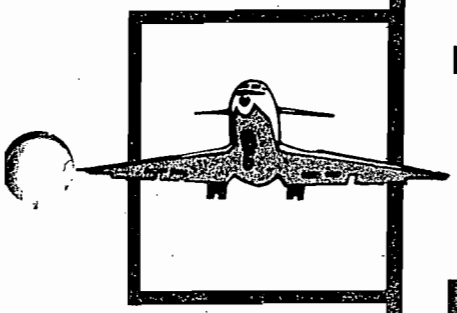

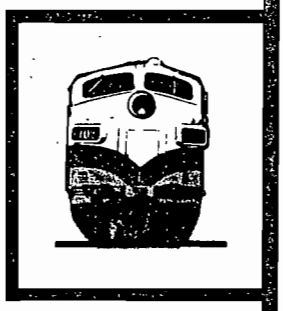

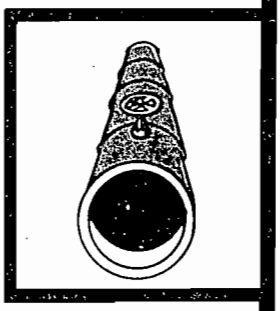

PB86-916411

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

MARINE ACCIDENT REPORT

COLLAPSE OF THE U.S. MOBILE OFFSHORE DRILLING UNIT PENROD 61 GULF OF MEXICO OCTOBER 27, 1985

NTSB/MAR-86/10

UNITED STATES GOVERNMENT

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16. Abstract

On October 27, 1985, the U.S. mobile offshore drilling unit PENROD 61 was drilling for oil at an offshore drilling site about 25 nautical miles (nmi) south of the Louisiana coast in the Gulf of Mexico. The PENROD 61, a self-elevating type drilling unit, was in the jacked-up mode in about 246 feet of water and was elevated about 50 feet above the surface of the water on three bottom bearing legs. About 2330 c.s.t. in seas reported to be in excess of 30 feet high and in winds gusting to 80 knots, the PENROD 61 collapsed into the sea. The 43 persons on board abandoned the vessel and all but one were later rescued. After it fell into the sea the PENROD 61 drifted with the wind and sea, struck the nearby PENROD 60, and subsequently sank about 9 nmi northwest of its drilling site. As a result of this accident the PENROD 61, valued at $40 million, was destroyed and one man lost his life.

The National Transportation Safety Board determines that the probable cause of the collapse of the PENROD 61 was a structural failure of undetermined origin to its bow leg. Contributing to the collapse of the PENROD 61 was the failure to inspect the legs of the MODU over their entire lengths. Contributing to the loss of life was the failure of the survival capsule to right itself after capsizing.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

MARINE ACCIDENT REPORT

Adopted: September 16, 1986

COLLAPSE OF THE U.S. MOBILE OFFSHORE DRILLING UNIT PENROD 61, GULF OF MEXICO, OCTOBER 27, 1985

INTRODUCTION

This accident was investigated jointly by the National Transportation Safety Board and the U.S. Coast Guard. Public hearings were held in New Orleans, Louisiana from November 19 to November 21, 1985 and from December 4 to December 6, 1985. This report is based on the factual information developed by the investigation. The Safety Board has considered all the facts that are pertinent to the Safety Board's statutory responsibility to determine the cause or probable cause of the accident and to make safety recommendations.

The Safety Board's analysis and recommendations are made independently of the U.S. Coast Guard. To insure that the public is aware of all Safety Board recommendations and responses thereto, a summary of all recommendations and responses is published in the Federal Register.

SYNOPSIS

On October 27, 1985, the U.S. mobile offshore drilling unit PENROD 61 was drilling for oil at an offshore drilling site about 25 nautical miles (nmi) south of the Louisiana coast in the Gulf of Mexico. The PENROD 61, a self-elevating type drilling unit, was in the jacked-up mode in about 246 feet of water and was elevated about 50 feet above the surface of the water on three bottom bearing legs. About 2330 c.s.t. 1/ in seas reported to be in excess of 30 feet high and in winds gusting to 80 knots, the PENROD 61 collapsed into the sea. The 43 persons on board abandoned the vessel and all but one were later rescued. After it fell into the sea the PENROD 61 drifted with the wind and sea, struck the nearby PENROD 60, and subsequently sank about 9 nmi northwest of its drilling site. As a result of this accident the PENROD 61, valued at $40 million, was destroyed and one man lost his life.

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INVESTIGATION

The Accident

On October 26, 1985, the U.S. mobile offshore drilling unit (MODU) PENROD 61 (see figure 1) was positioned at an offshore drilling site located in Grand Isle Block 86 in the

1/ Unless otherwise stated, all times in this report are central standard time based on the 24-hour clock.

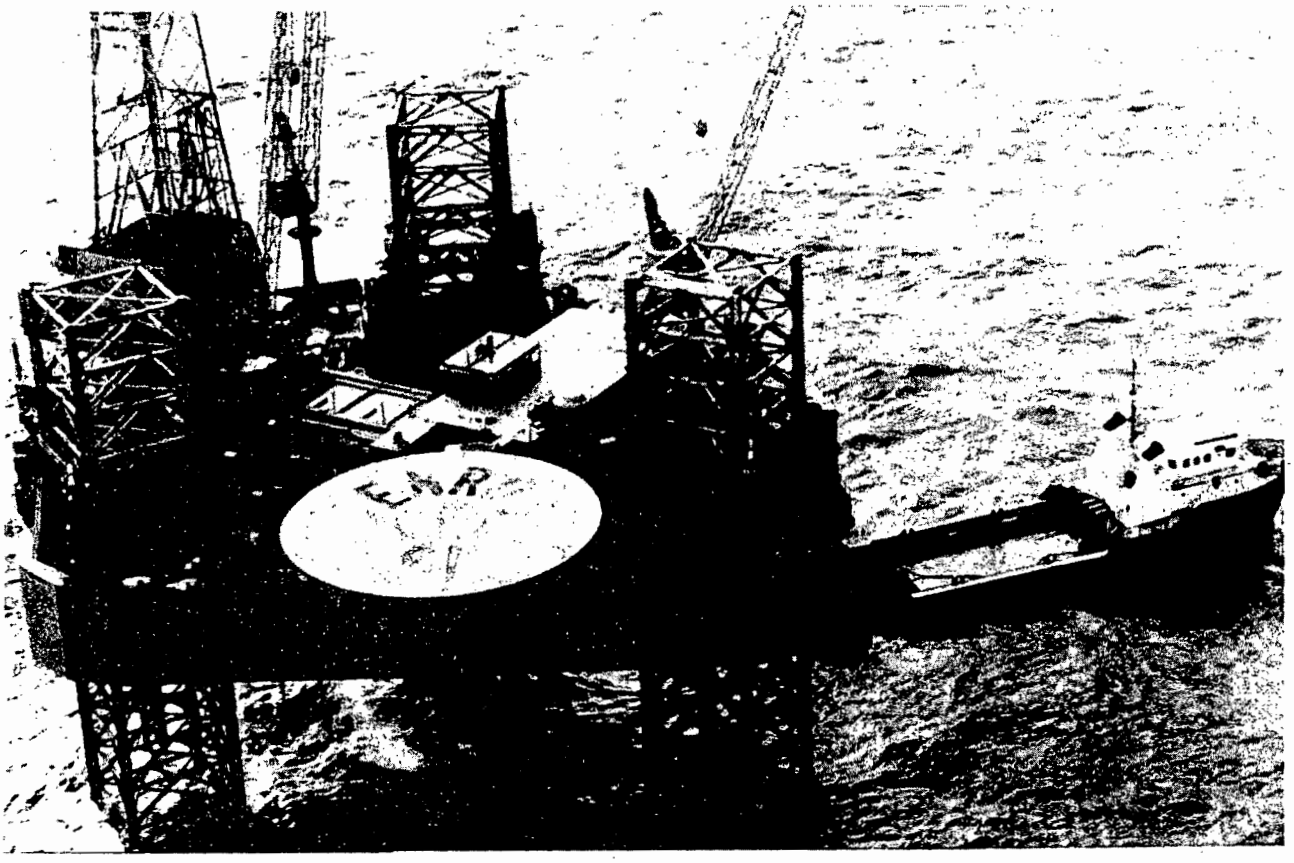

Figure 1.--U.S. Mobile Offshore Drilling Unit PENROD 61.

Gulf of Mexico about 25 nmi south of the Louisiana coast. It had been in this location since September 24, 1985. The PENROD 61, a self-elevating type MODU, was in the jacked-up mode in about 246 feet of water. There was about a 50-foot air gap between the bottom of the MODU and the still water surface of the sea. The vessel, owned by Penrod Drilling Company (Penrod), was conducting drilling operations under contract to Chevron U.S.A., Inc. (Chevron). Another Penrod MODU, the PENROD 60, was also conducting drilling operations under contract to Chevron and was jacked up at another site about 1/2 nmi northwest of the PENROD 61. A 100-foot standby vessel, the GILBERT C, was moored to an anchor buoy between the two MODUs.

The PENROD 61 was operating under the control and direction of a Penrod toolpusher and carried an operating crew of 25 Penrod employees in addition to the toolpusher. Chevron provided a drilling representative who was responsible for directing the drilling of the well. He was the senior Chevron official on the vessel and coordinated with the toolpusher in all major decisions concerning drilling operations. In addition to the operating crew, there were 16 other persons on board who were employed by various third party contractors who provided catering services or were involved in various specialized operations related to the drilling of the well.

A tropical depression 2/ in the Gulf of Mexico had intensified to become a tropical storm 3/ on the morning of October 26. The Penrod toolpusher and the Chevron drilling representative were monitoring the weather conditions and were aware of the storm.

2/ The formative stages of a tropical cyclone in which the maximum sustained surface wind is less than or equal to 33 knots.
3/ A warm-core tropical cyclone in which the maximum sustained surface wind ranges from 34 to 63 knots.

Regular weather reports were received from the Penrod office in Lafayette, Louisiana over the Penrod company radio. Additionally, the Chevron drilling representative was monitoring the National Oceanic and Atmopsheric Administration (NOAA) weather broadcasts on the VHF-FM radio. Drilling operations were suspended on the evening of October 26 because high seas near the MODU prevented the crew from unloading necessary equipment from an offshore supply vessel.

Sometime between 0800 and 0900 on October 27, 1985, the Chevron drilling superintendent who was shoreside, called the Chevron drilling representative on the PENROD 61 on the Chevron company radio and ordered the drilling representative to secure the well for heavy weather and to prepare for possible evacuation of the MODU. The drilling representative relayed the order to secure the well and to prepare for possible evacuation to the toolpusher. The Penrod safety representative on board the PENROD 61 testified that the wind velocity was about 35 mph (30.4 knots) and the seas were about 10 to 12 feet high at that time. The drilling representative and the toolpusher discussed the weather conditions and agreed that they were probably already too severe to allow for an evacuation of the MODU. However, the drilling representative did not attempt to contact the shoreside Chevron drilling superintendent to relate his opinion that the weather and sea conditions would not permit an evacuation of the MODU. The drilling representative testified that the standby vessel was "bobbing like a cork" in the seas at this time and that it would have been unsafe to attempt to transfer personnel to the standby vessel. The drilling representative did not attempt to arrange for helicopter transportation from the rig. He testified that, "I didn't see any reason to get any transportation at that time."

About 0900, the MODU crew began to secure the well and the MODU for heavy weather. The drilling pipe was pulled out of the well and secured in pipe racks on the after deck of the MODU. Doors and hatches were closed and secured, and loose gear about the vessel was either taken inside or tied down. By noon the well was secured and a storm plug was inserted into the well.

The Chevron drilling representative testified that at 1230 the winds were 40 to 50 knots and the seas were 20 to 25 feet high at the drilling site.

Sometime between 1230 and 1300 the drilling representative talked to the Chevron drilling superintendent and the Chevron drilling manager. Both shoreside officials instructed the drilling representative to evacuate the MODU, if possible. After completing these conversations, the drilling representative contacted a commercial helicopter firm to arrange for transportation to evacuate personnel from the MODU. However, he was told that weather conditions were too severe at that time to permit helicopter operations in the general area of PENROD 61. The drilling representative testified that he felt that there was nothing else to do but to ride out the storm on board the MODU.

Around 1500 the Chevron drilling representative heard a "popping" noise eminating from the MODU's legs and felt the MODU shudder. The drilling representative was concerned and went to see the toolpusher to ask about its significance. He said that the toolpusher stated that the brakes on the MODU's legs were slipping, that this happens frequently and that it was nothing to worry about. Since the toolpusher did not survive the accident, the Safety Board could not determine the accuracy of the drilling representative's recollection of this conversation. The drilling representative testified that the popping noise accompanied by the shuddering sensation continued several times each hour until the rig collapsed. Several survivors from the PENROD 61 testified that the "popping" noise was commonly heard emanating from the MODU's legs when the seas were rough.

Sometime after 1500 the Chevron drilling representative talked with the Chevron drilling superintendent once again. In this conversation the drilling representative informed the drilling superintendent that the use of helicopters was "out of the question" and that he would not be able to evacuate the PENROD 61.

The GILBERT C, moored to an anchor buoy between the PENROD 60 and PENROD 61, was under contract to serve as a standby vessel to the rigs. During the afternoon, high seas broke over the bow of the GILBERT C. The master of the GILBERT C, who was concerned about the safety of his vessel, requested and received permission to leave the area. About 1630 the GILBERT C left the area.

About 1730 the Chevron drilling representative was in the control room on the PENROD 61 when he looked at the bubble level indicator and noticed that the MODU was trimmed about 2° by the bow. The drilling representative asked the toolpusher the significance of the trim. The toolpusher replied that it was of minor significance and that when the weather abated he would jack the MODU to make it level again.

Around 1730 the night crew came on duty. The night driller took charge of securing the gear on deck at the stern of the vessel. The toolpusher instructed the night driller to place paint marks on each of the three jack-up legs and on the adjacent vessel structure so that any movement of the vessel in relation to the legs would be readily apparent. By 2030 all of the work to secure the MODU was completed and the night crew workers were instructed to go inside.

About 2230 the off-duty driller was having a cup of coffee in the galley with an off-duty crane operator when they noticed that the MODU was trimmed down by the bow. After reporting the condition to the toolpusher, the three men proceeded to the control room and looked at the level indicator. The off-duty driller testified that the indicator showed that the MODU was trimmed about 2° by the bow. He said that they remained in the control room for 10 to 12 minutes when they noticed that the trim had increased to 3 1/2 to 4°. The toolpusher then called the on-duty electrician and the on-duty mechanic over the rig's intercom system. He instructed the electrician to check the brakes on the bow leg and ordered the mechanic to start a second diesel-driven electric generator in preparation for jacking up the MODU on the bow leg.

Meanwhile, the on-duty driller had been checking the lashings on equipment on deck near the stern. He testified a large wave "hit" the stern legs of the MODU. He said that when this wave passed, he noticed that the MODU began to "list" toward the bow. He testified that he looked at his wristwatch immediately after the wave struck and noted that the time was 2233. After the wave passed, he went to each of the three jack-up legs to check the position of the marks that he placed on the legs and on the hull earlier in the evening. He noted that there had been no movement between the marks on the legs and the marks on the hull. He then proceeded to the control room and reported his findings to the toolpusher.

The toolpusher decided to contact a Penrod rig mover 4/ who was known to be on board the PENROD 96, which was located about 53 nmi northwest of the PENROD 61. The toolpusher explained to the rig mover on the Penrod Company radio that the PENROD 61 was trimmed 4° by the bow and asked the rig mover's advice on correcting the condition. The rig mover asked the toolpusher if the PENROD 61's variable

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4/ A specialist in moving jack-up type MODUs on and off station who has expertise in conducting MODU jacking operations.

load 5/ exceeded the variable load limitation. The toolpusher responded that it did not. The rig mover recommended that the toolpusher re-level the MODU by jacking the vessel up on the bow leg. The toolpusher informed the rig mover that the PENROD 61 was experiencing 40 to 60 mph winds gusting to 75 mph and that the seas were 20 to 25 feet high at that time. The rig mover recommended that the toolpusher test the brakes on the bow leg from the leg jacking control console in the control room rather than at the brake assemblies on the leg itself. Taking the rig mover's advice, the toolpusher then contacted the electrician via the rig's intercom and cancelled his previous instructions to the electrician to test the brakes at the bow leg. He told the electrician that he would test the brakes from the control console. The console contained an array of warning lights that would immediately illuminate when the jacking system was energized if the jacking motors were overloaded from an unreleased brake or other cause.

By this time, the mechanic had started the second electric generator and the toolpusher momentarily pressed the bow leg raise button to check the brakes and none of the warning lights illuminated. Seconds later, the toolpusher again pressed the bow leg raise button to raise the bow of the MODU and again none of the warning lights illuminated. After the leg-jacking system operated for about 5 seconds, the MODU suddenly fell by the bow a short distance and stopped. It then fell again in three or four more increments until the bow of the MODU was in the water. The stern of the MODU did not fall at this time, so that the MODU's deck was inclined at a sharp angle toward the bow.

When the bow of the MODU fell, the drilling representative ran to the control room. The drilling representative picked up the VHF-FM radio telephone in the control room and transmitted a "mayday" message. Another MODU, the PENROD 70, responded to the distress call and said they would relay the call for help. After receiving this response, the drilling representative went directly from the control room to the No. 2 survival capsule located on the starboard side of the MODU underneath the helicopter landing pad.

After the bow of the MODU fell to the water, waves washed over the foredeck and blocked access to the survival capsule embarkation stations. Rather than entering the water to reach their embarkation stations, three or four MODU crewmen went directly to an inflatable liferaft station located on the port side of the main deck aft of the deckhouse and launched a 20-man inflatable liferaft. When the raft inflated, they held it by its inflation cord (sea painter) close to the MODU's side long enough for one man, a welder, to get aboard. However, the wind was so strong that they could not hold the raft alongside and it drifted until it reached the full extent of the sea painter which was secured to the deck of the MODU. The sea painter parted some minutes later, and the raft with one man on board drifted away from the PENROD 61. By this time, the MODU's hull assumed a more level aspect and waves no longer washed over the foredeck to block access to the survival capsules. The men who had launched the raft then proceeded to the survival capsules where the rest of the persons on the MODU were gathering.

After the rig's bow fell to the water, the toolpusher came out of the control room and stood on the deck above the living quarters on the port side of the MODU. He instructed the off-duty driller to prepare the No. 2 survival capsule for launching and to obtain a count of the persons who boarded the capsule. The toolpusher proceeded down

5/ Variable load is the weight of supplies that are expendable, readily removeable, or consumed during drilling operations. Such consumables as drilling mud, cement, chemicals, diesel fuel, fresh water, drilling water, lube oil, drilling casing, drilling pipe, and drilling collars are designated as variable loads. The PENROD 61 could carry a maximum variable load of 4,116,666 pounds.

the portside ladder to the main deck and approached the No. 1 survival capsule. The Penrod safety representative, who was already at survival capsule No. 1, saw the toolpusher approaching and told him to get a portable radio for the survival capsule. The toolpusher turned around, apparently to get a radio, when the MODU suddenly experienced a substantial drop. It was about this time that the stern of the MODU dropped into the water and the MODU began to float. The safety representative then shouted to the people assembled at the No. 1 survival capsule, "Let's go. Don't wait for the radio." He then filled the capsule to what he thought was full capacity, and told the rest of the people in the area, "This boat is full. You all go to lifeboat number 2." He closed and secured the door of the capsule and it was immediately lowered to the water. The capsule's engine was running and everyone inside of the capsule was wearing a seat belt and a life preserver. Once in the water, the capsule was released and it motored away from the PENROD 61.

After the stern of the MODU fell into the water, the on-duty driller proceeded to the control room. The toolpusher, who had returned to the control room, told the driller to go to the toolpusher's office to retrieve the portable radios so that they could be placed in the No. 2 survival capsule. The toolpusher called the rig mover on PENROD 96 on the rig's VHF-FM radiotelephone and informed the rig mover that the PENROD 61 was in the water and drifting toward the PENROD 60 and that he thought the two rigs would collide. The rig mover from PENROD 96 testified that this second conversation took place about 30 minutes after their initial conversation.

Noticing that the two rigs were about to collide, the on-duty driller, who was on his way to the No. 2 capsule with two portable radios, warned the people in the capsule of the impending collision. He then ran back up to the deck over the living quarters. One of the third party service hands was standing outside of the capsule when he, too, realized the rigs were going to collide. It appeared to him that the helicopter landing pad on the PENROD 61 would strike the PENROD 60. Since the capsule was located directly under the helicopter landing pad, he thought that it might fall and crush the capsule in the collision. This man, who was wearing a life preserver, left the capsule and proceeded to the bow of the MODU and, moments before impact, jumped into the sea.

While the driller was taking the portable radios to the No. 2 capsule, the toolpusher contacted the rig mover on PENROD 96 again and reported that it looked as if the PENROD 61 might miss the PENROD 60. However, when the PENROD 61 struck the PENROD 60 about 2330, the toolpusher called the rig mover again and reported that the MODUs had collided, and that there did not appear to be any significant damage to the PENROD 60. In addition, the toolpusher stated that he was going to abandon the PENROD 61 and that he was taking a portable radio with him into the survival capsule. For unknown reasons, the toolpusher never activated the abandon rig alarm.

After the initial collision, the PENROD 61 bounced off the PENROD 60 several times before the PENROD 61 drifted clear of the PENROD 60. Once clear of the PENROD 60, the persons remaining on board the PENROD 61 boarded the No. 2 survival capsule. The Chevron drilling representative testified that there were 19 persons on board when the capsule was launched. After everyone was aboard, the capsule was lowered to the water and released. The capsule motored away from the PENROD 61 and later capsized in high seas, resulting in the occupants leaving the capsule and the subsequent drowning of the toolpusher.

The PENROD 61 continued to drift with the wind and seas until it sank in an upright position in South Timbalier Block 62 about 9 nmi northwest of its drilling site.

PENROD 60

About 0930 on October 27, 1985, the Chevron drilling representative on board the PENROD 60 received orders from the Chevron drilling superintendent ashore to cease drilling operations and to prepare for evacuation of the rig. The MODU crew immediately began to secure the well and the rig for heavy weather. The rig was secured by about 1400. The Chevron drilling superintendent contacted the drilling representative again about 1300 and ordered the evacuation of all non-essential personnel. However, the weather conditions were too severe to comply with the order. The drilling representative testified that the winds were gusting to 60 knots at that time and that by 1400 to 1500 there were gusts of 80 knots. The drilling representative discussed the situation with the toolpusher on the PENROD 60 and both agreed that the sea conditions were too severe to attempt to use the standby boat for evacuation purposes. Since the wind conditions precluded helicopter operations, they were reconciled to the fact that it was too late to evacuate the MODU and that they would have to ride out the storm. The toolpusher testified that he had no reservations concerning his vessel's ability to withstand the forces of the wind and sea. He allayed the concerns of the drilling representative when he informed him that the PENROD 60 was designed to withstand winds in excess of 100 knots.

Once the PENROD 60 was secured, all hands were ordered to remain inside the MODU and the crew was occupied with general cleaning and maintenance work inside the MODU for the remainder of the day.

The toolpusher was in the galley when he was informed that the PENROD 61 was in the water. After verifying that the PENROD 61 and one survival capsule were in the water, the toolpusher attempted to contact the Penrod office in Lafayette, Louisiana by radio, but this attempt was unsuccessful. He was able, however, to contact the toolpusher on the PENROD 54. The PENROD 60 toolpusher informed him that the PENROD 61 was in the water and that he was going to attempt to help the people in the survival capsule. The PENROD 60 toolpusher heard the PENROD 54 toolpusher relay this message to Penrod's Lafayette, Louisiana office over the radio.

Meanwhile the Chevron drilling representative, who also had gone outside to look at the PENROD 61, called the Chevron office at Leeville, Louisiana on the Chevron company radio to report the mishap and to request that the Leeville office notify the U.S. Coast Guard. While these conversations were in progress, PENROD 60 crewmen were preparing to lower a personnel basket to the water in an attempt to assist the PENROD 61 personnel in the survival capsule.

When the toolpusher completed his radio conversation, he went back outside and saw that the PENROD 61 was drifting directly toward the PENROD 60 so he made the decision to abandon the PENROD 60. He immediately went back inside the MODU and called the toolpusher on the PENROD 54 to report that he was abandoning the PENROD 60. He then sounded the abandon rig alarm. When the Chevron drilling representative heard the abandon rig alarm, he went back to his office and radioed his Leeville office to inform them that they were abandoning the PENROD 60. He testified that he was in an excited state at the time and did not wait for a response from Leeville because he had to get to the lifeboat.

All 39 persons on board reported to the single 58-man-capacity covered lifeboat on the PENROD 60. They boarded the lifeboat, fastened their seatbelts, and launched the boat. The lifeboat's engine was running before the boat hit the water. The drilling representative testified that when the boat was released into the water, the PENROD 61

was only about 50 feet away from the PENROD 60. The lifeboat had to be maneuvered between the PENROD 60's legs underneath the MODU to avoid being crushed between the two rigs. The lifeboat cleared the PENROD 60 and was on the starboard side of the MODU when the PENROD 61 struck on the port side of the PENROD 60. The lifeboat motored away from the MODU on a northerly course.

GILBERT C

The GILBERT C, a 100-foot-long steel hull passenger vessel owned by Gilbert Cheramie, Inc. of Golden Meadows, Louisiana, was operating under contract to Chevron to serve as standby vessel for the PENROD 60 and the PENROD 61. It was not specifically designed to serve as a standby vessel for MODUs in severe weather conditions. The GILBERT C did not have any specialized gear, other than a simple ladder which could be rigged over the side of the vessel, to retrieve persons from the water, and the vessel's crew was not trained in water rescue procedures. In addition, the master of the GILBERT C testified that he did not believe that he could have rescued anyone from the water in the sea conditions that prevailed on October 27. This vessel was certificated by the U.S. Coast Guard to carry 24 passengers. According to its master, the GILBERT C was to remain in the vicinity of the two MODUs to assist them in case of emergency and to carry parts and equipment from one MODU to the other. There is no Federal requirement that standby vessels be provided to MODUs.

On October 27, 1985 the GILBERT C was moored to an anchor buoy between the PENROD 60 and PENROD 61 in high winds and rough seas. The master testified that by 1200 the wind velocity was about 45 to 50 mph with gusts up to about 70 mph and that the seas were about 20 to 25 feet high. The master stated that the seas were breaking over his vessel's bow and that he was becoming concerned for the safety of his vessel and crew.

Between 1200 and 1230 the master contacted the PENROD 61 by radio to ask about their intentions concerning evacuation of the MODU. He could not identify the individual on board the MODU with whom he spoke, but he was told that "they were going to try to evacuate" and that he should stand by until evacuation was completed. The master testified that he was not informed of the manner of the proposed evacuation and he was not requested to proceed to the MODU to receive personnel. The master further testified that, in his opinion, the wind and sea conditions were too severe at that time to take personnel off the MODU onto his vessel safely.

The master stated that he did not know the identity of the persons with whom he spoke when he communicated with the rigs on the radio. He testified that there was no one person on the rigs that he recognized as being in charge of the standby vessel. He said that he would attempt to comply with any order that he received over the radio from anyone who identified themself as being from one of the rigs.

About 1430, the master again contacted the PENROD 61 by radio and asked how soon they were going to evacuate. He was told by the same unidentified person with whom he had spoken before that it was "too late" to evacuate the MODU by helicopter. The master then offered to move the GILBERT C over to the MODU to take personnel on board, but this offer was refused. He testified that the seas had increased to 22 to 28 feet by this time and that any attempt at personnel transfer from the MODU to the standby vessel would have been hazardous, but that he would have made the attempt if he had been requested to do so. However, he further testified that in order to do this, the stern of his vessel, which had only 4 feet of freeboard, would have been completely submerged by the high seas and people could have been washed overboard.

About 1500, the master of the GILBERT C called the PENROD 61 on the radio and requested permission to leave the area. In response, an unidentified voice reminded the master that it was his "job" to stand by and that if he wanted to "quit the job" he could go. Under these conditions the master of the GILBERT C decided to remain. The master then went to check the engineroom while the engineer monitored the radio on the GILBERT C. After about 10 minutes, the engineer came to the engineroom and informed the master that one of the MODU's called on the radio and released the standby boat. The master of the GILBERT C did not attempt to verify the order. He accepted the engineer's word that the order had been issued and started the vessel's engines and prepared the vessel to leave the area. About 1630 the master got the GILBERT C underway and proceeded on a course for Belle Passe, Louisiana.

The master of the GILBERT C testified that, had he remained in the area until the capsules were launched from the PENROD 61, he would not have attempted to rescue survivors from the capsules because the capsules might have been smashed against the side of his vessel in the high seas.

At approximately 2145, when the GILBERT C was about 3 miles offshore, large waves struck the vessel and collapsed the pilothouse windows. Sea water short circuited the navigation and vessel control equipment. The electrical steering controls, radar, and radio equipment were all rendered inoperative. The master steered the vessel all night using the twin engines. The next morning, when the seas had abated somewhat, he maneuvered the vessel into Terrebonne Bay.

Injuries to Persons

Injuries	PENROD 61	PENROD 60	Total
Fatal	1*	0	1
Serious	0	0	0
Minor/None	42	39	81
	43	39	82

*One other crewman from the PENROD 61 died 16 days after the accident from a massive pulmonary embolus. The Safety Board cannot determine whether this death was related to the accident.

Damage to Vessels

PENROD 61.--The PENROD 61 was destroyed in this accident. The loss was estimated at $40 million.

PENROD 60.--The PENROD 60 suffered extensive damage to the port side of its hull as a result of the collision with the PENROD 61. The damage was estimated at $150,000.

Crew Information

The PENROD 61 was manned by 43 persons, 26 of whom were employed by Penrod Drilling Company. The remaining 17 persons were employed by Chevron or by third party companies under contract to Chevron. The crew of the PENROD 61 worked 7 days and were off duty 7 days. When on duty, the crew was divided into two 12-hour shifts, one working from 0600 to 1800 and the other working from 1800 to 0600. The crew had come on duty aboard the PENROD 61 on October 24, 1985.

The PENROD 61 toolpusher was in overall command of the vessel and all vessel operations were conducted under his direction. Although the licensing of masters of non-self-propeller MODUs is not required, the toolpusher was licensed by the U.S. Coast Guard as master of column-stabilized or self-elevating motor drilling vessels of any gross tons upon oceans while under tow or engaged in mineral and oil exploration. His license was endorsed to show qualification as radar observer. He received his original license on October 13, 1977. Prior to the issuance of this license he was examined by a U.S. Public Health Service physician and was found to be physically competent to perform the duties incumbent with the license for which he applied. Persons who dealt with the toolpusher on the date of this accident testified that he appeared to be normally alert and active and that he displayed no behavioral abnormalities.

U.S. Coast Guard records showed that the toolpusher had over 10 years experience as a roughneck, motorman, derrickman, and driller on land based oil rigs; over 3 1/2 years experience as a driller on an offshore platform; and over 4 years experience as toolpusher on board MODUs before he obtained his original license in 1977.

Penrod Drilling Company records showed that the toolpusher had been employed in various capacities and for varying periods of time by this company since 1958 and that he had been employed as toolpusher on board the PENROD 61 since May of 1973.

The Chevron drilling representative was the senior Chevron official on board the PENROD 61. He testified that he was responsible for the drilling of the well and for obtaining transportation and supplies necessary for the drilling operations. He said that he normally would arrange for all transportation to and from the MODU. He further stated that the toolpusher was not subordinate to him concerning the operation of the MODU, and that he would consult with the toolpusher on important matters. The drilling representative, age 31, was not licensed and was not required to be licensed by the U.S. Coast Guard. He had an associate degree in petroleum engineering and technology and had 2 1/2 years experience in the offshore oil industry. He had been assigned to the PENROD 61 since July 1985.

Vessel Information

The PENROD 61 was a self-elevating mobile offshore drilling unit owned and operated by the Penrod Drilling Company of Dallas, Texas. The vessel was built in Vicksburg, Mississippi by the Marathon Le Tourneau Company in 1972 and was classed by the American Bureau of Shipping (ABS).

The PENROD 61 was designed and built to meet the 1968 ABS "Rules for Building and Classing Offshore Mobile Drilling Units." These rules required that the drilling unit's legs be able to withstand the forces of a 100-knot wind and a maximum wave height (determined by the owner) when the unit is elevated 5 feet above the crest of the design wave. Accordingly, the owner of the PENROD 61 submitted calculations to ABS which established that the legs of the PENROD 61 were designed to withstand the forces of a 100-knot wind and a maximum wave height of 43 feet when the unit was operating in the elevated mode in a water depth of 250 feet.

The MODU consisted of a roughly triangular-shaped barge hull of welded steel construction with three 467-foot long jack-up legs. (See figure 2.) The principal characteristics of the barge hull were:

Length (overall)	231.0 feet
Width (overall)	200.5 feet
Depth	26.0 feet

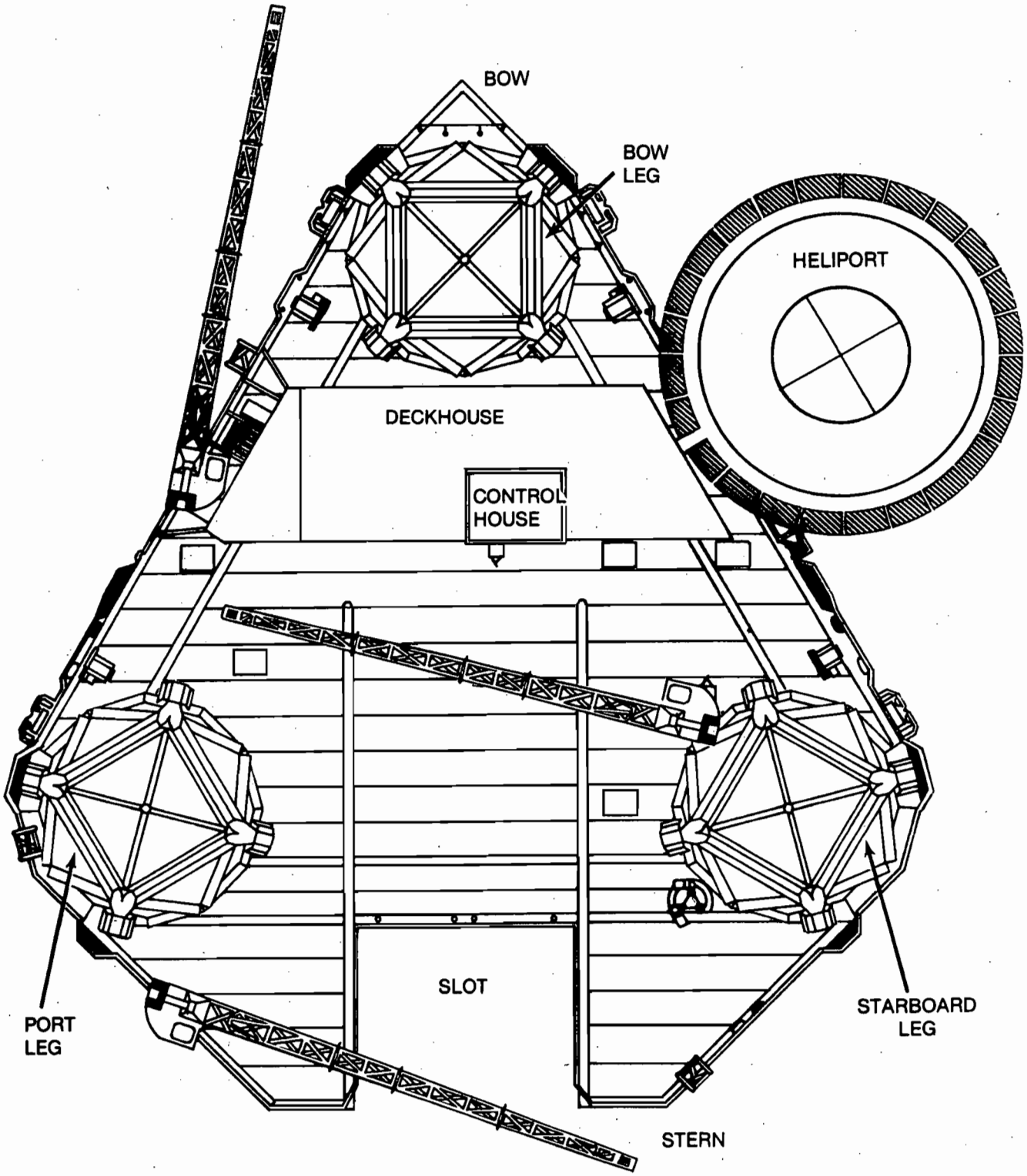

Figure 2.--Plan View of PENROD 61.

The bow leg was located on the vessel's centerline near the apex of the triangular shape and the other two legs were located on the port and starboard sides near the stern. At the bottom of each leg was a 46-foot diameter conical disc-shaped spud can footing 26 feet high. The spud can footings provided a bearing surface upon which the MODU could be supported when the legs were lowered to the sea floor and when the MODU was raised above the water's surface. (See figure 3.)

A 3-level deckhouse containing living accommodations for the crew was mounted on the main deck just aft of the bow leg. A control house, containing the MODU's control room where the leg jacking controls were located, sat atop the deckhouse. A 70 1/2-foot diameter heliport was appended to the starboard side of the vessel adjacent to the deckhouse. The top of the heliport was even with the top of the first level of the deckhouse.

The main deck aft of the deckhouse provided a work platform for drilling operations and an area for the storage of drill pipe, casing, and collars. The stern was slotted to accommodate the placement of the MODU over the well site for drilling operations.

The machinery deck, located one deck below the main deck, contained pumps, motors, and various equipment necessary for the operation of the MODU. Electrical power was supplied by three diesel driven generators located in the engineroom below the deckhouse. Normal rig operations required the operation of only one diesel generator, but leg jacking operations required that two generators operate at the same time.

Below the machinery deck the hull was subdivided into various compartments for the storage of such items as drill water, fresh water, and fuel. Tanks were also provided for preloading the unit prior to the commencement of drilling operations.

The MODU was not self-propelled. It was designed to be towed to a drilling site where the legs would be lowered to the sea floor and the unit would be elevated above the water surface.

The PENROD 61 was outfitted with an electromechanical leg jacking system that allowed the barge hull to be raised or lowered at a rate of about 1 1/2 feet per minute. A gear rack was mounted on the entire length of the four vertical support members of each leg. Four electrical motors mounted on each corner of the leg guide housing drove a reduction gear train which in turn drove a pinion gear which engaged the vertical gear rack. Each of the motors was fitted with a mechanical brake which could only be released when the motor was in operation. If, for any reason, electric power was lost, the brakes immediately set preventing the further movement of the hull in relation to the legs.

Controls for the leg jacking system were located on a console located in the control room. The console contained an on/off keylock switch and nine push button function switches (three push button switches for each leg) by which the barge hull could be raised, lowered, or stopped. Leg jacking operations could be conducted on each leg independently or on all three legs simultaneously. In order to jack the hull up on the bow leg, the toolpusher had to insert a key into the keylock switch to activate the console and then push the bow leg raise button. The console also contained a leg motor overload warning system with one analog kilowatt meter and one warning light display for each leg. According to the testimony of the rig mover from the PENROD 96, an amperage problem with any of the 16 jacking motors on a particular leg would be indicated by the needle deflection on the kilowatt meter for the leg and by the illumination of the warning light for the particular motor. If a problem developed, jacking operations would be stopped by pushing the appropriate button on the console.

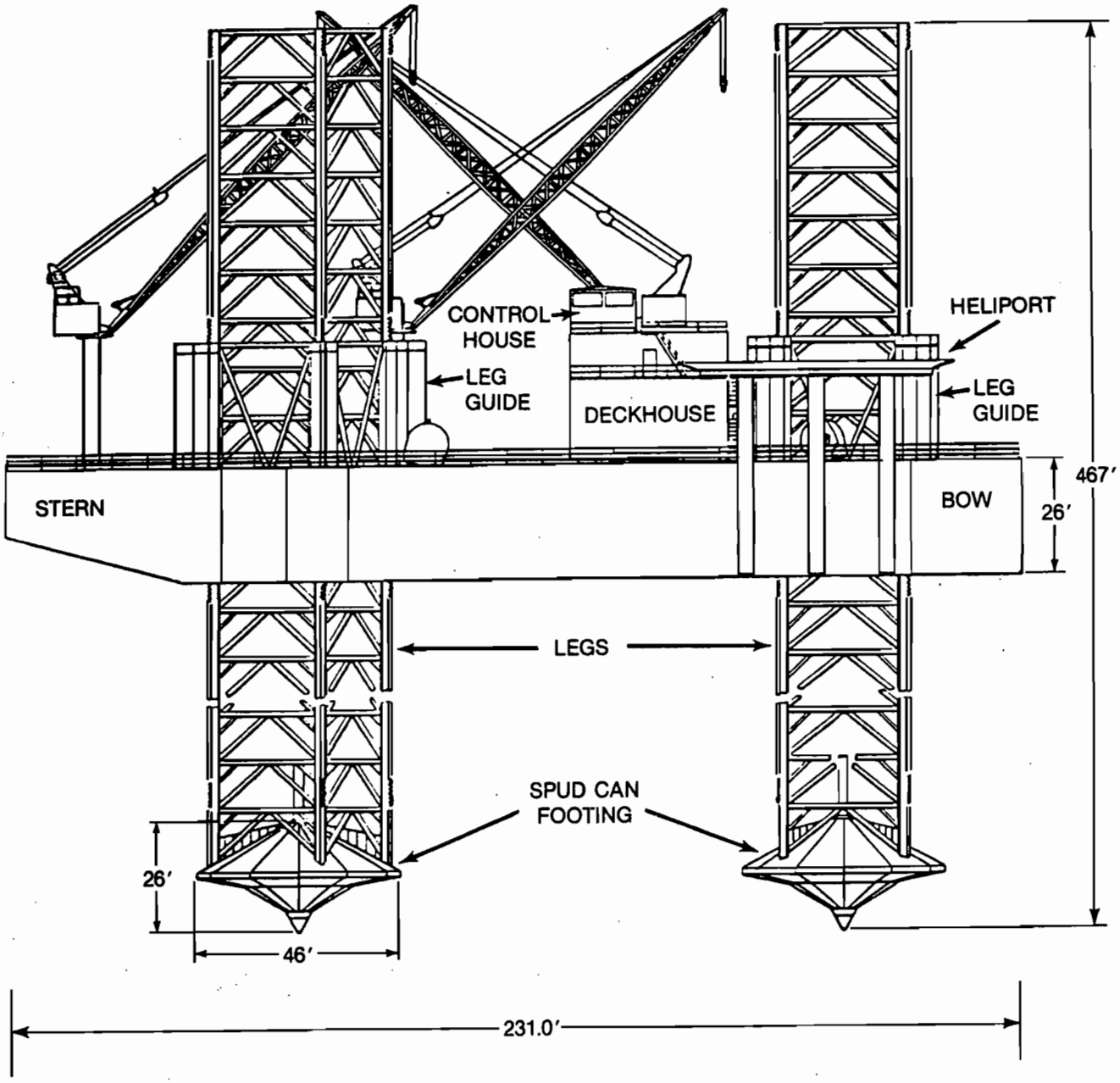

Figure 3.--Outboard Profile of PENROD 61.

The jacking system was capable of elevating or lowering the unit with a combined fixed 6/ and variable load of 8 million pounds. The maximum allowable variable load that the unit could carry during jacking operations was 4,116,666 pounds. The electrician, who was responsible for keeping track of the variable load on the PENROD 61, testified that the variable load on the unit as of 0500 on October 27, 1985 was 3,097,000 pounds.

Before the accident, the PENROD 61 was jacked-up 50 feet above the still water surface of the sea. (See figure 4.) The three legs penetrated the sea floor to varying depths, as indicated below:

Leg	Depth (To Bottom of Footing)
Bow	57 feet
Port	72 feet
Starboard	76 feet

In this configuration the legs exited from the top of the leg guide structure, which was 26 feet above the main deck, at various distances from the bottom of the footings as follows:

Leg	Distance
Bow	405 feet
Port	420 feet
Starboard	424 feet

The primary lifesaving equipment on board the PENROD 61 were two 28-man capacity Whittaker model 9091 survival capsules (see figure 5) and four 20-man-capacity Switlik inflatable liferafts. The survival capsules were inspected on February 21, 1985 by a U.S. Coast Guard marine inspector during a regular periodic inspection and found to be in a satisfactory condition. The inflatable liferaft installations were also examined and found to be satisfactory. The rafts, themselves, had been sent ashore to an authorized servicing facility the preceding year for annual inspection and servicing as required.

Scale model tests 7/ of the Whittaker model 9091 survival capsule performed in 1976 on behalf of the capsule manufacturer showed that when subjected to a 24-foot regular wave having a regular wave period of 6.32 seconds, the capsule remained "upright and stable" when allowed to drift in an unflooded dry condition, with doors closed, and with passengers (simulated by weights) secured and seated evenly about the capsule. However, when subjected to steep breaking waves having a full scale equivalent wave height of 45 to 48 feet, the capsule model capsized. These tests did not take into account the effects of wind.

Meteorological Information

Summary.--Hurricane Juan was first listed as a tropical depression on October 25 when a rapid increase in cloudiness and the development of gale force winds was noted in connection with a trough in the central Gulf of Mexico. After erratic movement in the central Gulf, it was labeled a tropical storm on October 26 and began a relatively steady

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6/ The weight of all equipment which is continuously attached to the hull, including cranes, winches quarters, heliport, engines, generators, and drilling machinery.
7/ "Survival Capsules O.T.C. Model Testing, September 7 and 8, 1976," Report No. 78-004, February 8, 1978.

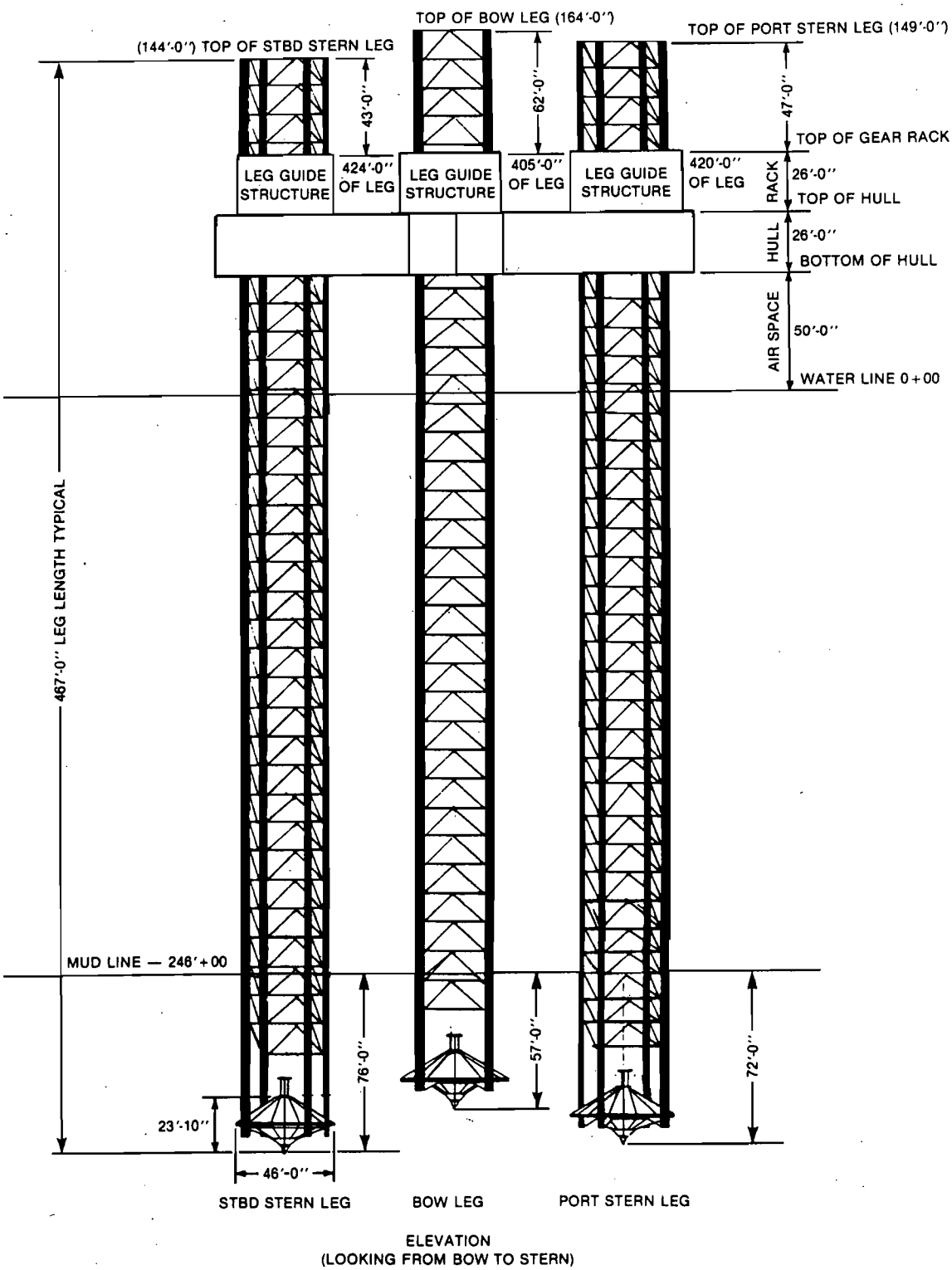
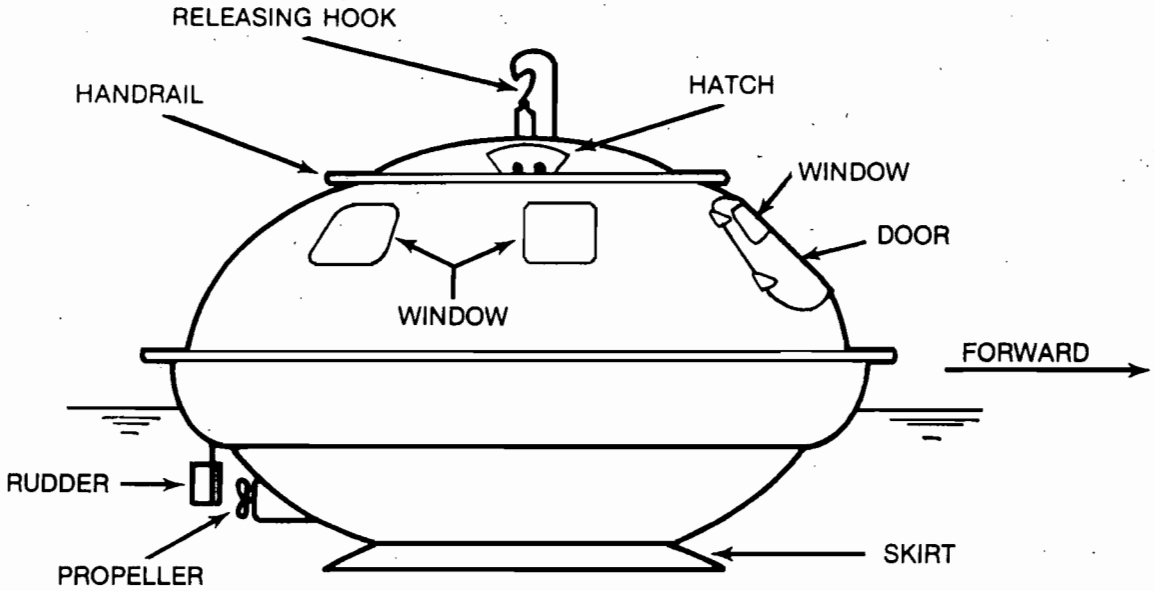


Figure 4.--Sketch of PENROD 61 showing vessel condition prior to accident.



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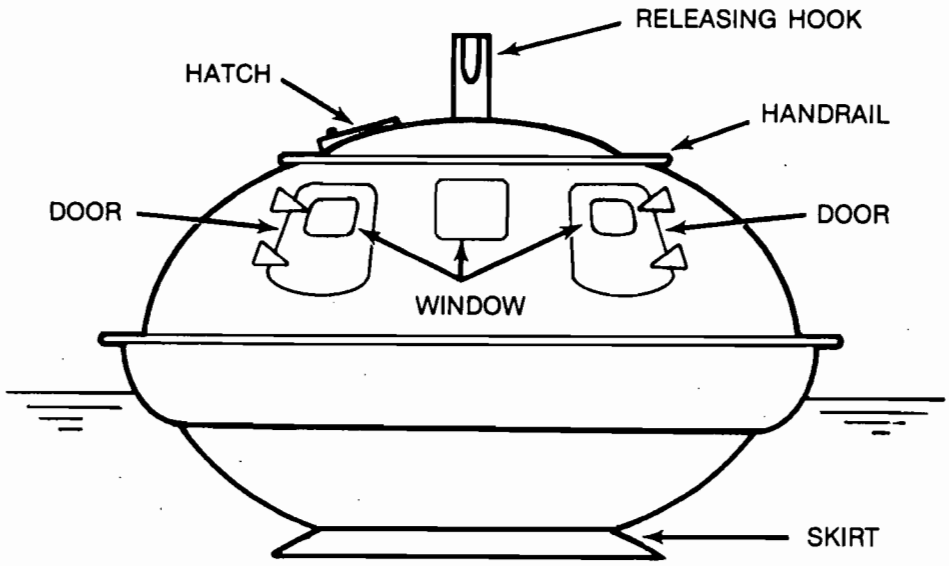

FRONT

Figure 5.--Sketch of Whittaker Model 9091 survival capsule.

northward movement on October 27. At approximately 1800 on October 27, the storm intensified to become a hurricane 8/. It continued its northward movement until reaching the Louisiana coast west of New Orleans on October 28; Hurricane Juan passed closest to the PENROD 61 at approximately 0000 on October 28. At that time, winds in the vicinity of the PENROD 61 were about 65 knots gusting to 80 knots and the seas were from 18 to 27 feet. Appendix A contains the reconstructed weather conditions in the vicinity of the PENROD 61 from 0000 on October 25 through 0600 on October 28.

Weather Forecasts

Weather forecasts were issued for the area in which the PENROD 61 operated by the National Weather Service Forecast Office in New Orleans, Louisiana. Tropical storm and hurricane warnings were issued by the National Hurricane Center in Miami, Florida. Additionally, the PENROD 61 had weather forecasts and storm warnings from a commercial weather forecasting company in New Orleans. (See Appendix B.)

Forecasts by the National Hurricane Center.--The National Hurricane Center at Miami, Florida, issued the first advisory concerning Hurricane Juan at 2200 on Friday, October 25. At the time, the storm was an unnamed tropical depression. After the first advisory, advisories were issued periodically throughout the life of the storm until it became extratropical over the southern United States. (See figure 6.) Neither Chevron nor Penrod used the forecasts of the National Hurricane Center to determine if the MODUs should evacuate. Instead, they relied primarily on the forecasts provided by a commercial weather forecasting firm.

Forecasts by the Commercial Firm.--Beginning with the advisory issued at 1500 c.d.t. on October 26 and continuing throughout the approach of the storm, the commercial firm recommended that offshore operations in the area of the PENROD 61 complete "hurricane precautions" by 1800 on October 27.

Throughout the day of October 26, the firm's weather advisories reported that the storm system was moving in a westward direction and forecasted that it would continue in this direction until it crossed the lower Texas or upper Mexican coast. Based on the forecasted westward movement of the storm, Chevron shoreside officials assumed that the storm would move away from the area where the PENROD 61 was located and that there was no need to evacuate the MODU. However, in the advisory issued at 0600 on October 27, the commercial firm reported that the storm changed direction and began to move in a north northeasterly direction and the storm was predicted to continue to move northward.

8/ A warm-core tropical cyclone in which the maximum sustained surface wind is greater than or equal to 64 knots.

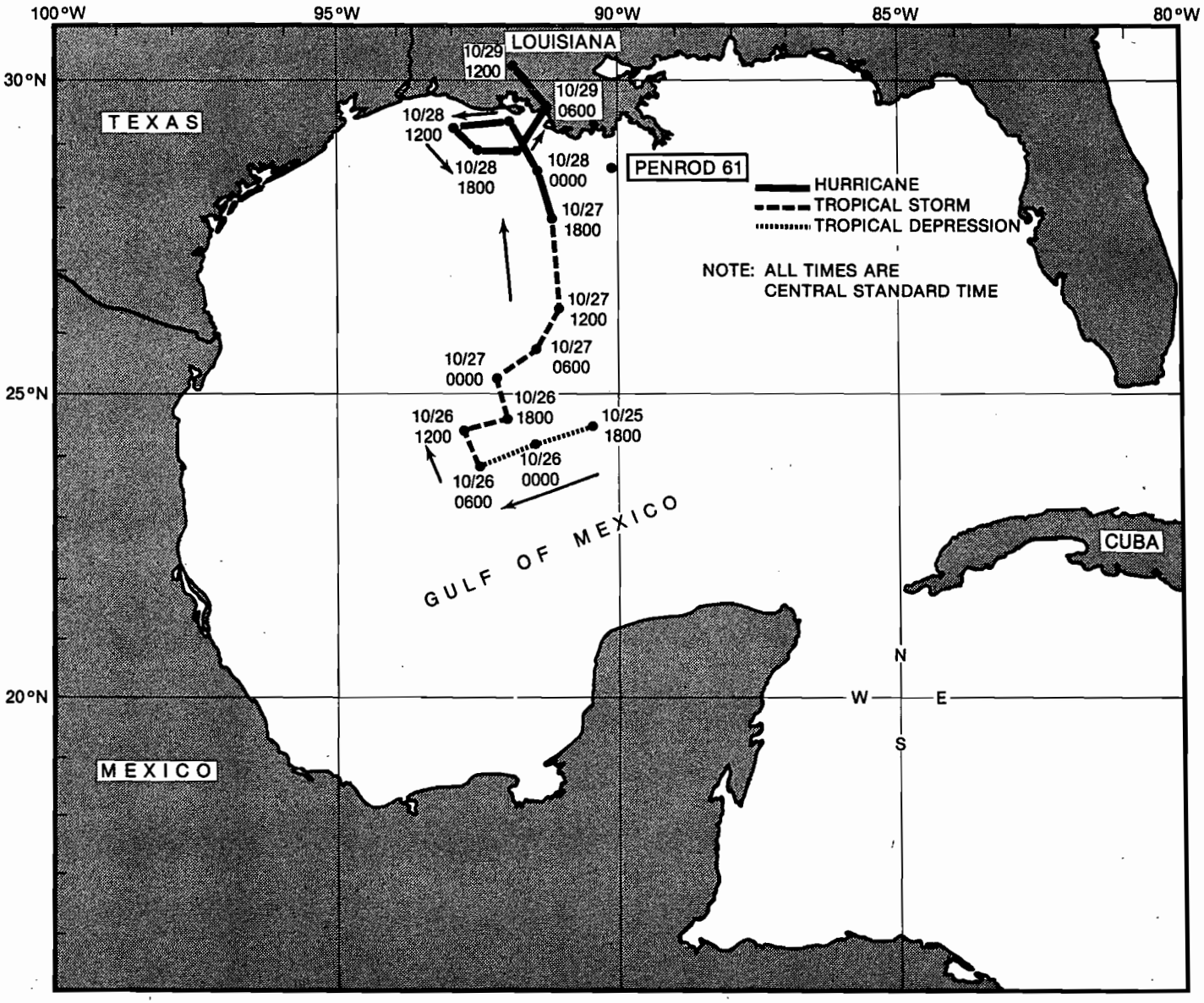

Figure 6.--Chart of the Gulf of Mexico showing accident site and track of Hurricane Juan.

Tropical Cyclone Statistics

The following is a compilation of statistics for the 20-year period from 1966 through 1985 showing the incidence of tropical cyclones in the Gulf of Mexico:

Tropical Cyclones	Number	Percentage
Total Tropical Cyclones	53	
Total Hurricanes	32	60% of all Tropical Cyclones
Tropical Cyclones that Originated in Gulf	22	42% of all Tropical Cyclones
Tropical Cyclones that Originated in Gulf and Became Tropical Storms	18	34% of all Tropical Cyclones and 82% of Tropical Cyclones that Originated in Gulf
Tropical Cyclones that Originated in Gulf and Became Hurricanes	9	17% of all Tropical Cyclones, 41% of all Tropical Cyclones that Originated in Gulf, 50% of Tropical Cyclones that Originated in Gulf and Became Tropical Storms, and 28% of all Hurricanes
Tropical Cyclones that Entered the Gulf	31	58% of all Tropical Cyclones
Tropical Cyclones that Entered the Gulf and Became Hurricanes	23	43% of all Tropical Cyclones, 74% of all Tropical Cyclones that Entered the Gulf, and 72% of all Hurricanes

Wreckage

Divers conducted surveys at the offshore drilling site in Grand Isle Block 86 in the Gulf of Mexico and at the wreck site in South Timbalier Block 62 where the PENROD 61 sank.

At the drilling site portions of all three legs were found sticking out of the mud on the sea floor. From markings on the legs the divers were able to determine the distance from the bottom of each spud can footing to the top of each leg portion:

Leg	Distance
Bow	347.5 feet
Port	365 feet
Starboard	367 feet

All three leg portions were inclined from the vertical toward where the bow of the vessel had been. The bow leg was inclined at an angle of about 40 degrees from the vertical while the port and starboard legs were inclined about 30° and about 45° respectively from the vertical. The forward two vertical members of the bow leg were sheared off, while the after two vertical members of the bow leg were heavily damaged from compression from the top downward for about 40 feet. Due to the prohibitive cost of such an operation, portions of the bow leg containing the fracture surfaces were not recovered from the drilling site for metallurgical examination. All three leg portions were found to be straight from the mudline upward. From markings on the bow leg, divers determined that the bow leg penetrated the mudline 81 feet from the bottom of the spud can footing. When corrected for the angle of leg inclination from the vertical, this established that the spud can footing was approximately at the same level of penetration in the sea floor as it was before the accident.

At the wreck site in South Timbalier Block 62, the PENROD 61 was resting on the bottom in an upright position in 93 feet of water. From markings on the legs, divers determined the distances from the bottom of each spud can footing to the point where the leg exited from the leg guide structure were as follows:

Leg	Distance
Bow	405 feet (approximately)
Port	419 feet
Starboard	423 feet

Horizontal and diagonal supports of the bow leg were broken and several were missing from inside of the leg guides and from inside of the leg well on the bow leg. The portion of bow leg that extended above the leg guide structure was angled in a forward direction between 12 1/2-28° from the vertical depending on the point from which the angular measurements were taken. The bow leg guide assembly was deformed due to the bending of the bow leg. The port and starboard legs and their associated leg guide assemblies remained vertical and very little damage to the horizontal and diagonal members of these legs was noted.

No damage was found to the deck of the MODU, but the hull had several holes in the No. 18 preload tank just aft of the starboard leg. Two holes were noted on the port side of the stern near the slot, one hole was about 6 feet by 8 feet and the other was about 1 feet by 2 feet. Since the hull was sitting in an upright position in the mud, it is unknown whether the bottom of the hull was holed.

Waterway Information

At the time of the accident the PENROD 61 was located in Grand Isle Block 86, about 25 nmi south of the Louisiana coast in the Gulf of Mexico. Since this location was on the outer continental shelf of the United States, drilling operations were regulated by the Minerals Management Service (MMS) of the U.S. Department of the Interior. Information obtained from MMS showed that seven wells had been drilled successfully by jack-up type MODUs in this block prior to the well that the PENROD 61 was drilling. According to the MMS:

> The surface site of the No. 5 well [the drilling site of the PENROD 61] is underlain by channel fill from the seafloor to about 3000 feet. Gas vents on the seafloor are present about 600 feet SSW and 1000 feet NW of the surface site. Biogenic gas is present in these shallow sediments which have potential for lowering the stability of rig footings and platform supports. The seafloor at the site of the No. 5 well was smooth and was not gas pressurized sufficiently to disrupt the shallow strata. No shallow faulting or shallow gas was observed on high resolution data or deep seismic data.

After the accident Chevron hired a commercial engineering firm to obtain core samples of the sea bottom in the immediate area of the well site to determine the type of soil and the soil strength. The core sample was taken within about 150 feet of the PENROD's bow leg and was tested and analyzed to determine its composition and physical characteristics. A representative of the commercial engineering firm that obtained the sample testified that the sample contained a uniform clay profile that had a linearly increasing shear strength with depth. He said that the shear strength started at about 30 pounds per square foot at the sea floor and increased to about 900 pounds per square foot at 100 foot depth and that there was negligible biogenic gas in the sample to 100-feet. He said that for every foot of penetration into the sea bottom, the shear strength increased about 10 pounds per square foot, and that the moisture content of the sample decreased with depth. He further stated that there were no anomilies in the soil sample between 50 foot and 75 foot depths, that the profile of the sample was very consistent throughout, and that there was no evidence that the soil would not support the weight of a jack-up type MODU. The results of this core sampling were compared to seven previous core samples taken at various locations in Grand Isle Block 86 and all eight samples were found to be "very consistent."

The engineering firm representative reviewed the information obtained from the MMS concerning the presence of gas vents near the well site. He said that the gas vents were a significant distance away from the drilling site and that they should not have had any influence upon the footing penetration of the PENROD 61.

Survival Factors

According to Coast Guard records, the Coast Guard Operations Center in New Orleans was first notified that the PENROD 61 was in trouble at 2333 by telephone from the Penrod office in Lafayette, Louisiana. At that time, the Coast Guard was informed that the crew was abandoning the rig into "lifeboats." The Coast Guard Operations Center was again telephoned by Penrod's Lafayette office at 2345 and informed that the PENROD 61 had collided with the PENROD 60, and that the crew of the PENROD 60 was also abandoning that MODU. The Coast Guard was informed that commercial vessels in the area were en route to render assistance and, at 0020 on October 28, 1985, the U.S. Coast Guard Cutter ACUSHNET was diverted from another case to assist. ACUSHNET's estimated time of arrival on scene was 1500.

After the PENROD 60 and PENROD 61 were abandoned, the covered lifeboat from PENROD 60 and the two survival capsules and the inflatable liferaft from PENROD 61 traveled in a northerly direction with the wind and seas. The lifeboat and the survival capsules proceeded under power provided by their engines.

The survival capsules heaved, rolled, and rotated in the heavy seas and the men inside them suffered from seasickness and fatigue. The capsules each had two steering stations--one in the front of the capsule near the doors and the other in the back of the capsule near the engine controls. Capsule No. 1 was steered from the steering position near the engine controls and capsule No. 2 was steered from the steering position near the doors. Visibility was severely limited, not only because it was night time, but also because of extreme height of the waves. Nevertheless, survivors testified that, at times, the lights of rigs and platforms in the area were sighted.

In the No. 2 capsule the toolpusher instructed the men to keep their life preservers on and to keep their seatbelts fastened. There were two portable Penrod company radios in capsule No. 2 which could transmit and receive messages on VHF-FM channels 6 and 8. Several attempts were made to use them but with negative results. The rig mover on PENROD 96 testified that the PENROD 61 toolpusher had informed him in their last radio conversation that he was taking portable radios with him when he abandoned the PENROD 61. The rig mover's attempts to contact the capsule on VHF-FM channels 6 and 8 were also unsuccessful.

Sometime around 0300 on October 28 the No. 2 capsule was struck by a large wave and capsized from back to front. When the capsule capsized, its engine immediately stopped operating. The men inside the capsule were suspended by their seatbelts in an inverted position. Some of the men shouted for everyone to remain buckled in their seats because, they said, the capsule would right itself. After some moments, however, it became apparent that the capsule would not return to the upright position and the men began to release themselves from their seat belts. Once free of their seat belts, some of the men moved to one side of the capsule and attempted to right the capsule by shifting their weight and rocking the capsule. However, this effort was not successful.

Immediately after the capsizing, water began to enter the capsule from an undetermined source. Within minutes there was 2 to 3 feet of water inside the capsule. One of the men reached into the water and released the latch to one of the capsule doors. The door was opened outward and the men began to exit the capsule. Since all of the men were wearing life preservers, they had to pull themselves underwater to exit from the doorway. Some went out head first and some feet first, but all of the men were able to escape from the capsule.

Once outside, the men grabbed a lifeline that was tied around the periphery of the capsule. Some of the men climbed on the capsule and sat inside a fiberglass skirt that was fitted to the bottom of the overturned capsule. However, they were soon washed off of the capsule by the high seas. Attempts to remain on the capsized capsule were futile as the high waves forced the men back into the water. The toolpusher was one of the persons who was repeatedly washed off the capsule. One of the survivors testified that while he was on the capsule with the toolpusher, the toolpusher complained of chest pains and said that he was having difficulty breathing. Another survivor testified that the last time he saw the toolpusher, the toolpusher had been washed off the capsule but did not attempt to swim back to it and was carried away by the waves. The toolpusher's body was later recovered still wearing a life preserver.

The No. 1 capsule was in the same general area as the No. 2 capsule. About 0430 the men in the No. 1 capsule sighted the lights of a nearby vessel, and one of the men in the capsule opened a hatch in the top of the capsule and fired a distress flare to attract the vessel's attention. This vessel, the M/V KODIAK II approached the capsule and kept a searchlight shining on it. When the men in capsule No. 1 realized they had been seen by the vessel, they shut off the capsule's engine and began to drift. At the same time, the M/V DARRYL TIDE which was also in the area, sighted the capsized capsule and the men in the water, and radioed the U.S. Coast Guard in New Orleans, Louisiana to report the sighting. At 0430 the Coast Guard launched a helicopter from the Coast Guard Air Station, New Orleans to render assistance. In the meantime, the KODIAK II and the DARRYL TIDE remained near the survivors and kept them illuminated with searchlights.

At 0515 the Coast Guard helicopter arrived on scene and began hoisting the survivors from capsule No. 1. However, after hoisting three persons from the capsule, the helicopter moved to the overturned capsule No. 2 and rescued the men who were in the water and clinging to that capsule. Another Coast Guard helicopter was dispatched to the scene from Mobile, Alabama. This helicopter arrived on scene at 0815 and rescued the remaining 19 persons from capsule No. 1.

The welder who had abandoned the PENROD 61 in the inflatable liferaft drifted with the wind and sea all night. He was rescued by the same Coast Guard helicopter which rescued the people from the capsized capsule.

The covered lifeboat from the PENROD 60 motored all night in a northerly direction. About 0930 on October 28 the lifeboat arrived at a manned offshore oil platform in South Timbalier Block 54. Platform personnel lowered a crane mounted personnel basket and rescued all 39 persons from the lifeboat without injury.

The third party service hand who jumped into the sea moments before the PENROD 61 collided with the PENROD 60 floated in the water all night. This individual, who testified that he weighed 255 pounds, had difficulty remaining afloat despite the fact that he was wearing a life preserver. The service hand used a board and a paint can he found floating nearby for additional buoyancy. Sometime after noon on October 28 he was spotted by the pilot of a commercial helicopter. Since commercial helicopters are not equipped with specialized water rescue equipment, the pilot could not rescue the man from the water. The pilot of the commercial helicopter hovered over the service hand until a Coast Guard helicopter arrived about 1330 and rescued him from the water.

Medical and Pathological Information

A post mortem examination of the toolpusher showed that he died as a result of salt water drowning. Other than minor bruises and abrasions on his extremities and a bruise on his right forehead, there were no visible signs of external injury. Examination of the victim's rib cage revealed non-dislocated fractures of the anterior right third through eighth ribs. Examination of the respiratory system showed that the victim had suffered from severe emphysema. This condition would have impaired the toolpusher's vitality and ability to remain active in activities such as treading water, swimming back to the capsule, and climbing aboard and clinging to the capsule.. Drug and alcohol screening was negative.

Other Information

Hurricane Evacuation.--According to the contract between Chevron and Penrod, Chevron was responsible for providing "necessary marine transportation between shore and well location for labor, equipment, and supplies." There was nothing in the contract which specifically addressed the responsibility to provide transportation for the purpose of evacuating the MODU in the event of hurricane, or other emergency. The production manager for Chevron's southeastern division, which included the area in which the PENROD 61 was working, testified that at the beginning of the hurricane season he was responsible to insure that a "viable hurricane evacuation plan" was prepared for the southeastern division. Accordingly, a three-phrase plan dated May 29, 1985, was in force at the time of the accident. This plan, however, dealt primarily with securing Chevron equipment and facilities ashore and did not specifically deal with MODUs working under contract to Chevron.

The Chevron drilling representative testified that it was not part of his responsibility to order a MODU evacuated on account of adverse weather conditions. He stated that the decision to evacuate a MODU due to weather conditions would have to be made by Chevron shoreside officials. The Chevron southeastern division production manager also testified that the authority to order such an evacuation rested primarily with shoreside company officials. Additionally, he stated that Chevron drilling representatives have the authority to order such an evacuation, but that they would not normally be expected to do so without first conferring with shoreside company officials. However he further testified that "perhaps the ultimate responsibility" to order a MODU evacuation because of adverse weather conditions rests with the MODU owner. He said, "It's his [the owner's] equipment. He knows how much it can stand, how much -- you know, how much bad weather, and he knows the design criteria and all that. . . ." The Chevron southeastern division production manager stated that if the Penrod representative (toolpusher) on either the PENROD 60 or PENROD 61 had requested transportation to evacuate their MODUs, Chevron would have provided it, if possible. The toolpushers on the PENROD 60 and the PENROD 61 made no request to any Chevron representative for transportation to evacuate their MODUs, nor did they make such a request to any Penrod official ashore.

The alternate toolpusher from the PENROD 61 testified that it was his understanding that any evacuation of the MODU due to weather would have to have been ordered by Chevron since Chevron provided all transportation to and from the MODU.

Penrod did not have a formal hurricane evacuation plan in effect for its MODUs and issued no orders for the evacuation of any Penrod MODUs working off the Louisiana coast. Inter-company correspondence dated May 9, 1972 and addressed to the toolpushers on the PENROD 60 and PENROD 61 established procedures for shutting down drilling operations and for securing the vessels in anticipation of a hurricane, but provided no direction or guidance on evacuating personnel from the MODU.

MODUs at Risk During Hurricane Juan.--According to information received from the International Association of Drilling Contractors (IADC), there were 171 MODUs working offshore with full crews on board in the Gulf of Mexico during Hurricane Juan. The geographical distribution of these MODUs was as follows:

Location	Number of of MODUs
Florida coast	3
Alabama coast	8
Louisiana coast	122
Texas coast	38

In addition, the IADC estimated that there were about 100 other MODUs with partial crews at various locations in the Gulf of Mexico, but not engaged in drilling operations when Hurricane Juan developed.

The IADC had no information regarding the number of these MODUs that were evacuated as a result of the storm.

Inspection Procedures.--Coast Guard regulation 46 CFR 107.267 allows for a special examination in lieu of drydocking for self-elevating MODUs. This regulation states:

> §107.267 Special examination in lieu of drydocking for self-elevating units.
>
> (a) A self-elevating unit must be specially examined in accordance with a plan-
> (1) Submitted in accordance with paragraph (b) of this section; and
> (2) Approved by the Commandant (G-MVI).
>
> (b) To meet the requirements in paragraph (a) of this section, the owner or operator of the unit must submit a plan to the Commandant (G-MVI) that provides for-
> (1) Examination of the unit's hull while it is in the elevated position; and
> (2) Examination of the supporting mat, spud cans, or footings while the unit is afloat.
>
> (c) The plan required in paragraph (b) of this section must contain the following information:
> (1) The planned location where the unit is to be examined.
> (2) The methods to be used to conduct the hull examination.
> (3) The method of visual presentation for examination of the underwater components.
> (4) The methods of determining the condition of the underwater components.
> (5) The underwater high stress areas and the welds in those areas that are to be examined.
> (6) The names of the diver or diving company selected for the examination.

The Coast Guard conducted a special examination in lieu of drydocking on the PENROD 61 in February 1985. During this examination a Coast Guard inspector examined the underwater portions of the legs and the spud can footings using divers equipped with video cameras. The Coast Guard inspector, who was in voice communication with the divers, directed the divers to what areas which were to be inspected and viewed these areas on a video monitor on board the MODU. At the time of the examination, the PENROD 61 was afloat and the legs were raised so that the tops of the spud can footings

were about 10 feet below the surface of the water. All external areas of the footings were examined with special attention given to the leg-to-footing connections, which are considered to be high stress concentration areas. No damage or other discrepancies were noted. The underwater portions of the legs were also examined and were found to be in a satisfactory condition. There is no record of any inspection of the remaining portions of the leg structures which extended above the deck of the MODU. Coast Guard regulations do not require that the entire length of the legs on self-elevating MODUs be inspected and the Coast Guard has not provided any guidance or procedures for inspectors to follow in order to conduct such an inspection.

ANALYSIS

The Collapse

The collapse of the PENROD 61 resulted from a failure associated with the bow leg. The first reported indication of a potential problem with the bow leg occurred about 1730 on October 27 when the Chevron drilling representative, looking at the bubble level indicator in the control room, noticed that the MODU was listing about 2° by the bow. He immediately informed the toolpusher and the toolpusher then instructed the night driller to mark the legs and the adjacent vessel structure so that any vertical movement of the vessel's hull in relation to the legs would become readily apparent. This was a proper action to take since there was no other way to determine whether the bow leg brakes were slipping, or whether there was some other cause for the list. However, it probably would have been more prudent for the toolpusher to have taken this action when he apparently suspected that the brakes were slipping after his 1500 conversation with the Chevron drilling representative in which the drilling representative asked the toolpusher about the shuddering and the popping noise emanating from the MODU's legs. However, the dive survey conducted after the accident at the wreck site established that the bow leg exited the top of the leg guide structure at approximately the same distance from the bottom of the footing as it did before the accident. The Safety Board, therefore, concludes that there had been no vertical movement of the MODU's hull in relation to the leg and that no failure of the leg jacking or braking system occurred.

Jack-up type MODUs sometimes collapse as a result of a rapid and unrestricted penetration of the sea floor by a leg footing. This phenomenon, commonly known as a "punch through," is normally caused by a stratified soil formation under the footing where a gas pocket or a layer of weak soil underlies a layer of stronger soil. The core sampling of the sea floor taken at the drilling site after the accident showed that the soil formation had a uniform clay profile with no stratification by weaker soil types and no evidence of gas pockets. Furthermore, the dive survey of the drilling site showed that the bow leg spud can footing was approximately at the same level of penetration after the accident as it had been before the accident. The Safety Board, therefore, concludes that the PENROD 61 probably did not suffer a "punch through" of the sea floor when the MODU collapsed.

Since the collapse of the PENROD 61 did not result from a failure of the leg jacking or braking system or from a "punch through," a catastrophic structural failure of the bow leg probably occurred. The PENROD 61's legs were designed to withstand wind and sea conditions more severe than those encountered at the time of the accident. The PENROD 60, which was identical in design, and slightly older than the PENROD 61, did not collapse, and it had been subjected to the same wind and sea conditions and to the significant additional forces which occurred when the drifting hull of the PENROD 61 struck it. The Safety Board, therefore, concludes that the wind and sea conditions alone did not cause the bow leg of the PENROD 61 to fail. The bow leg of the PENROD 61

could have been weakened sufficiently by corrosion, metal fatigue, previous structural damage, or construction defects to cause a structural failure of the bow leg. However, due to the prohibitive cost of such an operation, appropriate samples of the broken bow leg were not recovered for metallurgical analysis, and the Safety Board, therefore, is unable to determine the cause or precise manner of the failure of the bow leg.

If a defect existed in the bow leg structure in the area where the leg broke, it would not have been detected at the time of the Coast Guard inspection because the entire length of the leg was not thoroughly examined. The Coast Guard has no requirement that the entire length of the legs of self-elevating MODUs be thoroughly examined and there are no inspection procedures that would provide guidance to an inspector in conducting such an examination. Additionally, the offshore drilling industry has no known self-imposed inspection standard for conducting periodic examinations of self-elevating MODU legs over their entire length. Since these legs support the MODU in the elevated mode, their material condition is critical to safe MODU operations. Because MODUs are elevated to various heights depending upon the depth of water in which they are working, different portions of the legs are placed under load at different times. Additionally, these legs are subjected to the deteriorating effects of a marine environment and to physical damage from vessels that service the MODUs. A recent paper 9/ submitted to the International Maritime Organization's Maritime Safety Committee by the Government of Norway stated that from January 1, 1970 through December 31, 1984 there have been a total of 166 "significant" structural failures on board MODUs of all nationalities and that 45 of these failures occurred on board U.S. MODUs. Although it did not identify the nature of the structural failures, this report showed that structural failure was the major type of accident that MODUs suffered during this time and is indicative of the need for improved inspection procedures on MODUs. A defect can develop anywhere along the length of a leg, and if the entire length of the leg is not thoroughly inspected, it may not be detected before it causes a catastrophic failure. The Safety Board believes that the Coast Guard should require the thorough inspection of the entire length of self-elevating MODU legs at the time of their periodic drydock examination (or special examination in lieu of drydocking). Additionally, the Safety Board believes that the Coast Guard should develop an inspection procedure to provide guidance to their inspectors on the methods and criteria to be used in conducting such inspections.

It is possible that the fact that the bow leg failed just as the jacking system was engaged was purely coincidental, but it is also possible that the operation of the leg jacking machinery was related to the failure. When the jacking system was engaged, an additional compressive force would have been applied to the bow leg by the jacking motors. If a structural defect existed in the bow leg, this additional force may have been sufficient to have caused the leg to fail in the area of the defect and precipitated the collapse of the MODU. The operations manual for the PENROD 61 states that the jacking system should be operated only during periods of good weather both when the MODU is first placed on station and when it is taken off station. There is no information in the manual on conducting leg jacking operations to re-level the rig during inclement weather after it has already been elevated on station. The Safety Board believes that toolpushers on MODUs should be given appropriate instructions to take the correct course of action in an emergency, and that MODU operation manuals should contain complete instructions concerning the operation of the leg jacking machinery in all forseeable situations.

9/ Norwegian Maritime Directorate, "Mobile Offshore Drilling Units (MODUs)," May 26, 1986.

The PENROD 61 should have remained afloat after it became waterborn, if the hull had remained watertight. However, the diving survey conducted on the wreck after the accident showed that the sides of the hull had been holed in a number of locations. These holes were probably the result of the MODU's collision with the PENROD 60. Since the wreck was sitting upright on the bottom of the sea, the bottom of the hull could not be examined for holes. It is probable that the bottom of the hull was punctured by the broken legs when the MODU fell. Although the full extent of the hull damage of the PENROD 61 is unknown, the Safety Board believes that it was sufficient to have allowed enough water to enter the hull to have caused the vessel to sink.

Survival Aspects

When the bow of the PENROD 61 collapsed, the abandon rig alarm was not sounded. Since the toolpusher, who was in charge of the MODU, did not survive the accident, the Safety Board could not determine why he did not sound the alarm. However, the failure to sound the alarm had no effect upon the abandon rig operation since all the personnel on board the MODU reported to the abandon rig stations on their own initiative.

The crew of the PENROD 61 not only reported to abandon rig stations at their own initiative, but actually departed the vessel without first receiving orders from the toolpusher to do so. Both the inflatable liferaft and the No. 1 survival capsule were launched without the prior consent of the toolpusher. The abandon rig operation was not well organized and was not conducted under the direction of a central authority. The crew was not assembled so that a roll call could be taken, and the No. 1 capsule departed without anyone informing the toolpusher of the number of persons on board. If some of the crewmen had not been present to abandon the rig with the rest of the crew, their absence would not have been detected, and they would have been left behind when the survival capsules departed the rig. The Safety Board recognizes that the crew was faced with an emergency situation, and that the stress of the moment may have caused them to act rashly. However, the vessel remained afloat for an appreciable length of time after it entered the water, and there should have been sufficient time to have taken a roll call, or to have at least taken an accurate head count before the launching of any primary lifesaving devices took place. The fact that the crew reported to their embarkation stations and launched the lifesaving devices with no difficulty showed that the crew had a good familiarity with the equipment on board the MODU. At the same time, however, their precipitous launching of this equipment demonstrated a lack of discipline and a lack of the exercise of a central authority through a well established chain of command. It is clear that the toolpusher held the position of central authority on board the MODU, however, there was no one specifically designated as second in command nor any clear cut chain of command below the toolpusher. The toolpusher could not have been at the primary embarkation stations to control abandon rig operations and in the control room making necessary emergency radio broadcasts at the same time. If the MODU had an established chain of command for abandon-rig operations, the abandon-rig operation could have been conducted in an orderly and disciplined manner and there would have been no danger that some personnel might have been left stranded on the MODU when the capsules were launched.

On MODUs there is no formal chain of command similar to that which is found on board conventional merchant ships. The authority of persons other than the toolpusher extends only to certain prescribed functions. For instance, the driller is responsible only for drilling operations. Only the toolpusher's authority extends over all aspects of MODU operations. In an abandon-rig situation, several operations may be in progress simultaneously. Without an established chain of command, one man cannot hope to control the situation and provide for the safety of the crew.

As a result its investigation of the capsizing of another MODU in 1976, 10/ the Safety Board on April 17, 1979, recommended that the Coast Guard:

M-79-44

Determine and require a functional chain of command on mobile offshore drilling units to effectively cope with extreme situations.

Although concurring with this recommendation, the Coast Guard pointed out that the Outer Continental Shelf Act places limitations on the Coast Guard's ability to carry out the intent of this recommendation while a MODU is in the bottom bearing (elevated) mode, or while a MODU is operating outside the confines of the U.S. outer continental shelf. The Safety Board believes that the person in charge of a MODU must be designated and that the role of that person during underway and stationary operations must be defined as precisely as possible under current laws governing outer continental shelf activity. The Board has placed Safety Recommendation M-79-44 in an "Open—Unacceptable Action" status.

The survival capsules on board the PENROD 61 were of adequate capacity to accommodate all of the persons on board. With the exception of the welder who abandoned the MODU in an inflatable liferaft and the third party service hand who jumped overboard, all persons on board the PENROD 61 escaped in capsules before the MODU sank. The launching system operated properly and the capsules were lowered to the sea and released successfully. However, the heaving and rolling of the capsules caused most of the men inside to become seasick and fatigued very soon after the launching. Nevertheless, the capsules operated for some time without mishap and kept the survivors dry and protected from the elements. The capsules appeared to be performing adequately until the No. 2 capsule capsized suddenly approximately three hours after it was launched. Model tests of the 9091 Whittaker survival capsule showed that the capsule would remain upright when subjected to a 24-foot-high regular wave, and would capsize in steep, breaking waves 45- to 48-feet high. However, the tests did not take into account the affects of high winds and no tests were performed with waves heights between 24 feet and 45 feet so that the minimum wave height that would cause the capsule to capsize was not determined. The reconstructed weather conditions for the vicinity of the PENROD 61 close to the time of the rig's collapse showed that the maximum wave height was above 24 feet. Since ocean waves travel at different speeds, faster waves overtake slower waves and combine to form a resultant wave that can be appreciably larger than either of the individual waves. It is, therefore, possible that the No. 2 capsule encountered a wave appreciably greater than 24 feet in height which caused the capsule to capsize. In the OCEAN EXPRESS accident, two Whittaker model 9091 survival capsules capsized resulting in the loss of 13 lives. As a result of its investigation of this accident, the Safety Board recommended that the Coast Guard:

M-79-45

Develop appropriate survival capsule performance standards, including standards for safe towing.

10/ Marine Accident Report—"Capsizing and Sinking of the Self-Elevating Mobile Offshore Drilling Unit OCEAN EXPRESS near Port O'Connor, Texas, April 15, 1976" (NTSB/MAR-79/05).

M-79-46

Conduct model tests and computer simulations with Whittaker Corporation to determine the survival capsule's capsizing characteristics and behavior in storm seas.

The Coast Guard concurred with these recommendations. In response to these recommendations the Coast Guard Commandant stated,

> We will not limit consideration to survival capsules alone. A more complete understanding of the rough water characteristics of all types of totally enclosed lifeboats and liferafts is required. Research and development programs for three studies (enclosed lifeboats, rescue boats, and inflatable liferafts) have been developed. A period of background study and limited testing will identify designs and concepts for more complete testing. Test items will then be acquired for both model tests under controlled conditions, and full scale tests at sea. The tests will be followed by an evaluation period, and if necessary, another round of tests will be scheduled to evaluate proposed modifications. The program will include studies of towing, capsizing and self-righting characteristics, and rough water performance. The Coast Guard, representing the United States at the Inter-Governmental Maritime Consultative Organization in the revision of Chapter III, "Lifesaving Appliances," of the Safety of Life at Sea Convention, has supported the introduction of a requirement that all totally enclosed survival craft be self-righting when all hatches are closed, all persons are secured in their seats with seat belts, and there is no water inside. The United States has also introduced a requirement that all such craft be arranged to allow an above-water escape during any possible condition of flooding or equilibrium. The enclosed lifeboat research and development program is funded for FY 1980, and the contract for the first phase of the program has been awarded. The full program is expected to take five years with completion projected for 1984.

Despite the Coast Guard's response to these recommendations, the proposed research and development program was never completed and no model tests or computer simulations of the Whittaker survival capsule were ever conducted by the Coast Guard. However, on June 17, 1983 the Maritime Safety Committee of the International Maritime Organization, with the support of the U.S. Coast Guard, approved a revision to Chapter III ("Lifesaving Appliances and Arrangements") of the 1974 Safety of Life at Sea (SOLAS) Convention. The revised chapter includes performance standards for totally enclosed lifeboats, which include survival capsules. Under these standards, totally enclosed lifeboats will be required to be self-righting in both the intact and flooded condition. These new standards enter into force on July 1, 1986. The Coast Guard is currently involved in a regulation project to incorporate the new SOLAS requirements into the United States Code of Federal Regulations. Sometime in 1986 the Coast Guard expects to publish a notice of proposed rulemaking which addresses enclosed lifeboat performance standards.

Although the SOLAS convention does not specifically apply to non-self-propelled MODUs such as the PENROD 61, initial indications from the Coast Guard are that the new SOLAS performance standards for covered lifeboats will be applied to U.S. MODUs in the notice of proposed rulemaking currently under development. The Safety Board supports the Coast Guard's intention to apply these new standards to covered lifeboats on

MODUs, and believes that the safety of MODU crewmen will be significantly improved by these new standards. The Safety Board will hold Safety Recommendation M-79-45 in an "Open—Acceptable Action" status pending publication of a final rule incorporating these proposed changes. It is anticipated, however, that the new standards will apply only to lifeboats installed on new MODUs constructed after the effective date of the proposed regulations. In that case existing MODUs, therefore, will continue to carry lifeboats that do not meet the new standards, as long as the appliances are maintained in good and serviceable condition. The Safety Board is opposed to granting open-ended grandfather rights for primary lifesaving equipment. The Board believes that existing substandard lifesaving equipment should be phased out of service within a specific time period, such as five years. To continue to use outmoded primary lifesaving equipment on existing vessels in the face of required improvements on new vessels creates two standards of safety. MODU crewmen working on existing MODUs will face the same risks as those employed on new MODUs, but will be afforded a lower standard of safety. The Safety Board is disappointed that the Coast Guard has taken this position on such an important safety issue and has classified Safety Recommendation M-79-46 as "Closed—Unacceptable Action." We strongly urge the Coast Guard to give further consideration to the merits of this recommendation.

When the No. 2 capsule from the PENROD 61 capsized, all of the persons inside were able to escape. Once outside the capsized capsule, the men repeatedly climbed on top of the overturned capsule, only to be washed back into the sea by the high waves. The toolpusher, complaining of chest pains and of difficulty in breathing, was unable to cling to the capsule and was carried away by the seas. Post mortem examination of the toolpusher showed that he suffered from emphysema and sustained broken ribs. The ribs may have been fractured when high seas washed him against the capsule. These conditions probably accounted for the toolpusher's chest pains and for his difficulty in breathing and may have contributed to his drowning. Although he was wearing a life preserver, it would not have prevented him from being momentarily submerged when large waves broke over him. He would have had to exert himself in the water to regain the surface after being submerged and to keep his face turned away from the approaching waves. In his weakened state, the toolpusher probably had insufficient strength to remain on the surface and to avoid the aspiration of sea water. The death of the toolpusher from the PENROD 61 probably would not have occurred if the survival capsule in which he was riding had been self-righting. If it had been self-righting, the capsule would have returned to the upright position after it capsized, and no one would have been forced to enter the water. This accident not only demonstrates the need for the new covered lifeboat standards, but it also shows that lives will continue to be lost as long as non-self-righting covered lifeboats are allowed the be carried as primary lifesaving equipment on board existing MODUs.

Weather Advisories

The weather advisories issued by the National Weather Service were accurate and timely. The storm system was well tracked, and sufficient warnings were available to both marine and coastal interests concerning the movement and severity of the storm.

The weather advisories issued by the commercial firm which was supplying weather information to the PENROD 61 were fairly consistent with those issued by the National Weather Service and the hurricane warnings announced by the commercial firm were issued within a reasonable time after those issued by the National Hurricane Center.

Severe Weather Evacuation Planning

When orders to evacuate the PENROD 61 were received from Chevron about 1300 on October 27 the weather was too severe to safely evacuate. By this time the center of Tropical Storm Juan was less than 200 nmi away from the PENROD 61; winds at the PENROD 61 were in excess of 50 knots and the seas were in excess of 15 feet. The wind conditions precluded helicopter operations at the MODU and the sea state was probably too severe to permit safe transfer of personnel from the MODU to the standby vessel. In order for the evacuation order to have been effective, it should have been issued before the weather conditions became so severe as to preclude a safe evacuation.

In the majority of instances (72 percent), hurricanes in the Gulf of Mexico originate elsewhere and then move into the Gulf. In these instances there is usually an appreciable amount of time available for tracking and evaluating the storm system before it poses an immediate threat to the U.S. coastal waters. In this case, however, Hurricane Juan developed from a tropical depression that formed in the central Gulf of Mexico and intensified to a tropical storm and then to a hurricane quite rapidly. Tropical cyclone statistics show that more than 40 percent of all tropical depressions and 50 percent of all tropical storms that have formed in the Gulf of Mexico in the past 20 years have intensified into hurricanes. Based on these statistics, the Safety Board believes that there was a reasonable expectation that the tropical depression that formed in the central Gulf of Mexico on October 25, 1985 would intensify to become a hurricane, and that evacuation procedures should have begun as soon as it became known that the tropical depression had intensified. The Chevron shoreside officials who ordered the evacuation of the PENROD 61 on October 27 apparently relied on forecasts that the storm system would continue to move westward and away from the PENROD 61. They did not receive a revised forecast which reported that the storm system had, in fact, changed direction and moved northward until the next morning, by which time it was too late to evacuate the MODU safely. The Safety Board believes that these shoreside officials should have recognized that the movement of tropical cyclones is erratic and not predictable to a great degree of confidence. When the tropical depression intensified and became a tropical storm at 0730 on October 26, the center of the storm was less than 400 miles away from the PENROD 61 and the effects of the storm were already being felt at the PENROD 61 with 31-knot winds gusting to 41 knots and seas over 12 feet. These conditions were already approaching the limits for safe evacuation, and it would have been prudent to have ordered the well secured and the non-essential personnel evacuated from the MODU at that time, followed by the evacuation of the remainder of the crew, if possible, after the well was secured.

The hurricane contingency plan developed by Chevron which was in effect at the time of this accident did not provide clear, step-by-step instructions for the evacuation of personnel from MODUs working offshore and Penrod had no formal hurricane evacuation plan at all. The testimony of the Chevron southeastern division manager, the Chevron drilling representative, and the alternate Penrod toolpusher from the PENROD 61 indicates that there was confusion concerning who had the responsibility to order an evacuation of the MODU due to weather conditions. Areas of responsibility for evacuation of the rig appear to overlap since the oil company was responsible for providing transportation to and from the rig, and the drilling contractor was responsible for the safety of the rig and the safety of personnel on the rig. This division of responsibility has been a factor in previous MODU accidents which the Board has investigated, and the Board has repeatedly emphasized the importance of having one person designated as the decision-maker in an emergency. The Safety Board believes that this accident illustrates the need for severe weather evacuation plans for MODUs which

designate the person responsible for ordering the evacuation. The plan should include step-by-step procedures to be followed in carrying out the evacuation, and should clearly delineate the roles of oil company and drilling contractor employees in the evacuation process.

In order for a severe weather evacuation plan to be effective, it must clearly define when evacuation procedures should be initiated. Adverse wind and sea conditions typically arrive at a location far in advance of the center of the storm system. An evacuation must be ordered before the operational limits of the evacuation vehicles are reached at the evacuation site. Often this will mean that an evacuation must be ordered before the storm system has intensified to hurricane proportions. Criteria should be developed to correlate the decision to initiate evacuation with weather forecast information, taking into account the available time and distance factors before severe weather and sea conditions preclude a safe evacuation. The timely evacuation of a MODU, therefore, involves many details that must be worked out well in advance of the need to evacuate. The Safety Board believes that each MODU should have a detailed severe weather evacuation plan developed for each offshore location at which the unit is engaged in drilling operations. Additionally, the time necessary for securing the well, the number of persons to be evacuated, the distance over which the evacuation is to take place, and the available transportation resources must be considered in establishing the time factor for initiating an evacuation. Considering the high number of MODUs that work in the Gulf of Mexico, it is conceivable that situations may develop when insufficient resources are available to accomplish an evacuation safely. For this reason, the Safety Board believes that oil companies and drilling contractors who operate manned platforms and MODUs within the same offshore area in the Gulf of Mexico should develop joint hurricane evacuation plans which pool available transportation resources.

No Federal guidelines currently exist to provide the offshore oil exploration and exploitation industry with hurricane evacuation planning assistance. However, the U.S. Coast Guard, under the authority of the Outer Continental Shelf Lands Act Amendments of 1978 (Public Law 95-372), has primary responsibility for the protection of life and property on the outer continental shelf of the United States. Since any potentially hazardous weather conditions may place the lives of offshore workers in jeopardy, the Safety Board believes that the Coast Guard should take action to provide technical assistance and coordination support to the offshore oil industry in the development of joint hurricane evacuation plans. In addition to increasing the safety of offshore workers, such action would also benefit the Coast Guard. The timely evacuation of offshore facilities would reduce the amount of Coast Guard search and rescue resources needed during periods of hazardous weather.

GILBERT C

The GILBERT C had been contracted by Chevron to provide standby vessel services to the PENROD 60 and PENROD 61. The master maintained his vessel moored to an anchor buoy between the two MODUs until about 1630 on October 27, 1985. Throughout the day, the wind and sea conditions continued to deteriorate and when seas began breaking over his vessel's bow, the master became concerned for the safety of his vessel and crew. The Safety Board recognizes that, although the GILBERT C was placed on station to provide assistance to the MODUs, the master's primary responsibility was to the safety of his own vessel and crew. The Safety Board believes that the conditions were severe enough to pose a threat to this 100-foot vessel, and believes that the master was justified in his concern for the safety of his vessel and crew.

Despite his concern for the safety of his vessel, the master of the GILBERT C remained on station as long as possible and maintained radio contact with the PENROD 61. He asked about their evacuation plans and offered to take personnel off the MODU. Since his offer to take personnel off the MODU was refused, he requested and was granted permission to leave the area to seek a harbor of safe refuge from the storm. Considering the increasingly deteriorating weather conditions, the vessel's limited ability to withstand high wind and seas, and the refusal of the PENROD 61 personnel to accept the master's offer to take them off the MODU, the Safety Board believes that the master of the GILBERT C was justified in requesting permission to leave the area.

The GILBERT C was a conventional passenger carrying crewboat which was designed to take personnel to and from offshore installations. It was not specifically designed to serve as a standby vessel for MODUs in severe weather, and did not have sufficient capacity to evacuate all of the personnel on either rig. Neither was the GILBERT C outfitted with any specialized gear suitable for the retrieval of persons from the water, nor was the vessel's crew thoroughly trained in water rescue procedures. In addition, the master of the GILBERT C testified that he did not believe that he could have rescued anyone from the water in the sea conditions that prevailed on October 27. He said that, if requested to do so, he would have attempted to receive personnel on board his vessel from the deck of the MODU. However, he further testified that, in order to do this, the stern of his vessel, which had only 4-feet of freeboard, would have been completely submerged by the 20-foot seas and people could have been washed overboard. Additionally, the master of the GILBERT C stated that had he been in the area when the capsules were launched he would not have attempted to rescue survivors from the capsules because the capsules might have been smashed against the side of his vessel in the high seas. The Safety Board believes that, had the GILBERT C remained on station until the PENROD 61 collapsed, it is doubtful that its presence would have materially altered the outcome of this accident. However, if a vessel of sufficient size and greater seakeeping ability suitably equipped with rescue equipment and with a crew that had been thoroughly trained in water rescue procedures in adverse sea conditions had been assigned to standby duty, it might have been able to rescue all of the persons who were in the water after the No. 2 survival capsule capsized.

The master of the GILBERT C testified that he never knew the identity of the persons with whom he spoke on the radio when he communicated with the rigs, and that he would try to comply with any order that he received over the radio from anyone who identified themself as being from one of the rigs. Such a system of communication is too casual for the passing of important messages between a MODU and a standby vessel. The Safety Board believes radio communications between standby vessels and the MODUs that they are assigned to support should follow a more formal procedure in which the communicating parties specifically identify themselves so that the master of a standby vessel knows that the orders he receives are from a person in an appropriate position of authority to issue them.

Standby Vessels

The Safety Board believes that there is a need for standby vessels to be stationed near MODUs that are working offshore, that these vessels should be capable of remaining on station in adverse weather and sea conditions, that they should be outfitted with state-of-the-art water rescue equipment, and that their crews should be thoroughly trained in water rescue techniques. The Safety Board has addressed this issue in previous

MODU accidents. In 1982, the U.S. MODU OCEAN RANGER 11/ capsized and sank in adverse sea conditions resulting in the loss of 84 lives. Some of the crewmen from the OCEAN RANGER escaped from the MODU in a lifeboat, but when the standby vessel approached the lifeboat, the lifeboat capsized throwing the survivors into the sea. The crew of the standby vessel was unable to recover a single person from the sea because the vessel was not outfitted with equipment capable of retrieving incapacitated persons from the water. As a result of its investigation of this accident, the Safety Board recommended that the U.S. Coast Guard:

> M-83-20
>
> Require that a suitable vessel, capable of retrieving persons from the water under adverse weather conditions, be assigned to all U.S. mobile offshore drilling units at all times for the purpose of evacuating personnel from the unit in an emergency.

The Coast Guard partially concurred with this recommendation. However, rather than requiring standby vessels to be in attendance at all times for MODUs, the Coast Guard stated that offshore supply vessels which "routinely operate in the vicinity of mobile offshore drilling units" would provide adequate standby vessel support to MODUs if the offshore supply vessels were required to carry rescue boats capable of taking an unconscious person on board from the sea. The Coast Guard expects to issue a notice of proposed rulemaking by the end of 1986 which includes a requirement for rescue boats on offshore supply vessels. The Safety Board recognizes the need for rescue boats to be carried on offshore supply vessels, but also recognizes that the proposed regulatory action provides a lesser degree of support to MODUs working offshore than that envisioned by recommendation M-83-20. In reply to the Coast Guard's response to this recommendation, the Board pointed out that without a specific requirement it seems unlikely that offshore supply vessels would be in the vicinity of operating MODUs at all times. Additionally, the Board stated that it seems unlikely that an offshore supply vessel would be scheduled to replenish a MODU at a time when a severe storm is forecast. The Board reminded the Coast Guard that other nations (e.g. Canada, United Kingdom, and Norway) require standby vessels for MODUs operating within their jurisdiction.

As a result of its investigation of the capsizing and sinking of the U.S. drillship GLOMAR JAVA SEA 12/ which resulted in the loss of 81 lives, the Safety Board reiterated recommendation M-83-20. In response to this reiteration, the Coast Guard Commandant stated:

11/ Marine Accident Report--"Capsizing and Sinking of the U.S. Mobile Offshore Drilling Unit OCEAN RANGER off the East Coast of Canada, 166 Nautical Miles East of St. John's, Newfoundland, February 15, 1982" (NTSB/MAR-83/2).

12/ Marine Accident Report--"Capsizing and Sinking of the United States Drillship GLOMAR JAVA SEA In the South China Sea, 65 Nautical Miles South-Southwest of Hainan Island, People's Republic of China, October 25, 1983" (NTSB/MAR-84/08).

> We have given further consideration to NTSB recommendation M-83-020 which recommends that the Coast Guard require a suitable vessel, capable of retrieving persons from the water under adverse weather conditions, be assigned to all U.S. MODUs at all times for the purpose of evacuating personnel from the unit in an emergency. As a result, we published an advance notice of proposed rulemaking . . . in the "Federal Register" on March 7, 1985, (50 FR9290) soliciting comments regarding the use of standby vessels in an overall evacuation plan for MODUs and fixed platforms and lifesaving equipment requirements for fixed facilities.

Legislation 13/ is pending in Congress that would require a standby vessel capable of rendering immediate assistance in the immediate vicinity of all manned installations (including MODUs) on the outer continental shelf of the United States. On November 12, 1985, a Coast Guard representative presented a statement of the Coast Guard's position on this proposed legislation before the House of Representatives Merchant Marine and Fisheries Committee's Subcommittee on the Panama Canal and the Outer Continental Shelf. Pertinent excerpts from this statement are as follows:

> The Coast Guard feels that properly designed and equipped standby vessels in the immediate vicinity of manned OCS facilities may, in some cases, improve safety on the Outer Continental Shelf. In the event of a major casualty to an offshore installation, the immediate presence of a properly designed and equipped standby vessel, manned by a specially trained crew, might in some cases increase the chances of survival of the installation's crew members. We must not, however, lose sight of the fact that a major cause of rig and platform abandonment has historically been severe weather. Unless standby vessels are designed to withstand those severe conditions, requiring them to remain on scene could place the vessels and their crews in jeopardy. Further, the risks inherent in boarding a standby vessel in severe weather conditions must be compared to and analyzed against the advantages of using the installation's primary lifesaving equipment.
>
> A review of standby vessel regulations promulgated by the Norwegian, Canadian, and British Governments reveals very specific criteria regarding design, equipment, operations and crew training for vessels designated as standby vessels.
>
> The Coast Guard feels strongly that standby vessels, whether mandatory or required as part on an overall evacuation plan, should be designed and equipped specifically for this task and manned with personnel properly trained in marine rescue.
>
> This notwithstanding, the Coast Guard believes that reasonable, and perhaps safer, alternatives to standby vessels may exist. The well-being of the offshore worker is the driving force behind the proposed offshore installation emergency evacuation act. For this reason, the Coast Guard believes that sufficient flexibility must be provided to explore and, where possible, integrate the best and safest technology available to ensure the safety of these workers.

13/ H. R. 1748, Offshore Installation Emergency Evacuation Act.

The Coast Guard believes that a mobile offshore drilling unit or platform should, to the maximum extent possible, be self-sustaining and capable of providing its own means of abandonment in the event of an emergency. In this regard, the Coast Guard is continually striving to improve and incorporate the latest developments in the design and launching arrangement of primary lifesaving appliances.

We are now in the process of evaluating these comments [i.e. comments received in response to Advance Notice of Proposed Rulemaking, "Revision of the Regulations on Outer Continental Shelf Activities," 50FR9290, March 7, 1985] and developing a Notice of Proposed Rulemaking which will specifically incorporate the comments as appropriate.

Based on the information gathered thus far, it is envisioned that the Coast Guard proposed rules would establish an evacuation performance standard and require a site-specific emergency evacuation contingency plan, meeting that standard, and thereby provide greater flexibility in addressing specific evacuation needs of each installation. Such a plan would address the geographical, environmental, and unique design and operating characteristics of each installation. This would encourage the best available and safest technology concept addressed by the Outer Continental Shelf Lands Act, as amended. Such an approach would allow standby vessels, where appropriate, to become an integral part of an overall emergency evacuation plan that would be tailored to the specific needs of each installation, thereby providing the most feasible emergency evacuation of each manned installation on the OCS.

Considering the diversity of the environmental conditions that exist within the Outer Continental Shelf of the United States, from the Gulf of Mexico to the Arctic Frontier; new developments in primary lifesaving equipment; and the varying operations characteristics of offshore installations; the Coast Guard believes that the existing rulemaking project to revise the OCS activities regulations, Coast Guard docket number CGD 84-098, provides the most appropriate forum from which to address this issue and that legislation is not necessary. Therefore, we oppose enactment.

The Safety Board believes that the Coast Guard's stated position on the need for standby vessels in attendance at MODUs is ambiguous. On the one hand, the Coast Guard admits that properly designed, equipped, and manned standby vessels in the immediate vicinity of MODUs would increase the safety of offshore workers on the outer continental shelf; while on the other hand, the Coast Guard states that a MODU should be "self-sustaining and capable of providing its own means of abandonment in the event of an emergency." While the Safety Board agrees that MODUs should be capable of providing their own means of abandonment, accident investigations have shown that primary lifesaving devices and their launching equipment are subject to damage or destruction in an emergency and have not been available for use when needed. The OCEAN RANGER, the OCEAN EXPRESS, the GLOMAR JAVA SEA, and the PENROD 61 were all capable of providing for their own abandonment, but in each of these accidents primary lifesaving equipment was either damaged or failed in one manner or another. These accidents vividly demonstrate the need for standby vessels. More than 4 years have passed since the OCEAN RANGER accident occurred, and lives continue to be lost in MODU accidents

because there is no requirement that MODUs be attended by suitable standby vessels which are capable of withstanding adverse weather and sea conditions, properly equipped with state-of-the-art water rescue equipment, and manned by suitably trained crewmen. The collapse of the PENROD 61 demonstrates once again that there is a need for such a requirement. The Board has placed Safety Recommendation M-83-20 in an "Open—Unacceptable Action" status.

The Coast Guard's statement also points out the fact that a major cause of MODU abandonment has been severe weather and that, unless standby vessels are designed to withstand severe weather conditions, requiring them to remain on scene could place the vessels and their crews in jeopardy. The Safety Board wholeheartedly agrees with this portion of the statement. Recommendation M-83-020 recommends that the Coast Guard require that only a "suitable vessel" be assigned to a MODU to act as a standby vessel. The Board would not consider a vessel to be "suitable" unless it was designed to withstand severe weather conditions.

As an alternative to mandatory standby vessels, the Coast Guard statement proposed the establishment of "an evacuation performance standard" and a requirement for a "site-specific emergency evacuation contingency plan" which may or may not include the use of standby vessels. Although the Safety Board is not opposed to an "evacuation performance standard" or to a "site-specific" evacuation plan per se, we cannot visualize a situation where a standard or a plan should not include a requirement for a properly designed, equipped, and manned standby vessel.

CONCLUSIONS

Findings

1. No failure of the leg jacking or braking system on the PENROD 61's bow leg occurred which contributed to in the collapse of the MODU.

2. The bow leg of the PENROD 61 did not experience a rapid and unrestricted penetration of the sea floor.

3. The bow leg of the PENROD 61 most probably suffered a structural failure of an unknown nature which caused the MODU to collapse.

4. There is a need for the legs of self-elevating MODUs to be examined thoroughly over their entire length on a regular basis.

5. Continued use of non-self-righting covered lifeboats on MODUs endangers the lives of offshore workers.

6. The weakened physical condition of the PENROD 61 toolpusher and the injuries he suffered after the No. 2 capsule capsized contributed to his drowning.

7. The orders issued by Chevron to evacuate the PENROD 61 were issued too late to be safely executed.

8. There should have been a reasonable expectation that the tropical depression which formed in the Gulf of Mexico on October 25, 1985 would intensify to become a hurricane.

9. The hurricane contingency procedures developed by Chevron and by Penrod were not adequate to insure the safe and timely evacuation of the PENROD 61.

10. Oil companies and drilling contractors who operate manned platforms and MODUs within the same offshore area in the Gulf of Mexico could more effectively use available transportation resources by developing joint severe weather evacuation plans.

11. The GILBERT C was not suitably designed, equipped, or manned to serve as a standby vessel for a MODU in severe weather conditions.

12. The master of the GILBERT C was justified in requesting permission to leave the area and seek a harbor of safe refuge.

13. If a suitably designed, equipped, and manned standby vessel had been onscene when the No. 2 survival capsule capsized, it may have been able to rescue all of the persons who entered the water.

14. There continues to be a need for suitably designed, equipped, and manned standby vessels to be in attendance of MODUs working offshore.

15. There was no clear cut chain of command below the toolpusher on board the PENROD 61 which would have facilitated abandon rig operations in the event of an emergency.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the collapse of the PENROD 61 was a structural failure of undetermined origin to its bow leg. Contributing to the collapse of the PENROD 61 was the failure to inspect the legs of the MODU over their entire lengths. Contributing to the loss of life was the failure of the survival capsule to right itself after capsizing.

RECOMMENDATIONS

As a result of its investigation of the collapse of the PENROD 61, the National Transportation Safety Board reiterates Safety Recommendation M-83-20 issued to the U.S. Coast Guard on February 28, 1983, as a result of the Safety Board's investigation of the capsizing and sinking of the mobile offshore drilling unit OCEAN RANGER on February 15, 1982:

> Require that a suitable vessel, capable of retrieving persons from the water under adverse weather conditions, be assigned to all U.S. mobile offshore drilling units at all times for the purpose of evacuating personnel from the unit in an emergency.

The Safety Board also reiterates Safety Recommendation M-79-44 made to the U.S. Coast Guard on April 17, 1979, as a result of the Safety Board's investigation of the capsizing and sinking of the Mobile Offshore Drilling Unit OCEAN EXPRESS on April 15, 1976:

> Determine and require a functional chain of command on mobile offshore drilling units to effectively cope with extreme situations.

As a further result of its investigation of the collapse of the PENROD 61, the National Transportation Safety Board recommends:

--to the U.S. Coast Guard:

Amend 46 CFR 107 to require the thorough inspection of the entire length of self-elevating MODU legs at the time of regular drydock examination or special examination in lieu of drydocking. (Class II, Priority Action) (M-86-102)

Develop an inspection procedure which will provide guidance to Coast Guard marine inspectors in conducting inspections of the entire length of self-elevating MODU legs. (Class II, Priority Action) (M-86-103)

Develop seakeeping, equipment, and manning standards for standby vessels in attendance of mobile offshore drilling units. (Class II, Priority Action) (M-86-104)

In conjunction with the regulatory project to incorporate new Safety of Life at Sea Convention covered lifeboat standards into the U.S. Code of Federal Regulations, include a requirement that existing covered lifeboats that do not meet the new standards shall be phased out of service onboard mobile offshore drilling units within a reasonably short period of time. (Class II, Priority Action) (M-86-105)

Require that U.S. MODUs operating in the Gulf of Mexico have detailed severe weather evacuation plans which set forth the order in which personnel will be evacuated, identify the transportation resources to be used in the evacuation, and include time and distance factors for the initiation of evacuation before the onslaught of hazardous weather conditions at the location of the MODU. (Class II, Priority Action) (M-86-106)

Publish guidelines and provide technical assistance to aid MODU owners and operators in the Gulf of Mexico to develop effective severe weather evacuation plans. (Class II, Priority Action) (M-86-107)

--to the International Association of Drilling Contractors:

Encourage member contractors who operate mobile offshore drilling units in the same area of the Gulf of Mexico to develop joint severe weather evacuation plans to pool available transportation resources so that the simultaneous evacuation of a number of MODUs working in the same geographical area may be conducted in an orderly and effective manner. (Class II, Priority Action) (M-86-108)

--to the Penrod Drilling Company:

Amend the instructions contained in the operation manuals of all company-owned self-elevating MODUs to provide the toolpushers on such MODUs with complete instructions concerning the operation of leg jacking machinery in all foreseeable situations. (Class II, Priority Action) (M-86-109)

Amend emergency procedures for company-owned MODUs to establish a clear-cut chain of command below the toolpusher for the orderly and disciplined execution of abandon-rig operations in an emergency. (Class II, Priority Action) (M-86-110)

Develop formal radio procedures which require persons originating or receiving radio messages on company-owned MODUs to identify themselves whenever communications are necessary between these MODUs and regularly assigned standby vessels. (Class II, Priority Action) (M-86-111)

For each company-owned MODU, develop a detailed severe weather evacuation plan which sets forth the order in which personnel will be evacuated, identifies the transportation resources to be used in the evacuation, and includes time and distance factors for the initiation of evacuation before the onslaught of hazardous weather conditions at the location of each MODU. (Class II, Priority Action) (M-86-112)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ JOHN K. LAUBER
Member

/s/ JOSEPH T. NALL
Member

September 16, 1986

APPENDIXES

APPENDIX A

RECONSTRUCTED WEATHER CONDITIONS

The following are the reconstructed weather conditions in the vicinity of the PENROD 61 from 0000 on October 25 through 0600 on October 28. Where available, the conditions reported are those given from nearby oil rigs. Where observations in the immediate area were not available, conditions were estimated by extrapolation from other observations and the synoptic patterns.

Friday, October 25, 0000

Synopsis	:	A weak trough in the middle Gulf with a north-south axis about 90 degrees west
Clouds	:	Overcast
Precipitation	:	None
Pressure	:	1015.5 mb
Temperature	:	77° F
Wind	:	Estimated - ENE 10-15 knots
Sea	:	Estimated - 4-5 feet

Friday, October 25, 0600

Synopsis	:	A trough in the middle Gulf with a north-south axis about 90 degrees west
Clouds	:	Overcast
Precipitation	:	None
Pressure	:	1015.0 mb
Temperature	:	77° F
Wind	:	Estimated - ENE 8-12 knots
Sea	:	Estimated - 4-5 feet

Friday, October 25, 1200

Synopsis	:	1006 millibar low approximately 23.5 degrees north, 90 degrees west
Clouds	:	Overcast
Precipitation	:	None
Pressure	:	1013.5 mb
Temperature	:	78° F
Wind	:	Estimated - ENE 10-15 knots
Sea	:	Estimated - 4-5 feet

Friday, October 25, 1800

Synopsis	:	1004 millibar low approximately 24.5 degrees north, 90.5 degrees west (no closed 150 isobars)

Clouds	:	Overcast
Precipitation	:	None
Pressure	:	1013.5 mb
Temperature	:	78° F
Wind	:	NNE 34 knots gusting to 37 knots
Sea	:	Significant sea 6.6 feet, maximum wave 9.3 feet, period 6.1 seconds

Saturday, October 26, 0000

Synopsis	:	Tropical depression near 24.2 degrees north, 91.5 degrees west, maximum sustained winds 30 knots with gusts to 45 knots
Clouds	:	Overcast
Precipitation	:	None
Pressure	:	1013.0 mb
Temperature	:	79° F
Wind	:	NE 36 knots gusting to 40 knots
Sea	:	Significant sea 7.5 feet, maximum wave 11.4 feet, period 6.1 seconds

Saturday, October 26, 0600

Synopsis	:	Tropical depression near 23.9 degrees north, 92.5 degrees west, maximum sustained winds 40 knots with gusts to 50 knots, radius of 34-knot winds 250 miles northeast (includes accident site)
Clouds	:	Overcast
Precipitation	:	Intermittent rain
Pressure	:	1000.0 mb
Temperature	:	77° F
Wind	:	NE 31 knots gusting to 41 knots
Sea	:	Significant sea 9.2 feet, maximum wave 12.9 feet, period 6.1 seconds

Saturday, October 26, 1200

Synopsis	:	Tropical Storm Juan 24.4 degrees north, 92.8 degrees west (1000 position), maximum sustained winds 40 knots with gusts to 50 knots, radius of 34 knot winds 250 miles northwest (includes accident site)
Clouds	:	Overcast
Precipitation	:	Rain and drizzle
Pressure	:	1009.2 mb
Temperature	:	73° F
Wind	:	NE 37 knots gusting to 43 knots
Sea	:	Significant sea 9.4 feet, maximum wave 14.1 feet, period 6.1 seconds

Saturday, October 26, 1800

Synopsis	:	Tropical Storm Juan 24.5 degrees north, 92.0 degrees west (1600 position), maximum sustained winds 45 knots with gusts to 60 knots, radius of 34 knot winds 250 miles northwest (includes accident site)
Clouds	:	Overcast
Precipitation	:	Moderate to heavy rain
Pressure	:	1006.4 mb
Temperature	:	77° F
Wind	:	ENE 41 knots gusting to 47 knots
Sea	:	Significant sea 10.2 feet, maximum wave 18.5 feet, period 7.1 seconds

Sunday, October 27, 0000

Synopsis	:	Tropical Storm Juan 25.3 degrees north, 92.2 degrees west, maximum sustained winds 40 knots with gusts to 50 knots, radius of 34 knot winds 250 miles northeast (includes accident site)
Clouds	:	Overcast
Precipitation	:	Rain and rain showers
Pressure	:	1005.2 mb
Temperature	:	79° F
Wind	:	ENE 34 knots gusting to 42 knots
Sea	:	Significant sea 9.9 feet, maximum wave 14.3 feet, period 7.1 seconds

Sunday, October 27, 0600

Synopsis	:	Tropical Storm Juan 25.7 degrees north, 91.5 degrees west, maximum sustained winds 50 knots with gusts to 65 knots, radius of 34 knot winds 250 miles northeast (includes accident site)
Clouds	:	Overcast
Precipitation	:	Rain
Pressure	:	1002.2 mb
Temperature	:	75° F
Wind	:	NE 44 knots gusting to 57 knots
Sea	:	Significant sea 10.6 feet, maximum wave 14.9 feet, period 6.1 seconds

Sunday, October 27, 1200

Synopsis	:	Tropical Storm Juan 26.4 degrees north, 91.1 degrees west, maximum sustained winds 60 knots with gusts to 75 knots, radius of 34 knot winds 250 miles northeast (includes accident site)

Clouds	:	Overcast
Precipitation	:	Heavy rain
Pressure	:	999.7 mb
Temperature	:	75° F
Wind	:	ENE 51 knots
Sea	:	Significant sea 12.4 feet, maximum wave 16.3 feet, period 7.1 seconds

Sunday, October 27, 1800

Synopsis	:	Hurricane Juan 27.8 degrees north, 91.2 degrees west, maximum sustained winds 65 knots with gusts to 80 knots, radius of 34 knot, winds 250 miles northeast (includes accident site)
Clouds	:	Overcast
Precipitation	:	Heavy rain
Pressure	:	Estimated 992 mb
Temperature	:	76° F
Wind	:	East 66 knots gusting to 81 knots
Sea	:	Significant sea 18.1 feet, maximum wave 26.5 feet, period 8.2 seconds

Monday, October 28, 0000

Synopsis	:	Hurricane Juan 28.6 degrees north, 91.5 degrees west, maximum sustained winds 65 knots with gusts to 80 knots, radius of 50 knot winds 125 miles northeast, radius of 12-foot seas or higher 250 miles northeast (both include the accident site)
Clouds	:	Overcast
Precipitation	:	Heavy rain
Pressure	:	Estimated 920 mb
Temperature	:	Estimated 75° F
Wind	:	Estimated SE 55 knots gusting to 65 knots.
Sea	:	Estimated significant sea 18 feet, maximum wave 27 feet

Monday, October 28, 0600

Synopsis	:	Hurricane Juan 29.4 degrees north, 92.0 degrees west (0600 position), radius of 34 knot winds 100 miles southeast, radius of 12-foot seas or higher 100 miles southwest (both include the accident site)
Clouds	:	Broken to overcast
Precipitation	:	Intermittent rain showers
Pressure	:	Estimated 992.5 mb
Temperature	:	Estimated 76° F
Wind	:	SSE Estimated 25 to 35 knots
Sea	:	Estimated significant sea 8 to 12 feet. Maximum wave wave 16-20 feet.

APPENDIX B

EXCERPTS FROM WEATHER FORECASTS BY COMMERCIAL WEATHER FORECASTING FIRM

General Weather Situation at 6 a.m. on Saturday, October 26, 1985

A 29.63 inch tropical depression, with maximum sustained winds of 35 mph. . . gusts to 50 mph in squalls. . . has developed in the tropical low pressure zone over the South Central Gulf and is centered at 24.0 N, 92.7 W, or approximately 320 miles ESE of Brownsville and is moving west 8 mph. . . advisories will be issued if it intensifies. A 30.30 inch high pressure area centered over Ohio extends SSW over the northern gulf. The following conditions are expected. . .

Saturday - increasing E to NE wind and waves, tides above normal, deteriorating working conditions.

Sunday - Easterly wind and waves, tides above normal, generally poor working conditions.

Monday - Decreasing E to SE wind and waves late Monday, tides above normal, improving working conditions late Monday.

Tropical Disturbance Advisory J-1 Issued 8 a.m. c.d.t. October 26, 1985

Tropical storm centered at 8 a.m. October 26 at 24.0 N, 93.1W, or approximately 300 miles ESE of Brownsville, Texas, and moving West 5 mph. Forecasted movement from 8 a.m. October 26 to 6 p.m. October 26, West 6 mph.

The tropical depression has intensified to a tropical storm. Maximum sustained winds 50 mph, gusts to 65 mph in squalls. Central pressure 29.53 inches. It is expected to continue slow westward movement toward the lower Texas or upper Mexican coast. It is recommended that offshore operations in the north and south Padre Island areas commence hurricane precautions immediately and schedule their completion by 6 p.m. Sunday, if the later proves necessary.

Tropical Disturbance Advisory J-2 Issued 3 p.m., c.d.t. October 26, 1985

Tropical storm centered at 3 p.m., October 26 at 24.0 N, 93.1 W, or approximately 300 miles ESE of Brownsville, Texas, and is stationary. Forecasted movement from 3 p.m. October 26 to 8 p.m. October 26, W 4 mph.

Maximum sustained winds 50 mph, gusts to 65 mph in squalls. Central pressure 29.53 inches. Storm is expected to resume slow westward movement this afternoon or tonight toward the lower Texas or upper Mexican coast. It is recommended that offshore operations in the north and south Padre Island areas complete hurricane precautions by 6 a.m. Sunday. It is recommended that operations in the Mustang to High Island Offshore areas of the Texas coast, and the offshore areas of the Louisisna coast, be prepared to complete hurricane precautions by 6 p.m. Sunday, if the later proves necessary.

Tropical Disturbance Advisory J-3 Issued 8 p.m. c.d.t. October 26, 1985

Tropical storm centered at 8 p.m. October 26 at 24.0 N, 93.1 W, or approximately 300 miles ESE of Brownsville, Texas, and is stationary. Forecasted movement from 8 p.m. October 26 to 6 a.m. October 27, W 4 mph.

Maximum sustained winds 50 mph, gusts to 65 mph in squalls. Central pressure 29.41 inches. Storm is expected to resume slow westward movement tonight toward the lower Texas or upper Mexican Coast. It is recommended that offshore operations in the north and south Padre Island areas complete hurricane precautions by 6 a.m. Sunday. It is recommended that operations in the Mustang to High Island offshore areas of the Texas coast, and the offshore areas of the Louisisna coast, be prepared to complete hurricane precautions by 6 p.m. Sunday, if the later proves necessary.

Tropical Disturbance Advisory J-4 Issued 6 a.m. c.d.t. October 27, 1985

Tropical storm centered at 6 a.m., October 27 at 25.5 N, 92.0 W, or approximately 310 miles SE of Galveston, Texas, and moving NNE, 5 mph. Forecasted movement from 6 a.m. October 27 to 6 p.m. October 27, N 4 mph.

Maximum sustained winds 55 mph, gusts to 70 mph in squalls. Central pressure 29.17 inches. Storm has moved slowly NNE during the night and is expected to move slowly northward today. It is recommended that offshore operations in the Texas-Louisiana offshore areas be prepared to complete hurricane precautions by 6 p.m. today, if the later proves necessary.

General Weather Situation at 6 a.m. Sunday, October 27, 1985

Tropical storm "J," with maximum sustained winds of 55 mph, gusts to 70 mph in squalls, is centered at 25.5 N, 92.0 W, or approximately 310 miles SE of Galveston, Texas, and is moving NNE 5 mph. . . see Advisory J-4. At 30.24 inch high pressure area centered over the Virginia coast extends SSW over the Eastern Gulf. The following conditions are expected. . .

Sunday - E to NE wind and waves. Tides above normal. Poor working conditions.

Monday - E to NE wind and waves. Tides above normal. Poor working conditions.

Tuesday - Decreasing NE wind and waves, tides falling toward normal, and improving working conditions late Tuesday.

Tropical Disturbance Advisory J-5 Issued 11 a.m. October 27, 1985

Tropical storm centered at 11 a.m. October 27 at 26.1N, 91.7 W, or approximately 265 miles SSW of Venice, Louisiana, and moving NNE, 9 mph. Forecasted movement from 11 a.m. October 27 to 6 a.m. October 28, NNE, 6 mph.

Maximum sustained winds 70 mph, gusts to 90 mph in squalls. Central pressure 29.12 inches. Storm is expected to continue slow northward movement over the Central Gulf today. It is recommended that offshore operations in the Texas-Louisiana offshore areas complete hurricane precautions by 6 p.m. today.

The term hurricane precautions does not necessarily imply evacuation of offshore locations. Evacuation may not, in certain cases, be advisable because of the strong wind and rough sea conditions which developed before this storm formed. The term hurricane precautions means whatever precautionary measures for hurricane conditions are advisable at each location.

Tropical Disturbance Advisory J-6 Issued 3 p.m. October 27, 1985

Hurricane centered at 3 p.m. October 27 at 26.4 N, 91.5W, or approximately 240 miles SSW of Venice, Louisiana, and moving NNE, 6 mph. Forecasted movement from 3 p.m. October 27 to 8 p.m. October 27, NNE, 6 mph.

Maximum sustained winds 75 mph, gusts to 95 mph in squalls. Central pressure 29.06 inches. Storm has intensified to minimal hurricane intensity. Hurricane is expected to continue slow NNE movement over the Central Gulf late this afternoon and tonight. It is recommended that offshore operations in the Louisiana-Texas offshore areas complete hurricane precautions by 6 p.m. today.

The term hurricane precautions does not necessarily imply evacuation of offshore locations. Evacuation may not, in certain cases, be advisable because of the strong wind and rough sea conditions which developed before this storm formed. The term hurricane precautions means whatever precautionary measures for hurricane conditions are advisable at each location.

Tropical Disturbance Advisory J-7 Issued 8 p.m. October 27, 1985

Hurricane centered at 8 p.m. October 27 at 27.7 N, 90.8 W, or approximately 135 miles SE of Venice, Louisiana, and moving NNE, 15 mph. Forecasted movement from 8 p.m. October 27 to 6 a.m. October 28, NNE, 15 mph.

Maximum sustained winds 75 mph, gusts to 95 mph in squalls. Central pressure 29.06 inches. Hurricane is expected to continue NNE toward the southeast Louisiana-Mississippi coast tonight and early Monday morning. Tides 7 to 9 feet above normal are expected on the east side of the hurricane center where the center crosses the coast.

APPENDIX C

PERSONNEL DATA

John R. Nash, Toolpusher, PENROD 61

Mr. Nash had been employed by the Penrod Drilling Company over a period of 27 years. He had served as toolpusher on board mobile offshore drilling units for about 12 years and had been assigned as toolpusher on board the PENROD 61 for more than 10 years. Mr. Nash held a valid license issued by the U.S. Coast Guard as master of column-stablized or self-elevating motor drilling vessels of any gross tons upon oceans while under tow or engaged in mineral and oil exploration.

Timothy D. Everard, Chevron Drilling Representative, PENROD 61

Mr. Everard was the senior Chevron official on board the PENROD 61 at the time of the accident. He was not licensed and was not required to be licensed by the U.S. Coast Guard. Mr. Everard had an associate degree in petroleum engineering and technology and had 2 1/2 years experience in the offshore oil industry. He had been assigned as Drilling Representative on board the PENROD 61 since July 1985.

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