM traffic was rerouted via a remote communication site near Cordova. When the Naked Island site was inoperative, there was no communication link to Cape Hinchinbrook, which meant the loss of the Cape Hinchinbrook communication site. The loss of the Cape Hinchinbrook site forced the VTC to reroute HF-SSB communications between the VTC and vessels en route to Prince William Sound through the Cape Yakataga (HF-SSB) remote communication site.

According to the Coast Guard, during the first and second quarters of FY 1989, the Cape Hinchinbrook remote communication site was inoperative an average of 28.5 percent of the time and during the third quarter, the site was inoperative 6 percent of the time. In addition, during the second and third quarters of (FY 89) the Naked Island remote communication site was inoperative 11 percent of the time.

The CO, Operations Officer, the six VTC watchstanders, and the two Electronics Technicians assigned to MSO Valdez stated that they were generally dissatisfied with the way the VTS communication system performed. According to the Operations Officer, there were four recurring problems that frequently interrupted or interfered with radio communications with vessels transiting Prince William Sound: (1) Many buttons on the two communication consoles (original equipment installed in 1977) in the VTC that were used to switch VHF-FM radiotelephone frequencies often failed to function properly; (2) Radio interference caused by "bleedover"⁵³ frequently occurred; (3) VTS communications were interrupted owing to excessive radio noise in the VTC; and (4) VTS communications were interrupted by echoes created when VHF-FM radio sites utilizing landline/satellite relays were used.

Several VTC watchstanders complained that VHF-FM communications were frequently interrupted because the noise level within the VTC was excessive. When the VTC was established in 1977, the VTC radio and radar consoles were located in different areas. However, during the ensuing years, the VTC radar and radio watchstanding stations were combined at one site. As a result, a significant percentage of non-VTS radio traffic was overheard by the VTC radar watchstander, who was trying to concentrate on his duties on the other side of the room.

Both the CO and the Operations Officer of MSO Valdez stated that the Commander, Seventeenth Coast Guard District, was aware of the problems they were having operating and maintaining the communication equipment in Prince William Sound. In 1985, the CO submitted a planning proposal to Coast Guard headquarters requesting that the communication system in Prince William Sound be updated. According to the VTS Microwave and Communications Upgrade and Planning Proposal (PP #17-012-85) submitted by the MSO Valdez to the Commander, Seventeenth Coast Guard District, on December 3, 1985, "due to

⁵³Bleedover occurs when one radio channel or frequency is heard on another radio channel.

obsolescence and increasing difficulty in obtaining parts support, system reliability and performance are expected to begin deteriorating at the end of the current life cycle." In addition, the proposal stated that "pushing the communications and microwave network equipment beyond FY 89 without replacement is projected to result in degradation of reliability and on-air time."

In a letter dated December 6, 1988, to the Commander, Maintenance and Logistics Command Pacific (MLCPAC), the CO of MSO Valdez requested information regarding the status of the project (PP #17-012-85) to upgrade the communications system in Valdez. The MSO was subsequently notified⁵⁴ that as of February 13, 1989, "There is no project plan, or funds established for your upgrade at MLCPAC or COMDT."⁵⁵

The VTS communication system was maintained by an outside contractor, who was responsible for the maintenance of all electronic communication equipment maintenance for the Coast Guard's Seventeenth District. According to the Specific Operating Requirements, the communication system was required to maintain a 99.9-percent system availability.⁵⁶ Testimony and written statements by the CO, Operations Officer, and electronics technicians assigned to MSO Valdez indicated that over the past few years, the communication system in Prince William Sound had been plagued with numerous equipment failures. According to the Operations Officer, the equipment failures occurred for various reasons, including weather, aging equipment, and poor contractor performance.

According to the Operations Officer, the age of many of the components that comprised the communication system made it difficult for MSO Valdez to obtain necessary parts support.⁵⁷ He said that in some cases, it had taken several months to obtain necessary spare parts.⁵⁸

⁵⁴Letter from Commander, Coast Guard MLCPAC, to the CO, Coast Guard MSO Valdez, dated February 13, 1989.

⁵⁵Coast Guard headquarters (Office of Command, Control, and Communications)

⁵⁶System availability is defined as the "on-air" availability of all equipment in the system less scheduled preventative maintenance periods, the time between detection of the failure at the VTC and the Coast Guard's notification of the contractor, and the time allotted for the contractor to respond.

⁵⁷According to the Microwave & Communications Upgrade (PP# 17-012-85), the communication system had a 10-year expected life cycle.

⁵⁸According to the Operations Officer, in order to replace the oscillator for one of the microwave paths, for example, a replacement oscillator had to be custom-made because a ready-made replacement was not available. According to the Operations Officer, this component, which is a vital part of the microwave system was last manufactured about 10 years earlier. The component took about 5 months to replace.

The Operations Officer stated that he was generally dissatisfied with the performance of the contractor. He further stated that service representatives were not always available when part of the system became inoperative and as a result, repairs were not always made in a timely manner. He also complained of sloppy workmanship, such as the prevalence of jumper wires and loose circuit boards in the radio equipment. The senior ET stationed at MSO Valdez stated that the slow response time of the contractors was one of his biggest system maintenance problems.

The former Chief, Command, Control, and Communications Division, for the Coast Guard's Seventeenth District, stated that the communications maintenance contract contained a clause that was designed to penalize the contractor for failure to perform according to the terms of the contract. He stated that during the time he administered the contract for the Coast Guard, the contractor had been penalized under the terms of this clause on several occasions.

The microwave system installed in Prince William Sound performed the following functions:

- (1) It provided the necessary microwave paths linking each of the remote communication sites and the VTC;
- (2) It provided the microwave paths that enabled the VTC watchstander to control the radar transceivers located at the Valdez Spit and Potato Point; and
- (3) It provided the necessary microwave paths that permitted the transmission of returning target echoes from the remote radar sites to the radar consoles installed in the VTC.

In maintaining radar surveillance of vessel maneuvers, the VTC watchstander either monitors or plots each vessel, depending upon the vessel's location. The term "monitoring" means that the VTC watchstander is visually watching the progress of targets through the radar surveillance area. The latest edition of the Prince William Sound VTC Manual (November 1988) does not define what is meant by "monitoring," nor does the manual require that vessels participating in the system, except those participating vessels that are transiting the Narrows, be monitored by the VTC. According to statements made by the CO, Operations Officer, Assistant Operations Officer, and Senior Watchstander, despite the lack of written instructions, all VTC watchstanders were supposed to monitor the movement of all vessels under radar surveillance to the maximum range of the radar.

When the Prince William Sound VTS was established in 1977, the term "plotting" meant that the VTC watchstander was required to obtain the range and bearing of all vessels transiting the part of the system under radar surveillance (between Port Valdez and Bligh Reef) and manually plot the position of the vessel on a chart. The manual plotting of vessels was the only way that the VTC traffic watchstander could determine a vessel's true course, speed, and location, and verify that vessels transiting the VTS radar coverage area adhered to all VTS regulations during the transit.

In 1984, the Raytheon VTS radar was installed in Valdez. The Raytheon radar had a number of labor-saving features, such as automatic tracking⁵⁹ of up to 20 targets simultaneously. According to the CO of MSO Valdez, plotting the location of vessels that were participating in the system on charts was discontinued in 1984 when the Raytheon VTS radar was installed. Instead of plotting, vessel positions were recorded on data sheets. The CO stated that the new recording procedures permitted the VTC watchstander to recreate the path of a vessel at a later date, should the need arise. However, this change in procedures was not reflected in the August 6, 1986, edition of the Prince William Sound VTC Manual:

(Section 4.2.5.) Participating vessels within the area of radar coverage shall be plotted. The reported position of a vessel entering the radar coverage area shall be correlated with the contact observed on radar.

(Section 4.2.6) All participating vessels (including voluntary participants) will be plotted while in the radar coverage area.

Normally the intervals of fixes shall be every three minutes between Tongue Point and Entrance Island [Valdez Narrows] and every six minutes in all other areas.

Each fix will be plotted on the plotting sheets provided at the time the fix is taken.

On August 31, 1987, a memorandum issued by the Senior Watchstander to all VTC watchstanders initiated a change in the recording requirements.⁶⁰ According to the memo:

You no longer need to plot the vessels from the 15-mile mark (point located about .5 NM past Bligh Reef) southwest of Potato Point. Plots are required as follows: commence plot three marks prior to the vessel's entry into the Narrows, then until the vessel passes either Entrance Island (inbound), and Tongue Point (outbound). [In the foregoing, the word "plot" means a written record of vessel bearings and ranges from the Potato Point radar site.]

⁵⁹Automatic tracking refers to electronic monitoring of a vessel's progress through the radar coverage area. The term "tracking" evolved when the latest generation of radars was developed that was capable of acquiring and processing information from numerous targets. A radar that is tracking a target has information such as the vessel's range and bearing, true course and speed, and target history continuously updated for immediate access by the operator.

⁶⁰The memo was issued by the Watchstander Supervisor pursuant to guidance from the Assistant Operations Officer with the full knowledge and consent of the Operations Officer.

As a result of the memo, the VTC watchstanders were required to record the positions of only those vessels transiting the Valdez Narrows.

According to the Operations Officer, the August 1987 memo was issued because the dramatic increase in fishing vessel and cruise ship traffic during the summer months was placing excessive monitoring and recording burdens on the VTC watchstanders.

According to the Assistant Operations Officer, the August 31, 1987, memo required that VTC watchstanders record target data (i.e., target range, bearing, and time of observation) of all vessels transiting the Narrows. All other vessels under radar surveillance were still supposed to be monitored even though their positions were no longer required to be plotted. He also stated that the memo was not intended to relax the requirement to monitor the movement of all vessels under radar surveillance. When queried about the meaning of the new plotting requirements and the effect(s) that the new policy would have on VTS operations, he stated:

We no longer, after this date (referring to the memo dated August 31, 1987), we no longer marked the bearing and range of the vessel and recorded it. But the watchstanders were still told to watch the target.

During March 1988, the Raytheon data logger was installed in the VTS. Shortly thereafter, the recording procedures for participating vessels were formally incorporated into the latest edition of the Prince William Sound VTC Manual (November 2, 1988), which states:

(Section 4.2.6.) Participating vessels shall be plotted with the Raytheon data logger from a position one nautical mile prior to entering the Valdez Narrows and until the vessel has departed the One-Way Zone.

Plotting intervals outside of the Valdez Narrows shall be six minutes. Slow vessels may be plotted at ten minute intervals.

(Section 4.2.6.d.) With the addition of the Raytheon data logger, watchstanders are now available to devote additional time to vessel communications, telephone calls, and other matters.

The VTC Manual provides the VTC watchstander with specific guidance to be followed when monitoring the movement of participating vessels:

(Section 4.3.3.e.) The VTC may, on request, issue an authorization to deviate from the TSS rules on a "one-time" basis. Except for minor deviations not involving other traffic, the VTC shall refer all such requests to the Commanding Officer as per his standing orders. Deviations shall not be authorized for major vessel traffic except in unusual circumstances, and shall not be authorized strictly for convenience of the vessel (i.e. saving time, fuel economy, etc.) at any time.

(Section 4.3.3.f.) In an emergency, any vessel may deviate from the VTS rule to the extent necessary to avoid endangering persons, property, or the environment. The master or pilot must report the deviation to the VTC as soon as possible.

The VTS User Manual states:

A radio equipped vessel may join, cross, or leave a traffic lane only after the VTC has been notified of the point at which the vessel will join, cross, or leave the traffic lane.

The CO of MSO Valdez stated:

If a participating vessel intends to, and does, cross out of the traffic lanes completely (either east or west) the watchstander should contact the vessel and inquire into the vessel's intentions. If the vessel knows its position, and is maneuvering, no further radio contact is required but a vigilant radar watch of the vessel shall be performed. Nothing in the regulations prohibit a vessel from exiting the traffic lanes, however it must notify the VTS of its intentions.

He further stated:

- (1) The EXXON VALDEZ should never have deviated from the TSS where it did because it was not safe to do so;
- (2) There is no good reason for a vessel to deviate from the TSS;
- (3) A vessel requesting a deviation is requesting something out of the norm;
- (4) VTC traffic watchstanders do not have the authority to allow vessels to leave the traffic lanes north of Bligh Reef;
- (5) A vessel should call the VTC whenever it crosses a boundary line;
- (6) It is the responsibility of the watchstanders to identify those vessels that are deviating from the TSS; and,
- (7) When a VTC watchstander discovers that a vessel has departed the TSS, he should contact the vessel, inquire about its intentions, and tell the vessel that it does not belong outside the TSS because there is not enough room there.

According to the CO of MSO Valdez, a request from a tankship to deviate from the TSS (except those tankships proceeding to and from Knowles Head anchorage) must be forwarded to the OOD, who would then forward the request to either the CO or the XO for reply. The OOD on duty during the evening of March 23 stated that he departed the station about 2230⁶¹ and that he was not notified that the EXXON VALDEZ was deviating out of the southbound lane because of ice. He was, however, cognizant of other vessels deviating because of ice earlier in the day.

When the OOD was not available, the VTC watchstander was permitted to contact the CO or the XO directly for permission to allow vessels to deviate from the TSS. When the EXXON VALDEZ began its transit of the Valdez Arm on the day of the accident, neither the CO nor the XO was at the VTC and neither was aware that the master of the EXXON VALDEZ had notified the VTC that he intended to depart from the TSS. The Operations Officer stated that VTC watchstanders were authorized to grant permission to vessels seeking to deviate from one traffic lane to another without notifying the OOD or the CO. He also stated that he considered the deviation from one traffic lane into another a minor deviation.

The Assistant Operations Officer stated that the master of a vessel encountering ice in the traffic lanes had the option of maneuvering around the ice for safety reasons and that the master might depart from the TSS during such a maneuver. He also said that before the accident he was not aware that vessels were deviating from the TSS.

The 1600-2400 VTC watchstander stated that a vessel was permitted to depart from the TSS to provide a lee for the pilot when a vessel was proceeding to and from the Knowles Head anchorage and when small tankships with a State pilot aboard were given permission to exit Prince William Sound via Montague Strait. He also stated that most of the masters aboard outbound tankships were accustomed to deviating from the southbound traffic lane into the northbound traffic lane and that they normally headed toward a stretch of clear water near Bligh Reef buoy that was usually ice-free. The watchstander also stated that he could not recall ever having observed any vessel actually leave the TSS because the VTC generally lost radar contact with outbound tankships in the vicinity of Busby Island.

The 0000-0800 VTC watchstander stated that he was aware that vessels sometimes deviated from the TSS because of the presence of ice in the traffic lanes. He said that such deviations occurred at the discretion of the master. He stated that vessels generally reported to the VTC if they departed their traffic lane and crossed the separation zone boundaries. He went on to say that:

If a vessel requests permission to leave the lanes entirely or there exists opposing traffic, he would monitor closely on radar if conditions permit.

⁶¹When departing the station for any reason, the OOD is required to notify the VTC of his absence and to have a functioning radio and/or pager in his possession.

A vessel intending to leave their lane with conflicting traffic in the area would be advised by the VTC not to do so until the traffic had cleared.

Two other VTC watchstanders said that on several occasions they were either aware of or had given permission to vessels to deviate from the TSS because of the presence of ice in the traffic lanes. They also stated that because the ice often extended all the way across the lanes toward the vicinity of Bligh Reef buoy, vessels deviating from the TSS were frequently forced to pass close to Bligh Reef buoy.

Personnel changes have led to changes in supervision of the VTC. When the VTS was first established, there were five VTS watch supervisors, consisting of five lieutenants who performed OOD duties for MSO Valdez. As part of these duties, the watch supervisor stood a VTC watch along with two radarmen (RDs). In 1978, a Chief Warrant Officer (CW04) billet was added to the VTC. One of the lieutenants was then replaced on the watch rotation by the CW04, and the lieutenant was assigned to non-VTS duties of the MSO Valdez. According to the 0000-to-0800 VTC watchstander involved in this accident, the watch supervisors were required to be qualified as Deck Watch Officers⁶² before the billet reduction.

During 1982, MSO Valdez was reorganized and four of the five watch supervisors were made department heads and were tasked with additional MSO duties and responsibilities that had little to do with the day-to-day operation of the VTS. According to the CO, this was an effort to provide these individuals with additional challenges, as well as the opportunity to exercise leadership. He also stated that exclusive use of these officers to stand 12-hour VTC watches was not, in his opinion, an efficient use of their talents.

In a letter to the Commandant dated August 1, 1986, the CO of MSO Valdez proposed that MSO Valdez be downgraded to a Marine Safety Detachment under the authority of MSO Anchorage and that the VTS become a separate command under the control and supervision of the Program Officer on the Seventeenth Coast Guard District staff. The primary motivation for the proposal was to reduce the number of billets assigned to support roles, i.e., public works and personnel services, etc. The proposal also called for the elimination of five VTS officer watchstander billets and their replacement with two lieutenant (junior grade) billets. According to the CO, "As I see it, the present structure of 5 watch officers (4 lieutenants and 1 CW04) is a waste of officer talent and billets." The proposal was approved by CGD17 and forwarded to Commander, Pacific Area, who endorsed the letter and forwarded it to Commandant (G-CMA) for consideration on January 13, 1989.

⁶²A qualified Deck Watch Officer is an individual who has been certified to stand a bridge navigation watch aboard commissioned vessels of the Coast Guard.

In a memorandum issued by the Operations Officer dated August 7, 1987, the MSO/VTS OOD watches were discontinued and replaced by a Command Duty Officer (CDO) duty section. This new section consisted of the Marine Safety Department head, the Operations Officer, the Assistant Operations Officer, the Public Works Department head, and the Personnel Services head (later changed to Administration Department). The CDO, unlike the MSO/VTS OOD, was no longer required to be in the VTC during routine vessel transits of the Valdez Narrows. CDOs were, however, required to be in the VTC whenever any conflicts in the one-way zone or other serious traffic problems existed. There was no specific guidance specifying what type of conflict or serious problem traffic must exist before his presence was required.

On February 23, 1988, the Coast Guard announced plans to reduce VTS staffing at MSO Valdez by seven billets. MSO Valdez later counterproposed the elimination of five VTS billets and two MSO billets. The Personnel Allowance Amendment dated March 3, 1988, indicates that five VTS billets, including three lieutenants, a third class boatswain mate and a third class RD were eliminated.

The loss of five VTS billets forced the CO to reorganize MSO Valdez. The Operations Officer was assigned a number of duties and responsibilities unrelated to the VTS, including Maritime Defense Zone (MDZ) contingency planner, Classified Materials Custodian (COMSEC), Unit Training Officer, and Claims Investigating Officer. The lieutenant, who previously acted as head of the Communications Division,⁶³ no longer participated in day-to-day VTS activities. The Assistant Operations Officer, who had been in charge of day-to-day supervision of the VTC traffic watchstanders, stated that because of his additional duties, he was able to devote about 5 hours a week to the VTS program. As a result, the Senior Watchstander, by default, assumed responsibility for supervision of the day-to-day operation of the VTS. When he did so, he became responsible for monitoring the performance of the five VTC watchstanders (three civilians with previous Coast Guard military experience and two enlisted Coast Guard personnel) and five enlisted radio watchstanders assigned to the communication center. The Senior Watchstander worked days and also stood VTC watches when watchstanders called in sick, took annual leave, or were otherwise unavailable.

In a memorandum dated May 16, 1988, the CO stated that because of a reduction in personnel at the unit, the CDO and OOD duty sections would be merged. The resulting watch was called the OOD. On weekdays, OODs stood watch between 0900-2230. On weekends, they stood watches between 0900-2400. They were required to carry a beeper/radio and were required to check in with the VTC before leaving the station building. The OOD acted to a large extent in a security capacity. According to the VTC Manual, one of the OOD's responsibilities was to ensure that the performance of the watch in the VTC was in accordance with all applicable instructions. Thus, the security

⁶³As head of the VTS Division, his responsibilities included supervising the VTC traffic Watchstanders to ensure that they followed all Coast Guard Rules and regulations and local VTS policies on a day-to-day basis.

duties of the OOD were expanded to include some supervision of VTC operations. In addition, the VTC Manual stated that OODs were to be informed when hazardous circumstances existed or were anticipated anywhere in the VTC area. According to the VTC Manual, the OOD was to:

monitor the performance of the radar/VTC watchstander and the communications watchstander. When necessary, he shall personally take charge of vessel communications.

check all display, communications, and other equipment for proper operation. If not operating properly, insure that the Commanding Officer has been notified.

On the day of the accident, only one of the OODs was qualified as a VTC traffic watchstander.

Pilotage Information.--The Trans-Alaska Pipeline Authorization Act,⁶⁴ which enabled the pipeline to be built, specified that any domestically produced crude oil transported by the pipeline was for domestic consumption and that the North Slope crude oil "should be equitably shared, directly or indirectly, by all regions of the country." This meant that the crude oil would be transported to U.S. refineries. A provision of the Jones Act pertaining to the transportation of cargo (cabotage) from one port in the United States or its possessions to another port in the United States or its possessions requires that such cargo must be transported by U.S. flag vessels. The significant exception to the cabotage requirements of the Jones Act permits cargo between the U.S. Virgin Islands and other U.S. ports to be carried by foreign flag vessels.

Federal law (46 USC 8502) also requires that coastwise seagoing vessels (domestic vessels) be under the direction and control of a Federally licensed pilot while transiting U.S. pilotage waters, which include waters inside the 3-mile territorial seas, such as coastal waters, bays, inlets, rivers, harbors, and ports of the United States, its territories and possessions. Therefore, domestic tankships calling at Port Valdez are required to be under the direction and control of a Federally licensed pilot while transiting Prince William Sound. A Federally licensed pilot may be an officer on the vessel who has acquired a Federal pilot's endorsement on his license from the Coast Guard for the particular waterway. To obtain a Federal pilot's license for Prince William Sound, a licensed deck officer must complete 20 roundtrips over the waterway and pass an examination administered by the Coast Guard.

Prior to the commencement of crude oil shipments from Port Valdez,⁶⁵ several U.S. oil companies cooperated to provide a tankship for pilotage training of their masters and prospective masters. These mariners rode the

⁶⁴Public Law 93-153.

⁶⁵The first shipment of North Slope crude oil left Port Valdez on August 1, 1977, on board the U.S. Tankship ARCO JUNEAU.

vessel for a number of trips over the route that they would follow from the entrance to Prince William Sound at Cape Hinchinbrook to the vicinity of the Alyeska Terminal in Port Valdez so that they could become familiar with the waterway and acquire the requisite number of transits to qualify for a Federal pilotage endorsement on their licenses. The initial plan of the U.S. oil companies was that their masters, once they obtained the required Federal pilotage, would pilot their own vessels through Prince William Sound and into Port Valdez to the vicinity of the Alyeska Terminal. Upon arriving off the piers of the terminal, each vessel would be met by tugs and be boarded by a docking master, who would then conduct the docking, or berthing, of the vessel. The undocking of each vessel was also to be conducted by a docking master.

About this same time, State-licensed pilots of the Southwest Alaska Pilots Association also were seeking a means to participate in piloting the tank vessels that would be calling at Port Valdez. As a result of lobbying efforts, the State pilots succeeded in obtaining passage of an Alaska State law⁶⁶ requiring tankships of 50,000 or more deadweight tons, when navigating State waters, either to:

1. Employ a pilot licensed by the State; or
2. A Federally licensed pilot whose duty station had been on that tank vessel throughout that particular voyage.

The law also required that control of the vessel during all docking operations be conducted by either the State or the Federal pilot referred to in the law, thereby excluding the use of docking masters. To facilitate the commencement of oil shipments from Port Valdez, the U.S. oil and tank vessel companies chose to accept State-licensed pilots for vessel movements between Cape Hinchinbrook and the Alyeska Terminal and for docking and undocking their vessels at the terminal. The State-licensed pilots also possessed Federal licenses for Prince William Sound and Port Valdez and thus met the Coast Guard requirements for Federal pilotage on U.S. vessels.

The Southwest Alaska Pilots Association established a state pilot station at Cape Hinchinbrook in 1977 using a converted fishing vessel, the BLUE MOON, and commenced providing pilotage for all tank vessels engaged in carrying Alaska North Slope crude oil. High winds and heavy sea conditions, particularly in the winter, frequently made it difficult to keep the BLUE MOON on station and dangerous to embark and disembark pilots. On January 7, 1980, the BLUE MOON foundered during heavy weather, leaving the pilots with no means to board vessels at Cape Hinchinbrook. The State pilot station was then moved to the vicinity of Rocky Point in Valdez Arm. The State of Alaska Board of Marine Pilots subsequently decided not to reestablish the pilot station at Cape Hinchinbrook, and the Board eliminated the State requirement for pilotage between Cape Hinchinbrook and the pilot station at Rocky Point.

⁶⁶State of Alaska Statutes Sec. 08.62.185.

The requirements for Federal pilotage remained in effect, but there was no means for a pilot to board a transiting tankship following the sinking of the BLUE MOON. The lack of a pilot station at Cape Hinchinbrook had little effect on most U.S. tankships calling at Port Valdez because most U.S. masters held the necessary Federal pilotage endorsement. However, foreign flag tankships, which had started carrying Alaska crude oil from Port Valdez to an American refinery in St. Croix, U.S. Virgin Islands, and a few U.S. tankships whose officers did not hold Federal pilotage were directly affected because they depended on the pilot station at Cape Hinchinbrook for pilotage to navigate Prince William Sound.

To accommodate foreign flag tank vessels and those U.S. vessels whose licensed deck officers did not have Federal pilotage endorsements for Prince William Sound, the Coast Guard COTP for Port Valdez established a set of requirements that were intended to enhance navigation safety for such vessels while navigating Prince William Sound and to help compensate for the lack of a pilot on board. The requirements were promulgated as OTP Order 1-80 on February 25, 1980. (See appendix I.) The order required compliance with the following:

1. Status of all machinery, personnel, charts, publications and navigation equipment required by 33 CFR 164 will be reported.
2. Based on satisfactory condition, entry of the vessel into Prince William Sound will be permitted, provided transit to or from the pilot station can be completed during daylight hours and during a period of predictably good visibility.
3. A licensed officer, in addition to the licensed officer on watch, will be employed as a navigator to continuously plot the position of the vessel during the transit of Hinchinbrook Entrance and Prince William Sound. This position will be reported on request to Valdez VTC.
4. The Valdez Port Pilot will board or depart the vessel at the entrance to Valdez Arm off Bligh Reef in lieu of the established pilot station at Busby Island.
5. Transit to the anchorage area off Knowles Head during other than emergency conditions will be evaluated on a case basis, taking into account weather, vessel traffic, and operating conditions.
6. An English-speaking officer will be on watch during the entire Prince William Sound Transit period.

The COTP or the duty officer, based on the vessel's reported condition, time of day, and reported visibility, determined whether the vessel would be permitted to transit Prince William Sound.

The requirement in COTP Order 1-80 that vessels without Federal pilots (nonpilotage vessels) transit Prince William Sound only during daylight resulted in vessel delays, numerous complaints to the Coast Guard from vessel operators, and requests for relaxation of the daytime requirement. A review of Coast Guard files revealed that the need for Federal pilotage in Prince William Sound was being evaluated as early as the implementation of COTP Order 1-80, which stated that proposed rulemaking to revise or rescind the pilotage requirement already was under consideration. Other internal memoranda indicated that cancellation of COTP Order 1-80 as an alternative was considered by the Coast Guard soon after its implementation. Other COTP orders augmented COTP Order 1-80 from time to time, but it was this order that was ultimately rescinded by the COTP.

In 1986, the COTP cancelled COTP Order 1-80, except for the provision that the requirements of the checkoff list were to be incorporated into VTS procedures; hence, the requirements for an English-speaking officer on the bridge, an additional officer on the bridge for navigation, frequent fixing of the vessel's position, and obtaining vessel information from each nonpilotage vessel would continue in effect. The CO's decision was explained in a memorandum dated September 3, 1986, directed to all OODs and VTC watchstanders. The requirement for daylight transits by nonpilotage vessels was eliminated. The primary factor for determining whether a nonpilotage vessel would be granted permission to transit Prince William Sound would be a requirement that visibility be 2 miles or greater. If visibility was less than 2 miles, nonpilotage vessels normally would not be allowed to transit Prince William Sound. However, consideration would be given to a vessel's need to enter Prince William Sound for safety reasons.

Although COTP Order 1-80 and other Coast Guard correspondence mentioned the possibility of rulemaking as a means of eliminating the requirement for Federal pilotage in Prince William Sound, this was not a feasible solution at the time because the Coast Guard lacked legal authority to change the designation of pilotage waters to nonpilotage status. Public Law 98-557, sponsored by the Alaska Congressional delegation, amended the Federal Pilotage law at 46 U.S.C. 8502 by adding that the "Secretary [of Transportation] shall designate by regulation the areas of the approaches to and waters of Prince William Sound, Alaska, on which a vessel subject to this section is not required to be under the direction and control of a [Federal] pilot."

Following passage of Public Law 98-557, the first proposed regulatory change to reduce the requirement for Federal pilotage in Prince William Sound was published by the Coast Guard in the Federal Register on June 24, 1985. This rulemaking effort would have eliminated the requirement for Federal pilotage in Prince William Sound between the entrance at Cape Hinchinbrook and Rocky Point in Valdez Arm. After a review of comments on the proposed change, the Coast Guard, on June 6, 1988, published a supplemental notice of proposed rulemaking, which, like the June 24, 1985, proposed rules, addressed a number of pilotage issues in addition to reduced pilotage requirements in Prince William Sound. The section of the 1988 supplemental notice regarding pilotage in Prince William Sound was worded

differently from the 1985 proposed rules as a result of written comments received by the Coast Guard; however, it was still very similar in substance to the 1985 proposal. The pertinent part of the 1988 supplemental notice of proposed rulemaking is quoted below:

- (1) Vessels are excluded from pilotage requirements when entering or departing Prince William Sound, Alaska, via Hinchinbrook Entrance and
 - (a) Proceeding directly to and from the established Valdez/Whittier pilot station at Rocky Point (Latitude 60°57.1'N, Longitude 146°46.0'W), or
 - (b) Proceeding to ...Cordova ..., [or]
 - (c) Proceeding directly to or from a designated anchorage described in 33 CFR 110.⁶⁷

The Coast Guard received no significant adverse comment on that part of the 1988 supplemental notice pertaining to Prince William Sound pilotage. However, considerable comment was received on other pilotage issues contained in the notice, and the need for the Coast Guard to address those comments delayed implementation of the entire package of pilotage regulations. Following the grounding of the EXXON VALDEZ, the Coast Guard withdrew the proposed pilotage changes for Prince William Sound for further review.

On April 12, 1989, the Alaska Board of Marine Pilots relocated the pilot station for Port Valdez from Rocky Point to a location of latitude 60° 49' N, longitude 147° 01' W so that pilots would embark and disembark south of Bligh Reef. The pilot station at this location ensures that there will be a pilot on board throughout the length of Valdez Arm.

Alternative Tankship Designs.--On June 1, 1989, the chief of the U.S. Coast Guard's Office of Marine Safety, Security, and Environmental Protection requested the assistance of the National Academy of Science to investigate methods of minimizing accidental pollution from tankships. The task was assigned to the Marine Board's Committee on Tank Vessel Design. The "Statement of Task" as outlined by the Coast Guard was as follows:

The committee will review the safety, economic, and environmental implications of alternative oceangoing tank vessel designs and make recommendations. It will update what is known about tank vessel accidents and the effectiveness of alternative tank vessel designs in preventing accidental oil pollution; assess technical concerns about alternative tank vessel designs; identify

⁶⁷This includes Knowles Head Anchorage, which is described at 33 CFR 110.233.

needed research; and elucidate the safety, environmental, and economic costs and benefits of alternative tank vessel designs. The committee will focus its assessment on tanker vessels 10,000 deadweight tons (DWT) and larger.

The committee will use a series of meetings to collect and analyze data; identify and assess alternative tank vessel designs and their implications; formulate recommendations; and ensure access to the widest possible range of perspectives on the issues. In its final report, the committee will identify how alternative tank vessel designs might affect the overall consequences of tank vessel accidents.

The Coast Guard will use the technical information, analysis and recommendations of the Academy in its deliberations concerning whether to establish new or alternative tank vessel design requirements as one measure to improve maritime safety and marine environmental protection. The results of the study will also be of interest to the U.S. Congress, the domestic and international marine transportation industry, the International Maritime Organization, environmental protection organizations, and States and communities along tank vessel routes.

This study will be completed within 15 months of its initiation. Funds for this project are being provided by the U.S. Coast Guard.

The Safety Board was informed by the Marine Board that they were reviewing two generic groupings of alternative tankship designs: (1) prevention of penetration of the cargo oil containment barrier and (2) prevention or restriction of oil outflow after penetration. Some of the alternative oceangoing tank vessel designs under review were:

- 1 Double bottom
2. Double sides
3. Double hull (double bottom and sides)
4. Use of high tensile steel in the hull
5. Relocation of protectively located ballast tanks
6. Cargo tank internal membranes
7. Interior/exterior honeycomb bumpers
8. Collapsible bow (crashworthiness)

9. Subdividing the cargo tanks horizontally, vertically, or both ways
10. Rapid pumping of cargo from a damaged tank to an empty (ballast) tank
11. Elevating the cargo/ballast piping above the tank bottom for protection of the piping systems
12. Creating a vacuum in the cargo tank, including the rapid, automatic closure of deck openings and valves
13. Octagonal-shaped tanks
14. Damage control (patches)
15. Pressure loading, i.e., cargo loading levels limited to height that equalizes the internal pressure (head + I. G. pressure) in the tank with the exterior hydrostatic pressure at the planned draft of the vessel.

Pressure loading was one option that could be adopted without any change to a vessel. The Safety Board calculated the approximate amount of cargo the EXXON VALDEZ would have been able to carry if it had been pressure loaded for a planned draft of 56 feet (draft restrictions owing to water depth at the port of Long Beach).

For the purpose of these calculations the tankship was assumed to be hard aground on an even keel in a static condition without adverse environmental influences and with the inert gas system activated. Ullages used were those recorded prior to vessel departure from Valdez and after the tankship had grounded on Bligh Reef. Because of draft restrictions, cargo was loaded to bring the vessel to a draft of about 56 feet, and cargo tanks were filled, on average, to about 84 percent capacity.

At the time the EXXON VALDEZ departed from the terminal at Valdez, Alaska, the average internal pressure at the bottom of the cargo oil tanks was calculated to be about 28 psi and the external hydrostatic pressure was about 24 psi with a draft of about 56 feet. Based on the assumptions and calculations performed by the Safety Board, the EXXON VALDEZ would have spilled about 170,000 barrels had it been loaded to 84 percent of capacity. However, ullage readings indicated that the amount actually spilled by about 0900 was about 225,000 barrels. (See tables 1 and 2 on page 27.) The difference in the calculated versus actual oil outflow could be owing to several factors such as vessel ahead motion, vessel listing, loss of cargo containment because of extensive damage, tides, and currents.

If the cargo tanks were loaded to about 98 percent capacity (1,484,829 barrels), with a corresponding draft of 63.5 feet, the internal tank pressure would have been about 34 psi and the external hydrostatic pressure would have been approximately 28 psi. In this condition of loading, the EXXON VALDEZ would have spilled about 329,000 barrels owing to the increased internal tank pressure.

By loading the tankship using the pressure loading method, the EXXON VALDEZ cargo tanks could have been filled to about 70 percent capacity (about 1,060,000 barrels). Then the internal and external pressure would have been equalized at about 24 psi and theoretically, no oil would have been spilled. The EXXON VALDEZ would have carried about 230,000 barrels less cargo if pressure loading had been the method used.

Tank Arrangement Requirements Applicable to the EXXON VALDEZ.--The 1973 International Convention for the Prevention of Pollution from Ships, commonly referred to as MARPOL '73, established regulations that govern the design and arrangement of cargo tanks aboard tank vessels. These regulations require that cargo tanks be sized and arranged to limit the accidental outflow of oil (including crude oil, fuel oil, sludge, and other petroleum products) to 30,000 cubic meters (1,059,440 cubic feet/188,693 barrels) or 400 times the cube root of the vessel's deadweight,⁶⁸ whichever is greater, assuming the number does not exceed 40,000 cubic meters (1,412,590 cubic feet/251,571 barrels). In addition, MARPOL '73 regulations limit the volumetric capacity of cargo tanks. A wing cargo tank is limited to 75 percent of the hypothetical oil outflow, and a center cargo tank is limited to a capacity of 50,000 cubic meters (1,765,730 cubic feet/314,464 barrels).

In 1978, a protocol to MARPOL '73 introduced the concept of locating segregated ballast tanks (SBTs) in a manner that would provide a means of protection against accidental oil outflow in case of collision or grounding. The segregated ballast arrangement consists of protectively locating ballast tanks along the cargo tank length to provide side and bottom protection. In addition, the SBTs are required to have sufficient capacity to allow the ship to have enough trim and draft to operate in the ballast condition. This requirement virtually eliminates the need to use cargo tanks as ballast tanks, thereby reducing the amount of operational pollution discharges. However, the international maritime community rejected the U.S. proposal to require that segregated ballast be carried in double bottoms having a depth of at least one-fifteenth the breadth of the ship (B/15) or 2 meters, whichever was less, to protect against groundings.

Mathematical formulas were developed to help ship designers locate the ballast tanks and meet the objectives of damage protection and reduction of dirty ballast discharges. The formulas governing the protective location of ballast tanks were primarily based on an area-ratio coefficient, which is a ratio of the protected shell area to the total side and bottom shell area within the cargo tank length. The regulations provide guidelines for

⁶⁸Deadweight refers to a vessel's carrying capacity, including cargo stores, and provisions, in tons.

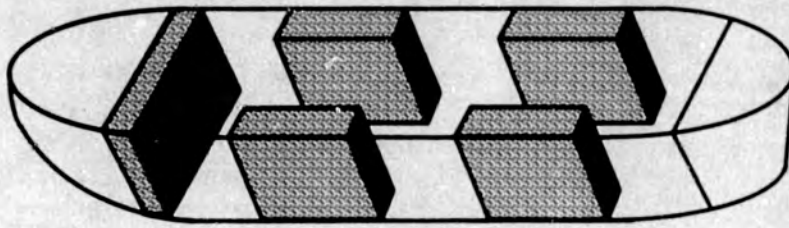
determining the size and location of the SBTs, but they do not specify a ballast tank configuration.

The vessel owner is permitted to meet the regulations by implementing the tank configuration that will result in the lowest cost and least loss of deadweight. For most vessel owners, a staggered wing tank configuration (see figure 12) constitutes the most operationally efficient and cost-effective option. For tank vessels over 20,000 deadweight tons,⁶⁹ a typical staggered wing tank arrangement would consist of four sets of wing tanks, two sets carrying segregated ballast and two sets carrying cargo. This arrangement, however, only provides partial protection against oil outflow owing to collisions because only four wing tanks are ballast tanks, and only minimal protection from grounding is provided because none of the cargo tanks are protected. This method was used in the design and construction of the EXXON VALDEZ.

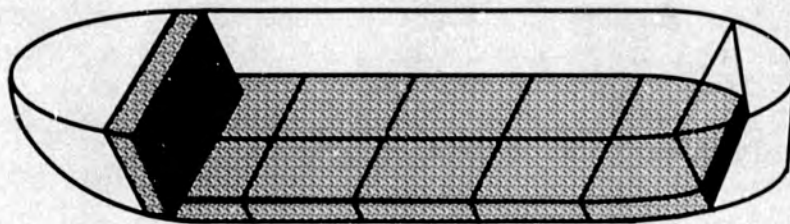
Oil Spill Response.--This section considers only the first 24 hours of the oil spill response. The preparation for and the initial response to the oil spill was governed by three Federal plans, one State of Alaska plan, and one plan produced by the Alyeska Pipeline Service Company, that had been approved by the State of Alaska. Subsequent response to the spill was conducted by Exxon Shipping Company pursuant to Exxon's spill response plan, but this was more than 24 hours after the spill and is therefore not covered in this report. Two of the Federal plans, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and the Alaska Regional Oil and Hazardous Substances Pollution Contingency Plan (RCP), provide for implementation by a team that is similar to a board of directors for a company. Members of each team include representatives from various Federal government agencies and in the case of the RCP, a representative from the State of Alaska. The NCP board of directors was referred to as the National Response Team (NRT) and the RCP board was referred to as the Regional Response Team (RRT). The third Federal plan was the COTP Prince William Sound Pollution Action Plan, which was the local Coast Guard plan for investigating a pollution incident, identifying the responsible person or company, monitoring oil spill cleanup activities, granting permission in some cases for the use of certain cleanup methods, and taking over responsibility for the cleanup if necessary.

The State of Alaska Oil and Hazardous Substances Pollution Contingency Plan provided guidelines for a coordinated response to spills. State regulations require terminals in Alaska that handle oil and hazardous substances to produce spill cleanup plans and to provide resources to clean up spills. Pursuant to State regulations, the Alyeska Pipeline Service Company (Alyeska) had developed a spill plan to clean up spills occurring at the Alyeska marine terminal in Valdez, spills from tankships carrying North Slope crude oil in Port Valdez, and spills in Prince William Sound. The Alyeska plan governed the activities initiated to contain and clean up the

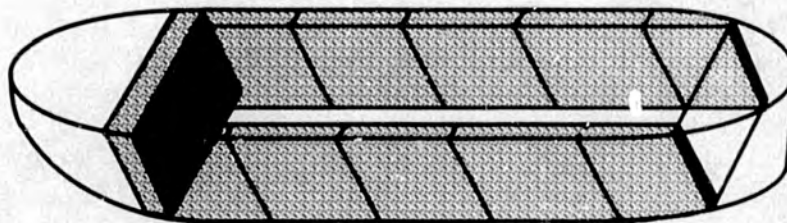
⁶⁹The size of tankships that would be required to have SBTs and to meet other requirements for cargo tank size was determined by international agreement to be those crude carriers over 20,000 deadweight tons.



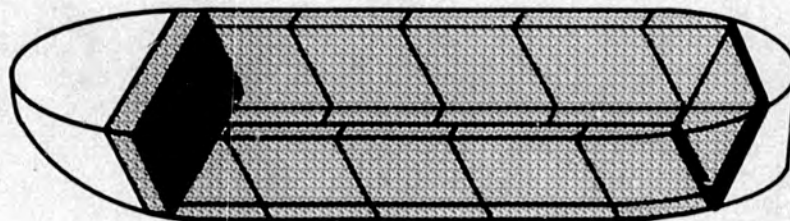
a. Staggered wing tanks



b. Double bottom



c. Double sides



d. Double hull

Figure 12.--Tankship design alternatives.

oil spilled by the EXXON VALDEZ, using equipment and manpower provided by Alyeska. Alyeska's cleanup equipment was the first to arrive on scene.

About 0027 on March 24, 1989, the master of the EXXON VALDEZ reported to the Coast Guard VTC at Valdez that his vessel was aground on Bligh Reef and leaking oil. The vessel's log book shows that the EXXON VALDEZ grounded at 0004 on March 24. The height of the tide was about +9.8 feet above mean lower low water (MLLW), which is the chart datum of soundings.

About 0030, the COTP for Prince William Sound at Valdez, Alaska, closed the port to all traffic. About the same time, the VTC watchstander requested that the tug STALWART be dispatched from the Alyeska Valdez Marine Terminal (Terminal) to assist the EXXON VALDEZ. He then notified the Alyeska marine operations supervisor on duty at the Terminal of the accident and oil spill. The marine supervisor on duty notified his superiors, commenced the Alyeska mobilization call-out, and ordered that the pollution response barge and cleanup equipment be prepared for deployment. In response to a Safety Board query, the Valdez Terminal Marine Manager stated, "There is no list of equipment 'normally loaded' on Alyeska's response barge because every spill is unique in size, location and viscosity and, by definition, every spill will require different equipment."

At 0030, about 26 people were working at the Terminal. They included 10 marine technicians and 2 power vapor technicians, who were available to prepare spill response equipment. The remaining personnel were handling Terminal functions and vessels. By 0330, 57 people were working at the Terminal, 38 of whom were manning the emergency center and handling oil response activities. By 0500, 83 persons were at the Terminal, of whom 63 were involved in the spill response. By 0600, approximately 140 people were working at the Terminal, and 113 were involved in spill response.

About 0040, the COTP, who was the Federal on scene coordinator (OSC), and the MSO's XO arrived at the MSO. About 0050, the COTP called the Alyeska marine operations supervisor on duty and told the supervisor that he wanted to talk to the marine superintendent. The COTP also advised the marine operations supervisor "to start thinking about getting dispersants up here, we may want to use them." About the same time, the OSC notified the person in charge of the Alaska Department of Environmental Conservation (ADEC) Prince William Sound District Office about the grounding and the oil spill, and the XO notified the Coast Guard alternate cochairman of the RRT at the Seventeenth Coast Guard District Office, Juneau, Alaska. The Coast Guard cochairman of the RRT and the District Commander also were notified. The person in charge of the ADEC District Office initiated the ADEC communications plan. The commissioner of ADEC testified that "within about 2 hours, we had staff either preparing to move or actually moving toward Valdez."

At 0115 and 0130, respectively, the Alyeska emergency response centers opened in Valdez and Anchorage. At 0125, the president of Alyeska in Anchorage notified the president of the Exxon Pipeline Company, in Houston, who then notified the president of the Exxon Shipping Company, who was also in Houston. Alyeska in Valdez commenced mobilizing men and equipment from

the local area, as well as from other parts of the State and from pipeline employees.

At 0148, MSO Valdez contacted the Coast Guard Air Station at Kodiak, Alaska, for a helicopter overflight of the grounded vessel at first light. High tide, which was predicted to occur at 0206 at +12.8 feet above MLLW, failed to refloat the EXXON VALDEZ and oil continued to spill from the vessel. The next low tide was predicted to occur at 0821 at -0.3 feet below MLLW. About 0227, the tug STALWART arrived at the EXXON VALDEZ and stood by. At that same time the pilot boat CHIRIKOF reported that there was an oil slick about one-half mile south of the EXXON VALDEZ.

About 0230, the XO and the SIO from the MSO, together with the person in charge of the ADEC District Office, departed Valdez on the pilot boat SILVER BULLET for the grounded vessel.

At 0238, the Alyeska marine manager at Valdez and the COTP discussed the need to use dispersants on the spill. The COTP advised the Alyeska to prepare to use dispersants.

At 0249, the OSC requested assistance from the Coast Guard Pacific Area (PACAREA) Pollution Strike Team at San Francisco. Members of the team were expected to arrive in Cordova, Alaska, at 1530. The XO and the SIO from MSO Valdez and the ADEC District Office chief arrived on board the EXXON VALDEZ at 0335 to assess the situation and to begin the accident investigation. They learned from the master of the EXXON VALDEZ that about 138,000 barrels of oil had already been lost from the EXXON VALDEZ's starboard wing tanks Nos. 1, 3, and 5 and the No 5 center tank. They reported this to the OSC.

Between 0414 to 0445, the OSC made lightering of the EXXON VALDEZ a "high" priority because of concern about the stability of the vessel. Alyeska had to provide fenders and hoses for lightering. The OSC and Exxon officials decided to use the tank vessel EXXON BATON ROUGE, then en route to Valdez, for lightering the EXXON VALDEZ. That vessel's estimated time of arrival on scene was 1100.

By 0435, Exxon had activated the Exxon-wide response team, their third and highest level of response. They were mobilizing, sending, or contracting for available oil spill cleanup equipment to be sent to Alaska. Oil spill response equipment was ordered from stockpiles in San Francisco, California, and in Southampton, England. Oil containment booms or sea barriers were ordered from the USSR, Norway, Denmark, France, Canada, and the United Kingdom. Contracts were let for dispersant aircraft, and dispersant stockpiles were being located and transported to Anchorage. The Exxon Company plane with the president of the Exxon Shipping Company and other company employees departed Houston at 0836 for Valdez.

By about 0600, all members of the RRT had been notified by the Seventeenth Coast Guard District and given preliminary information about the spill. A telephone conference meeting of the RRT was scheduled for later that morning at 1000.

At 0727, a Security Air Company helicopter contracted by Alyeska was airborne for an overflight of the accident area with a Coast Guard investigator on board. The oil slick by that time was 1,000 feet wide and 4 to 5 miles long.

At 0830, ADEC convened a meeting of its response staff members in Juneau, and the Governor joined via telephone conference call from Fairbanks. About 0930, the commissioner of ADEC departed Juneau for Cordova. Shortly after his arrival in Cordova, a Coast Guard helicopter took the commissioner for an overflight of the accident area.

About 0830, the Regional Response Center (RRC) in Juneau received, via facsimile, an application from Alyeska to use dispersants on the oil spill. This application was relayed to the other members of the RRT.

At 1010, the tug SEA FLYER departed the Terminal with lightering equipment for the EXXON VALDEZ. At 1137, the Alyeska barge departed the Terminal under tow of the tug PATHFINDER. The barge had to be moved to a loading area on the Terminal at 0200, where 25 tons of pollution response equipment was loaded on board. Equipment stowed on the barge had been removed to permit cleaning after an oil spill response in January 1989 and for repairs to the barge following damage sustained during a wind storm in early February. The repairs had not commenced before the barge was reloaded with spill response equipment for this incident. The barge had one or two connex boxes (8'x8'x20' shipping container) with containment boom on board before the additional equipment was loaded. The 200,000-barrel spill scenario described in the Alyeska contingency plan for Prince William Sound allowed a 5-hour response time for the tug and contingency barge to arrive on scene, about 30 miles from the Valdez Terminal, near the same location as the grounded EXXON VALDEZ.

About 1130, an RRT telephone conference was held with the OSC to update the team and to discuss use of dispersant chemicals (dispersants) and in-situ (wherever the oil is located) burning of the oil. The spill was approximately 3 miles wide and 5 miles long. A decision on dispersant use in Zone 2 was not made at that time. (See figure 13.) The OSC had pre-approved authority to use dispersants in Zone 1. The RRT concurred in the use of in-situ burning, which could not commence until the State of Alaska issued a burn permit. About 1200, Alyeska submitted a handwritten request to the Coast Guard in Valdez for permission to conduct in-situ burning.

The estimate of cargo lost was increased to 200,000 barrels by the OSC at 1310 and to 250,000 barrels at 1459.

At 1430, the Alyeska barge arrived 2.5 miles north of Bligh Reef and proceeded southwest of the EXXON VALDEZ to deploy its equipment. It arrived 1/2 mile south of Bligh Reef at 1454. At 1510, the OSC authorized a dispersant test on the leading edge of the oil slick in Zone 1. During most of the time on the first day, the oil remained in Zone 2 and was drifting toward Zone 1. Exxon arranged for three aircraft and two Air Deliverable Dispersant System (ADDS) packs to be delivered to Alaska for use on fixed

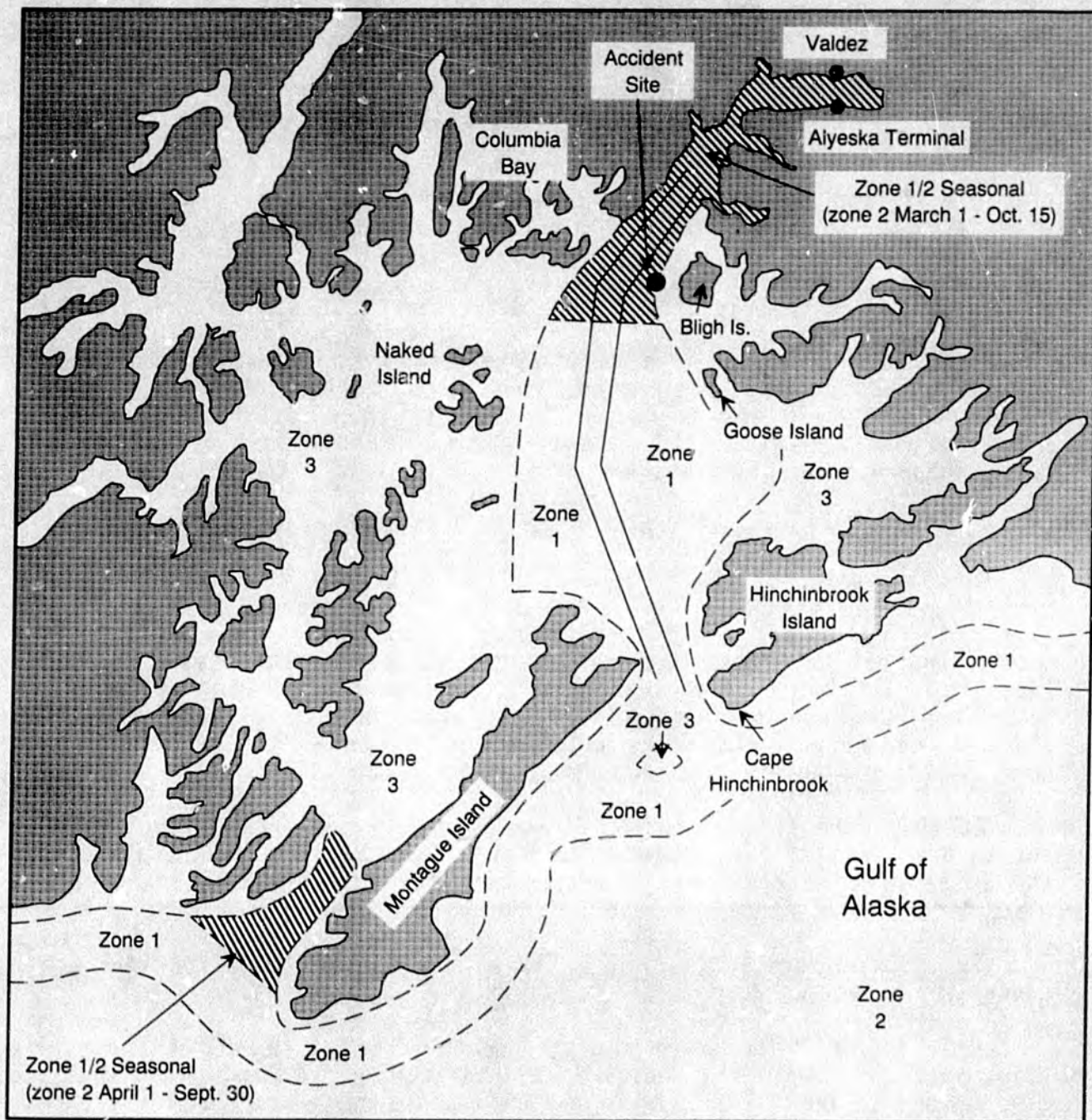


Figure 13.--Oil dispersant use zones.

wing aircraft, but they did not arrive during the first 24 hours after the spill.

About 1500, the RRC in Juneau received, via facsimile, an application for in-situ burning of oil from Alyeska. This application was relayed to the other members of the RRT. A State of Alaska burn permit dated March 24, 1989, was telecopied to Exxon on March 25, 1989.

About 1700, the Governor of Alaska and the commissioner of the ADEC boarded the EXXON VALDEZ. They observed the dispersant test from the vessel and departed at 1907.

At 1737, the president of the Exxon Shipping Company arrived in Valdez. He met with the OSC and, about 1930, with the Governor.

At 1800, Exxon conducted, with the OSC observing from a helicopter, the oil dispersant test application. The dispersant test was conducted on the leading edge of the spilled oil about 4 miles from the EXXON VALDEZ. The dispersant was delivered by a helicopter with a spray bucket that had a capacity of 300 gallons. As reported by the OSC in Pollution Report No. 3, the dispersant test was conducted "with less than satisfactory results. Effects minimal due to lack of wave action. Further use of dispersants deemed inappropriate at this time."

At 1820, 11 Coast Guard PACAREA Strike Team members arrived at Cordova.

By the evening of the first day of the spill, ADEC had established its command post in Valdez. The post was fully operational for its role of oversight, assessment, and monitoring of cleanup activities. The commissioner of ADEC testified at the public hearing that "about 18 hours into the spill, it became clear that Alyeska was not responding under the conditions of the contingency plan and that neither Alyeska nor Exxon appeared to be able to carry out the requirements of the plan." The commissioner did not specify what requirement he was referring to.

At 2010, the EXXON BATON ROUGE was alongside the EXXON VALDEZ but was not secured until 2154. Between 2215 and 2338, two transfer hoses between the vessels were connected in preparation for lightering operations that were planned to commence about 0630 on March 25.

At 2030, divers contracted by Exxon arrived on the EXXON VALDEZ for underwater survey work.

The CO, MSO Valdez, who was the Federal OSC, was asked at the public hearing if there was "any reason as OSC to take over cleanup activities [to give more specific direction, to purchase and order more equipment, and to hire contractors] in the first 24 hours?" He replied: "No. There wouldn't have been anything that I could have done. There were no other resources readily available to put in place than those that were already there [Alyeska equipment] or en route. So there was no benefit to be derived from me taking it over." The OSC also testified that: "If basically I took over the spill [cleanup from Alyeska], we [the Coast Guard] would have to basically tell

Alaska to do the same thing they were already doing, just, now you're being paid to do it by the Federal government." When asked if taking over the spill cleanup response would enhance the situation, the OSC replied: "Well it wouldn't have. That's the bottom line. It wouldn't have in this situation because there is nothing--actually, it probably would have been a substantial delay in getting the Federal mechanism up to speed to take over the response."

The regulations describing the NCP are found at Title 40 CFR Part 300 and were developed to "effectuate the response powers and responsibilities created by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the authorities established by section 311 of the Clean Water Act (CWA), as amended." The plan describes procedures and standards for conducting response activities for discharges or substantial threats of discharges of oil and hazardous substances. The Environmental Protection Agency (EPA) is the agency responsible for amending the NCP; however, before amendments are published, EPA must seek comments from the NRT members.

Subpart A of the NCP contains the introduction, authority, and definitions used in the plan. National planning and coordination of the NCP was accomplished through the NRT. Subpart B lists the Federal agencies on the team and the responsibilities delegated to those agencies. There were 14 Federal departments or agencies that were members of the NRT: EPA, the Coast Guard, DOT, Department of Defense (DOD), Department of the Interior (DOI), Department of Commerce (DOC), Department of Agriculture, Department of State, Department of Justice, DHHS, Department of Labor, Department of Energy, Nuclear Regulatory Commission (NRC), and the Federal Emergency Management Agency (FEMA).

Subpart C describes the organization of the response activities. It sets forth the activities and responsibilities of the NRT, RRT, OSC, and special teams. Also addressed in this subpart are multiregion responses, worker health and safety, public information, and OSC reports. Paragraph 300.31 states in part: "Three fundamental kinds of activities are performed pursuant to the Plan: Planning and coordination, operations at the scene of a discharge and/or release, and communications." When the NRT is activated for a pollution response action, either the EPA or the Coast Guard provides the chairman, depending on the location of the spill, inland or coastal, respectively, or as agreed on by the two agencies. The NRT will try to arrive at a consensus on all matters brought before it, but if a problem cannot be resolved, each agency representative has one vote in the proceedings. The NRT also monitors incoming reports from the RRTs, develops procedures to ensure that response groups coordinate their activities in handling discharges, monitors response-related research, and monitors response training among agencies.

Subpart D of the plan requires Federal regional contingency plans for each standard Federal region, Alaska, and the Caribbean, as well as local contingency plans for areas in which the Coast Guard provides the predesignated OSC. Where the EPA is the predesignated OSC, it is encouraged, but not required, to maintain local plans for its zones of responsibility.

The OSC is either the Federal official predesignated by the Coast Guard or EPA to coordinate and direct Federal responses under Subpart E and removals of spilled pollutants under Subpart F of the NCP or the DOD official designated to coordinate and direct removal actions from releases of hazardous substances, pollutants, or contaminants from DOD facilities and vessels.

Subpart E describes the "Operational Response Phases for Oil Removal:" Phase I:--Discovery and notification, Phase II:--Preliminary assessment and initiation of action, Phase III:--Containment, countermeasures, cleanup, and disposal, and Phase IV:--Documentation and cost recovery. After the OSC has been advised or has discovered an oil spill, he shall classify the size of the spill, determine and make contact with the responsible party, determine if the responsible party is taking proper removal action, contact the appropriate State and local officials, and either initiate phase III or monitor the responsible party for phase III actions, or if necessary, take over the cleanup. If the responsible polluter is unknown, or he or his representative is not taking timely or adequate actions to clean up the oil, the OSC shall determine whether authority for a Federal response exists. If so, the OSC will assume cleanup response activities.

Subpart F describes hazardous substances discharge/spill response and Subpart G describes the actions to be followed when natural resources are lost or damaged as a result of an oil or hazardous substance discharge.

Authorization for the use of dispersants and other chemicals to remove or control oil discharges is provided for in Subpart H of the NCP. The OSC, with the concurrence of the EPA and the State(s) representative(s) to the RRT may authorize the use of dispersants, surface collecting agents, and biological additives on the oil discharge, provided that products are on the NCP Product Schedule. Burning agents may be used on a case-by-case basis under the same concurrences as described. Sinking agents are not authorized for use on oil discharges.

The Alaska Regional Oil and Hazardous Substances Pollution Contingency Plan, which was referred to as the Federal RCP, was developed for the Alaska region in accordance with the NCP. The RCP, with its annexes and appendixes, was to be used by the OSC in conjunction with and not independent of the NCP. It was a plan developed for the coordinated and integrated response to pollution incidents by agencies of the Federal and the State governments. The plan provided for an RRT cochaired by the Coast Guard and EPA. The RRT consisted of representatives from the same Federal departments or agencies that were on the NRT and a representative from the ADEC.

The RRT was an advisory body to the OSC that enabled Federal, State of Alaska, and local government agencies to participate in the response to major pollution incidents. The OSC presented information to and received advice from the RRT. The OSC for Prince William Sound (Coast Guard COTP Valdez) testified at the public hearing that "specific members of the RRT, with respect to dispersants, are required as per the national contingency plan to approve the use of dispersants. So it's--the members of the RRT [who] approve certain items. The RRT as a whole is an advisory body."

Each Coast Guard COTP in Alaska, under the authority of the NCP and the Alaska RCP, coordinates Federal response activities on scene as either the predesignated OSC or as the first Federal official on scene, in the absence of the predesignated OSC.

The OSC, as delineated in the RCP, shall:

1. collect pertinent facts about the discharge and its potential impact on the environment, human health, and safety;
2. promptly advise the appropriate State of Alaska agency about the spill;
3. address worker health and safety at the response scene;
4. notify, as promptly as possible, the affected land managing agency and trustees of natural resources;⁷⁰
5. direct response operations as described in Subparts E and F of the NCP;
6. consult regularly with the RRT when it has been activated;
7. evaluate incoming information and advise FEMA of potential major disaster situations and the DHHS when a public health emergency exists; and
8. consult with DOI and DOC National Oceanic and Atmospheric Administration (NOAA) if a discharge may adversely affect any endangered or threatened species or result in the destruction or adverse modification of the habitat of such species.

The appropriate RRT cochairman will activate the RRT whenever one of the following situations occurs:

1. a major or potentially major discharge or release of more than 100,000 gallons of oil (activation in these situations is automatic);
2. any pollution emergency when the OSC or any member of the RRT makes a request to the RRT cochairman; and
3. at any time when deemed necessary by either cochairman.

⁷⁰The head of the Federal agency authorized to protect or manage certain lands and/or other natural resources.

The cochairmen of the RRT on March 10, 1989, and ADEC's Chief, Oil and Hazardous Spill Response Section on March 20, 1989, approved an amendment to the Memorandum of Agreement between the Coast Guard, EPA, and ADEC regarding Oil Dispersant Use Guidelines for Alaska that specifically addressed the use of dispersants in Prince William Sound and incorporated this amendment into the RCP for Alaska. The Sound was divided into three zones (see figure 13):

- a. Zone 1 - the OSC is pre-authorized to use dispersants.
- b. Zone 2 - conditional; before the OSC can use dispersants, the RRT must concur with their use.
- c. Zone 3 - dispersant use is not recommended; before the OSC can use dispersants, the RRT must concur with their use.

During the first 24 hours of the spill from the EXXON VALDEZ, the spill was located within zone 2; part of the spill then spread into zone 1.

Burning oil "in-situ" to reduce the effects of oil in the water and to clean up spilled oil is an option available to the OSC, but the State of Alaska must issue a burn permit after the RRT recommends the use of this method of cleanup.

The COTP Prince William Sound at Valdez is the predesignated Federal OSC for Prince William Sound and the COTP Prince William Sound Pollution Action Plan is the local contingency plan developed in accordance with the requirements of the NCP and the RCP. The plan may also be used in conjunction with the Alyeska Pipeline Service Company's Oil Spill Contingency Plans for Prince William Sound and Port Valdez. The COTP plan provides "COTP Prince William Sound personnel specific action plans with which to work in the event of oil or hazardous substance spill within the COTP Prince William Sound area of responsibility." It does not duplicate information in the NCP or RCP. The COTP plan describes the geographical area of responsibility and the duties of MSO Valdez and other Coast Guard personnel.

The State of Alaska developed an Oil and Hazardous Substances Pollution Contingency Plan to provide State "guidelines for a coordinated response of Federal, State, and local government agencies to spills of oil and hazardous substances within Alaska." It is Alaska's policy:

1. to protect the State's natural and human resources from the damage that may be caused by the discharge of oil;
2. that to the maximum extent possible, the prompt containment and cleanup of discharges is the responsibility of the spiller;

3. to ensure that those engaged in oil storage, transfer, transportation, exploration and production are capable of responding to an oil discharge; and
4. that third parties suffering damage for oil discharges will be compensated promptly by those responsible for the spill.

The ADEC has four statutory responsibilities for oil spills:

1. provide for containment and cleanup of oil discharges of unknown origin;
2. require the maximum practical use of private contractors in cleanup activities;
3. ensure that the cleanup action is initiated in a timely and adequate manner; and
4. identify the source and cause of the spill and the party responsible for cleanup.

When the Federal RRT is activated, the ADEC representative is required to be prepared to render aid on spill response activities, to act as a clearinghouse for input from other local or State agencies, and to act as an adviser to the Federal OSC. The ADEC representative may advise the Federal OSC on the following subjects: State and local resources available for information and help; priority areas for cleanup or protection; preferred methods of containment, abatement, and cleanup; potential staging areas; potential disposal areas; human and wildlife resources threatened; adequacy of cleanup; and activation of State-funded response.

According to the State plan, the decision to use dispersants will be made on a case-by-case basis after extensive consideration has been given to containment of the oil by mechanical means. The State plan provides for a State on-scene coordinator. If the State is in charge of the cleanup (unlikely in any major spill), the State OSC may use dispersants if it appears that they are the only means to diminish the threat and damage from the spilled oil. However, the State OSC must consult with Federal and State agencies before dispersants are used.

Alyeska had an Oil Spill Contingency Plan dated January 1987. Alyeska and the Trans-Alaska Pipeline System (TAPS) is owned by seven common-carrier pipeline companies: Amerada Hess Corporation, ARCO Pipe Line Company, Exxon Pipeline Company, Mobil Alaska Pipeline Company, Phillips Petroleum Company, BP Pipe Line Company, and Union Alaska Pipeline Company. Each company has an undivided interest in the pipeline, which it operates as if it were a discrete or separate pipeline. Each pipeline carrier publishes Federal or State tariffs with the Federal Energy Regulatory Commission and the Alaska Public Utilities Commission, respectively. Alyeska is the operator of TAPS. Alyeska is not a common carrier, does not have a published tariff, and does

not collect tariff revenues for the carriers. Shippers are those persons who have North Slope oil that needs to be transported through TAPS.

Before an oil terminal facility is permitted to operate in Alaska, it must have an oil discharge contingency plan approved by ADEC. Also, before oil is transferred to or from a tank vessel in the State of Alaska, the vessel must have an oil discharge contingency plan that has been approved by ADEC. The ADEC is the only State agency empowered to approve a terminal's oil discharge contingency plan, and State law requires that the plan must be reviewed at least every 3 years by the ADEC. Alyeska had prepared oil spill contingency plans required by Alaska State law for the pipeline (12 individual volumes for the 12 pipeline sections) and the Valdez Terminal Plan for the storage and terminal facilities at Port Valdez (1 volume). Alyeska had also prepared a General Plan (one volume) and a Prince William Sound Plan (1 volume).

The following excerpts from the General Plan are pertinent to this accident.

Alyeska will direct cleanup operations of spills resulting from:

Trans-Alaska Pipeline operations, including spills within the right-of-way or related facilities under the ownership or control of Alyeska or the owners.

Marine Terminal at Valdez operations involving tankers carrying or destined to carry crude oil transported through the Trans-Alaska Pipeline System occurring at the Valdez Terminal [or] in Port Valdez, Valdez Arm or Prince William Sound.

Introductory information in the Prince William Sound Plan states:

This contingency plan covers the entire Prince William Sound from Middle Rock in Valdez Narrows to the southern limit of Hinchinbrook Entrance off Cape Hinchinbrook. This contingency plan has been developed specifically for rapid and effective response to possible oil spills due to marine vessels in trade with Alyeska's Valdez Terminal.

The Alyeska plans for the Prince William Sound area cover organization, alert procedures, response actions, exclusion site descriptions, two oil spill scenarios, response times, cleanup procedures, lightering of tank vessels, climatology information, oceanography information, wildlife/fish resources, sensitive areas to be protected, a listing of booms and other equipment used in cleanup, a list of cleanup cooperatives, oil spill supervisory personnel assignments, personnel qualification sheets, and training of personnel in oil spill response. There is nothing in the Alyeska plans that provides for a tank vessel's owner or operator to assume cleanup responsibility from Alyeska. The president of Exxon testified that Exxon had submitted oil spill contingency plans for its vessels to the ADEC

on two occasions; however, the plans were returned and Exxon was advised by the ADEC that it did not have to provide any contingency plans because its vessels were covered by the Alyeska plans. The State of Alaska stated in a letter dated December 12, 1989, that "the ESC response plan did not meet the State's requirement for a contingency plan, and it was never approved by the State as [a] free standing contingency plan." The president of Exxon also testified that:

I think we have an understanding with them [Alyeska] that they're the initial responder, but I don't think we have any formal agreements as such. We've traded letters. Very recent letter, maybe six months ago, they [Alyeska] asked us to clarify under which circumstances would we exercise our oil spill response team to take control, and I think we told them that in spills roughly over 250 barrels or any spills that they felt were out of their control we would certainly exercise our response team.

When the manager of the engineering department of Alyeska was asked whether Alyeska had a policy on how to transfer spill response responsibility to an owner company, he testified:

No, I don't believe we have a policy. We have an understanding with several owner companies. As I mentioned before, Alyeska is prepared to engage in initial response in ongoing cleanup in the event of any spill in Port Valdez and Prince William Sound. We have an understanding with ARCO Pipeline Company and Exxon Pipeline Company that they will probably come up and take over a major spill in which they are the spiller.

In May 1988, ARCO Marine, Inc., and Alyeska conducted a 2-day Administrative Oil Spill Drill at the Valdez Civic Center. Alyeska's letter inviting participants to attend stated: "The purpose of the drill is to exercise the resources of ARCO Marine, Inc., in taking over management of an oil spill from an ARCO vessel in Prince William Sound." When the Federal OSC was asked if anyone from Alyeska had informed him explicitly in the first 24 hours that Alyeska was turning over its response responsibilities under the contingency plan to Exxon, he replied:

I don't recall. Although, ...in my mind was the ARCO drill that ...we had done last May, ...where that scenario was played out, and I think probably, if it wasn't expressed vocally, it was at least in my mind...that [the] same, ...chain of effects [events] may take place in this spill.

When the Commissioner of ADEC was asked whether Exxon's Contingency Plan, which Exxon implemented, was consistent with State regulations, he testified that "there is only one State-approved contingency plan for oil spill response and that is Alyeska's." All tank vessel companies are required to have a contingency plan by State of Alaska statutes and

regulations 18 AAC 75.305 and .345, which state that the plans must be submitted by the owner or charterer of the tank vessel. The transmittal letters that accompanied the Alyeska Pipeline Service Company Contingency Plans stated that Alyeska submitted the plan as an "agent" of the owner companies. Likewise, the Alyeska Pipeline Service Company Contingency Plan general provisions, pages 1-1 and 1-3, state that Alyeska is acting as "agent" for the owner companies. The State believes "that the word agent in this context means that Alyeska submitted the plan on behalf of all the owner companies."

The Alyeska Oil Spill Contingency Plans were developed in 1976, republished in 1978 and 1980, and revised in 1987. In 1987, a supplement to the Valdez Terminal plan and a 200,000-barrel oil spill scenario for the Prince William Sound Plan were required by ADEC as a condition for approving the 1987 Alyeska Oil Spill Contingency Plan. The supplement provided information on the application of the contingency plan using personnel as they are organized at the Valdez Terminal. It also contains information on the minimum oil spill response competence required for Valdez Terminal technicians, and it provides information on current training hours for Valdez Terminal personnel.

There are two oil spill incident scenarios, a 4,000-barrel spill and a 200,000-barrel spill, included in the 1987 Prince William Sound volume of Alyeska's contingency plan that can be summarized as follows:

1. Spill of 4,000 Barrels: An outbound tanker near Entrance Point experiences a steering casualty and goes aground at Potato Point. One wing tank is damaged and loses 2,000 barrels of oil the first hour and 500 barrels per hour for the next 4 hours. The spilled oil is concentrated in an area about 6,000 yards on each side of Potato Point--into Valdez Arm and into Port Valdez. The scenario assumes that "the sea state and weather conditions are in and remain in a state conducive to oil containment and cleanup. Sea state is less than 5 feet, currents are less than 1.6 knots, waves are less than 2 feet, and visibility is equal to or greater than 2 miles." It also assumes that "the simulated weather is sunny to overcast with some light rain, winds are from the southwest at 8 knots, high tide is approximately 6 hours after the incident," and the incident occurs on June 22, 1986. Three hours after the incident, skimming equipment is on scene and operating. The cleanup should take about 2 months.

If the spill had occurred in an area where dispersants could be used and the OSC approved the use of them, Alyeska could have had an airplane on scene prepared to spray dispersants in as little as 9 hours, with an average response time of about 17 hours.

2. Spill of 200,000 Barrels: Alyeska believes "it is highly unlikely a spill of this magnitude would occur. The spill incident occurs through some failure of the tanker crude tanks and does not discuss other disaster possibilities such as collision or fire." The incident would involve either an immediate spill of 200,000 barrels or a spill of 10,000 barrels per hour for 20 hours about 30 miles from the terminal. Assumptions under this scenario are: the incident occurs at 6 a.m. on June 22 and "the sea state and weather conditions are in and remain in a state conducive to oil containment and cleanup. For example, winds less than 15 knots, sea state less than 5 feet, currents less than 1.6 knots, waves less than 2 feet, visibility equal to or greater than 2 miles." The wind is from the east at 5 knots.

A table provided with the scenario indicates that a tug towing a contingency barge from the Alyeska Terminal, with response equipment aboard, could be on scene in 5 hours. Dispersant use was included as a spill control measure. According to the plan, "There would, of course, be a long-term cleanup of the spill on the various beaches of Prince William Sound.... Burning also has to be looked at as a very good alternative to the cleanup in Prince William Sound on the various inlets and bays in which oil may accumulate."

The Manager of Alyeska's Engineering Department testified: "There are no response times specifically required. The response times mentioned in all the scenarios are estimated times." When asked whether Alyeska had a fire boom⁷¹ available in Valdez at midnight on March 24, he replied: "I don't know. If they weren't there, they were on the way... They were not on the way before the accident... We obtained them from two sources, on the North Slope, [and] one in Seattle."

The 200,000-barrel spill scenario also included the statement: "The closest empty or light loaded tanker will be directed to the spill site with an estimated maximum arrival time of 12 hours." Response equipment listed for initial response included two tanker lightering systems. The Prince William Sound Contingency Plan also described guidelines for lightering a distressed tanker. The manager of Alyeska's engineering department testified: "The lightering of a vessel in distress is an integral part of the plan."

⁷¹A fire boom is a inflatable oil containment collar that will not be destroyed by fire.

The Alyeska General Plan stated that "the use of dispersants at the Marine Terminal in Valdez and in the waters traveled by tankers using the terminal provide an additional spill control measure. The use of dispersants is not considered a 'cleanup' technique. However, they do provide Alyeska," the OSC, and the RRT "with an important trade-off option. When considering the advantages and disadvantages of physical removal techniques, burning, natural degradation, and shoreline cleanup, it becomes apparent that chemical dispersants are an additional response option that could be used alone or in conjunction with these techniques." As a State of Alaska, an Alyeska, and a Coast Guard representative testified, dispersants are not very effective in low wind and calm sea conditions. The RCP provides some guidelines for the use of dispersants but does not contain any guidelines for in-situ burning. The Alaska RCP and the Alyeska plans do not contain any information concerning what type of oil (and whether it is mixed with water or the degree of debris present) and under what weather conditions (wind velocity, water temperature, and sea state) dispersants are effective, when in-situ burning is effective, or what is needed to conduct a burn.

Alaska State oil regulations 18 ACC 75.375 require that the ADEC be informed within 3 days whenever any "significant equipment specified in a contingency plan becomes nonoperational,...and provide a schedule for its substitution, repair, or return to service." The Alyeska marine manager at Valdez stated in a letter dated December 22, 1989, that "The barge was not nonoperational and was deployed in the spill response without any delay attributable to its condition." The Manager of Alyeska's Engineering Department testified: "The barge was ready for response....No, the barge was not loaded." He also testified: "The spill plan does not require Alyeska to have the barge loaded....It was our [Alyeska's] normal practice to have the spill barge loaded with six connex containers, five of which contained containment boom, the sixth contained various absorbent booms and absorbent pads and other supplies, and normally the Vikoma sea skimmer was mounted on the barge with its power pack."

Global Positioning System .--GPS is a highly accurate, real-time, satellite-based navigation system developed by DOD. The complete GPS satellite constellation will consist of 18 active satellites and 3 spares in 6 orbits, with each orbit spaced so that at least 4 satellites are in view at the same time anywhere on Earth. Each satellite rotates around the Earth at an altitude of nearly 11,000 miles about two times per day, continuously transmitting atomic frequency standard time, orbital information and other parameters. A GPS receiver receives a satellite signal, interprets a digital sequence on the signal, measures the elapsed time since the signal was transmitted with reference to its own internal clock, and converts the signal to the distance to the satellite. Three satellites are required for a marine fix. GPS signals provide surface navigation fixes, accurate to less than 100 meters, 95 percent of the time.

A land-based receiver can be used in conjunction with the GPS satellites to provide greater accuracy and continuous coverage of an area. One such station, referred to as a differential GPS station, could provide very accurate navigation throughout Prince William Sound.

The vessel's position, provided by GPS or Loran, can be projected as a dot on an electronic chart, which is a video display of a navigation chart. The process is similar to showing a navigation chart on a television screen. This system obviates the need for plotting and enables the vessel's position and the proximity of dangers to navigation to be ascertained by simply watching the electronic chart. Furthermore, a vessel's coordinates can be transmitted by radio and projected on an electronic chart ashore, thereby enabling a VTC to monitor continuously the movements of the vessel very accurately.

New Investigative Techniques: Voice Analysis

One responsibility of the Safety Board, as defined by the Transportation Safety Act of 1974, is to "assess and reassess techniques and methods of accident investigation" (88 Stat. 2168, 49 U.S.C. 1903). Such an assessment was completed during the current investigation, using speech analysis of recorded radio conversations made by the master of the Exxon Valdez. It was anticipated that speech information might provide a secondary source of evidence to supplement toxicological and eyewitness information concerning the master's physical condition at or near the time of the accident.

Several recent scientific papers have reported measurable changes in speech associated with alcohol consumption. In its work, the Safety Board solicited assistance from the two research organizations that are the most active in developing the scientific literature. It should be noted, however, that even informal speech examination has long been recognized by the law enforcement community as a source of information on drug use. The DOT recently developed a Drug Evaluation and Classification Program that trains officers to recognize patterns of speech that may show alcohol/drug impairment. These patterns include "thick, slurred speech," "difficulty in speech," "repetitive speech," "low, raspy speech," and "slow, mumbled, and incoherent" speech.⁷² Such characteristics are also recognized by the general public. For example, the ship's agent, who met the master on the day of the accident and later reviewed tape-recorded communications of the master, stated to Safety Board investigators that his speech on the tape was slower than when she spoke to him by radio shortly after the vessel departed Valdez. It was this observation and similar observations by investigators that led the Safety Board to assess speech analysis as an investigative technique.

⁷²Briefing Paper: Drug Evaluation and Classification Program. U.S. DOT, National Highway Traffic Safety Administration, October 1989.

Description of the Available Recordings⁷³

All the recorded statements selected for analysis were excerpted from radio transmissions from the bridge of the EXXON VALDEZ. The master and three officers of the EXXON VALDEZ were authorized to make radio transmissions from the bridge, and several distinct voices could be readily recognized in the EXXON VALDEZ transmissions recorded by the Coast Guard.

Forty-two statements by the master were identified. (See appendix J.) The master made these statements during the five periods noted below; each has implications for issues of alcohol consumption:

- (1) Thirty-three hours before the accident. These statements were recorded about 1500 on March 22 as the EXXON VALDEZ was inbound to Valdez.
- (2) One hour (about 45 minutes) before the accident. These statements were recorded from 2324.50 to 2330.54 on March 23 during the outbound passage.
- (3) Immediately after the accident. These statements were recorded from 0026.41 to 0038.47 on March 24 and include the initial report of the accident.
- (4) One hour after the accident. These statements were recorded from 0107.29 to 0131.36.
- (5) Nine hours after the accident. These statements were recorded from 0912.00 to 0938.19 on the morning following the accident while the master discussed salvage of the cargo.

A composite recording of all statements made by the master was used in evaluations by Safety Board staff members and by expert consultants at two outside research organizations, the Addiction Research Foundation, Toronto, Canada, and the Speech Research Laboratory, Indiana University, Bloomington, Indiana. Their reports are included in appendix J.

Evidence of Effects Produced by Alcohol

Alcohol is associated in the scientific literature with four effects on speech: (a) slowed speech, (b) speech errors, (c) misarticulation of

⁷³Additional technical description of the study is available in the reports: "Speech Examination Study" and "Speech Examination Study--Addendum" included in the NTSB public docket on the accident.

difficult sounds, and (d) changes in vocal quality. These four effects were evaluated in the master's speech and are summarized as follows:

(a) Slowed Speech: Several scientific experiments indicate that the speaking rate slows in response to alcohol.^{74 75 76 77 78} The graph in figure 14 summarizes speaking rate evidence from two experiments with relatively large numbers of subjects and data points. Sixteen male volunteers who had a history of alcoholism participated in the first experiment (see footnote 74). The subjects read an identical prose passage aloud on three separate occasions: once while they were sober, once after drinking a medium level of alcohol (estimated BAC = 0.10 percent), and once after drinking a high level of alcohol (estimated BAC = 0.25 percent). Sixteen male college students who had no history of heavy alcohol use took part in the second experiment (see footnote 75). These subjects also read an identical prose passage while under the effect of three levels of alcohol consumption. Figure 14 summarizes the degree of speech slowing found for each group in response to different levels of alcohol.

Measurements of speaking rate were made on all 36 extended statements by the master. The measurements were completed at the Safety Board's audio laboratory by means of computer digitization and accessing of speech segments. Table 6 is a mathematical table that summarizes the speaking rate measures obtained.

Figure 15, based on the data in table 6, is a graph that summarizes the master's average speaking rate during each of the five time periods. An analysis-of-variance test confirmed the statistical significance of the differences observed during the five time periods (probability of occurring by chance less than 1 in 1,000). Contrast tests confirmed that the master's speech about 45 minutes before the accident was significantly slower than his

⁷⁴Sobell, L. C., and Sobell, M. B., "Effects of alcohol on the speech of alcoholics," Journal of Speech and Hearing Research, 15, 1972, pp. 861-868.

⁷⁵Sobell, L. C., Sobell, M. B., and Coleman, R. F., "Alcohol-induced dysfluency in nonalcoholics," Folia Phoniat., 34, 1982, pp. 316-323.

⁷⁶Pisoni, D. B., and Martin, C. S., "Effects of alcohol on the acoustic-phonetic properties of speech: Perceptual and acoustic analyses". Alcoholism: Clinical and Experimental Research, 13, 1989, pp. 577-587.

⁷⁷Pisoni, D. B., Yuchtman, M., and Hathaway, S. N., "Effects of alcohol on the acoustic-phonetic properties of speech," Alcohol, Accidents, and Injuries, Society of Automotive Engineers, Pittsburgh, Pennsylvania Special Paper P-173, 1986, pp. 131-150.

⁷⁸Lester, L., and Skousen, R. "The phonology of drunkenness," ed. A. Bruck, R. Fox, and M. LaGaly, Papers for the Parasession on Natural Phonology, Chicago Linguistic Society, 1974, pp. 233-239.

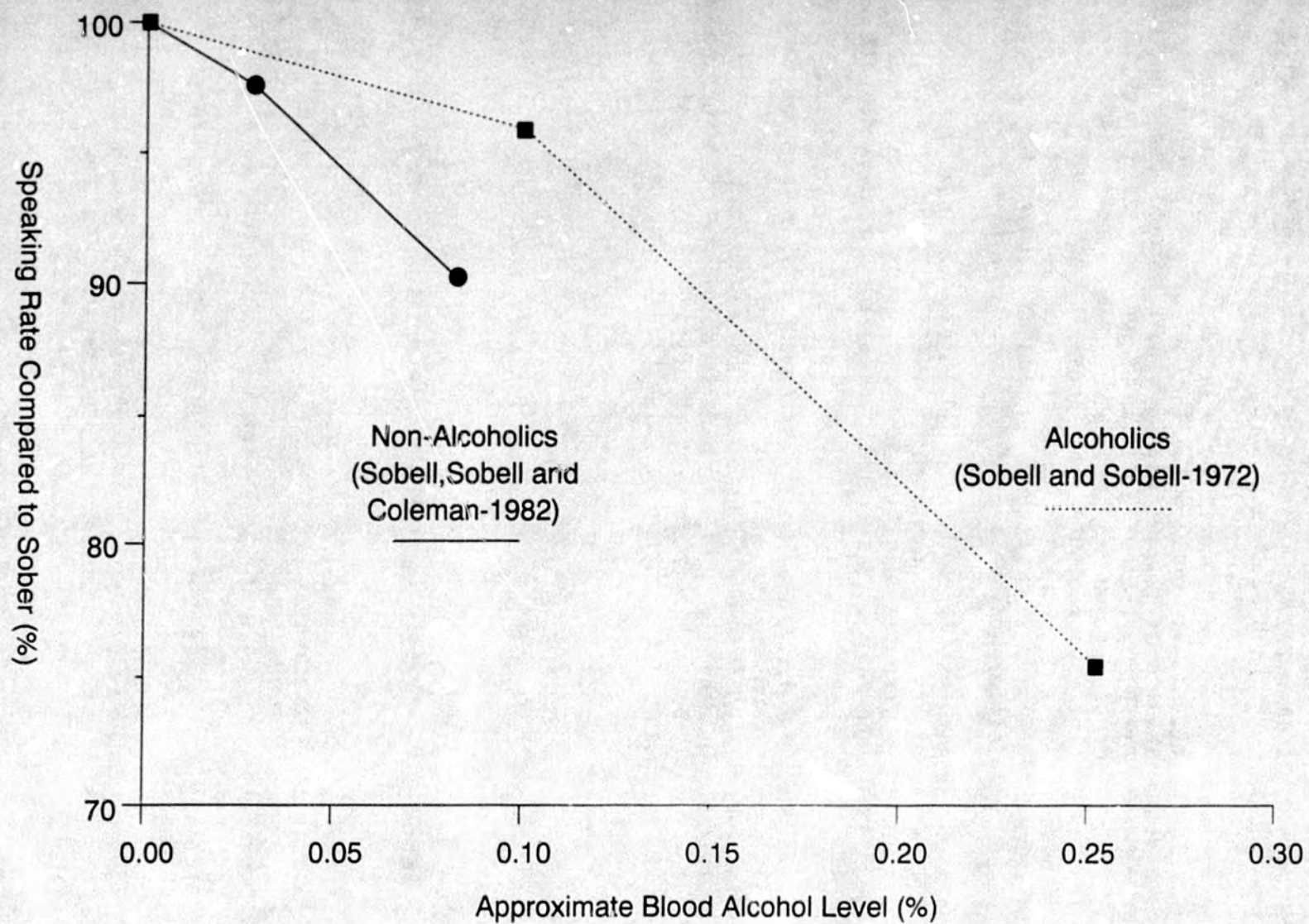


Figure 14.--Speaking rate changes with blood alcohol level.