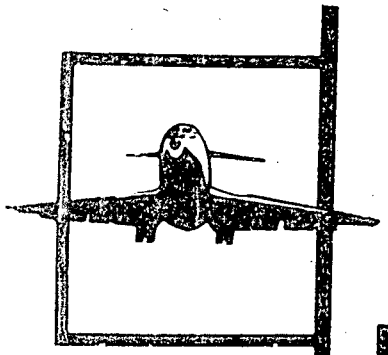

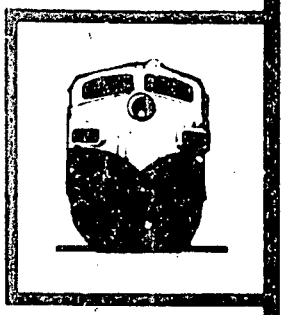

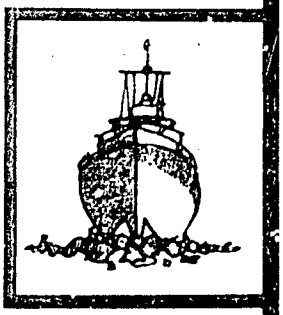

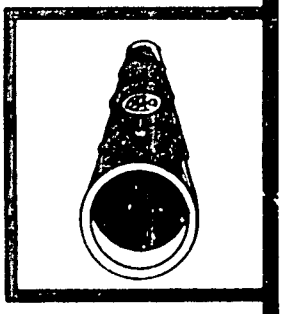

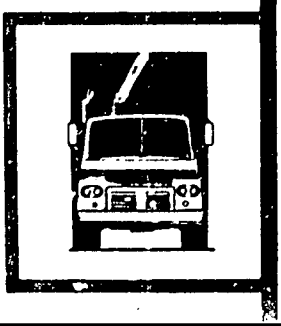

PB87-916402

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

MARINE ACCIDENT REPORT

CAPSIZING AND SINKING OF THE UNITED STATES DRILLSHIP GLOMAR JAVA SEA IN THE SOUTH CHINE SEA 65 NAUTICAL MILES SOUTH-SOUTHWEST OF HAINAN ISLAND, PEOPLE'S REPUBLIC OF CHINA OCTOBER 25, 1983

NTSB/MAR-87/02

(SUPERSEDES: NTSB/MAR-84/08)

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16. Abstract

About 2355 on October 25, 1983, the 400-foot-long United States drillship GLOMAR JAVA SEA capsized and sank during Typhoon LEX in the South China Sea about 65 nautical miles south-southwest of Hainan Island, People's Republic of China. Of the 81 persons who were aboard, 35 bodies have been located, and the remaining 46 persons are missing and presumed dead. The GLOMAR JAVA SEA currently is resting on the bottom of the sea in an inverted position in about 315 feet of water; its estimated value was $35 million.

The National Transportation Safety Board determines that the probable cause of the sinking of the United States drillship GLOMAR JAVA SEA during Typhoon LEX was the decision by the master, the Atlantic Richfield Company drilling supervisor, and the Global Marine drilling superintendent to maintain the drillship at anchor at the well site with all nine anchors, which subjected the vessel to the full force of the storm and allowed it to capsize to starboard as a result of severe rolling while experiencing a 15° starboard list from an undetermined cause. Contributing to the large loss of life was the failure of the master, the Atlantic Richfield Company drilling supervisor, and the Global Marine drilling superintendent to evacuate nonessential personnel from the GLOMAR JAVA SEA before the weather conditions deteriorated sufficiently to make evacuation dangerous.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

MARINE ACCIDENT REPORT

Adopted: March 3, 1987

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 OCTOBER 25, 1983

INTRODUCTION

This accident was investigated jointly by the National Transportation Safety Board and the U.S. Coast Guard with the cooperation of the Bureau of Harbor Superintendents of the People's Republic of China. Hearings were held in Hong Kong from December 12 to December 14, 1983, and in Houston, Texas, from January 23 to January 30 and on June 13 and June 14, 1984. This report is based on the factual information developed by the investigation. The Safety Board has considered all facts pertinent to the Safety Board's statutory responsibility to determine the cause or probable cause of the accident and to make recommendations.

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

SYNOPSIS

About 2355 on October 25, 1983, the 400-foot-long United States drillship GLOMAR JAVA SEA capsized and sank during Typhoon LEX in the South China Sea about 65 nautical miles south-southwest of Hainan Island, People's Republic of China. Of the 81 persons who were aboard, 35 bodies have been located, and the remaining 46 persons are missing and presumed dead. The GLOMAR JAVA SEA currently is resting on the bottom of the sea in an inverted position in about 315 feet of water; its estimated value was $35 million.

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INVESTIGATION

There were no survivors from this accident who could provide information regarding the events aboard the drillship leading to the sinking of the GLOMAR JAVA SEA. The description of events was compiled from the testimony of shoreside personnel who had voice radio communications (MARISAT 1/ and single sideband (SSB)), the master of the NANHAI 205 who had voice radio communications (SSB and very high frequency (VHF)) with personnel aboard the GLOMAR JAVA SEA, and printed radio communications (SSB) received ashore.

The Accident

On October 22, 1983, the United States drillship GLOMAR JAVA SEA (see figure 1) was moored in about 315 feet of water in the South China Sea about 65 nautical miles (nmi) south-southwest of Sanya on Hainan Island, People's Republic of China (PRC), drilling an exploratory well for ARCO 2/ China, Inc. (See figure 2.) The weather at the drillship location was 6-knot (kn) winds from the northwest, 2-foot-high waves from the northwest, and 5-foot-high swells 3/ from the northeast. The drillship was rolling about 2° and pitching about 2°. 4/ The exploratory well was part of a joint contract among the China National Offshore Oil Company (CNOOC), wholly owned by the PRC; Sante Fe Minerals (ASIA), a subsidiary of Sante Fe International Corporation; and ARCO China, Inc., a subsidiary of the Atlantic Richfield Company (ARCO). The 400-foot-long GLOMAR JAVA SEA was owned by Global Marine Deepwater Drilling, Inc., and was operated by Global Marine Drilling Company. The owner and the operator both were subsidiaries of Global Marine, Inc., of Houston, Texas. Eighty-one persons, including the ARCO drilling supervisor, the Global Marine assistant rig manager, the Global Marine drilling superintendent, and the master, were aboard the GLOMAR JAVA SEA. Of the 81 persons, there were 37 U.S. citizens, 35 PRC citizens, 4 British citizens, 2 Singaporean citizens, 1 Canadian citizen, 1 Australian citizen, and 1 Philippine citizen. (See appendix A.)

At 1630 local time 5/ on October 22, the Meteorological Service Company (METEO), a PRC weather reporting service under contract to ARCO to prepare meteorological and oceanographic forecasts for the GLOMAR JAVA SEA and ARCO China's headquarters in Zhanjiang, PRC, issued a forecast stating that a tropical depression (less than 34-kn winds) which was located 420 nmi to the east of the drillship, had been upgraded to a tropical storm (34 to 47 kns) and was moving west-northwest at 10 kns with the center of the storm expected to pass to the south of Sanya about 0200 on October 24. (See figure 2.) The ARCO drilling superintendent in Zhanjiang later testified that on October 22 he discussed securing the well before the forecast arrival of the storm with the ARCO supervisor aboard the GLOMAR JAVA SEA. When he talked to the ARCO supervisor, the ARCO supervisor told him that they already had begun the first phase of preparing for the storm, the process of hanging off [5]. 6/ At 1000, they had begun a

1/ An international satellite communications system.
2/ ARCO is the acronym for Atlantic Richfield Company.
3/ Swells are waves generated at some distance away from the observed area.
4/ Roll is the transverse angular motion of the vessel. Pitch is longitudinal angular motion of the vessel. The roll and pitch reported by the crew was measured from the perpendicular to one side.
5/ All times herein are local time (+8 hours from Greenwich mean time) based on a 24-hour clock unless otherwise stated.
6/ Numbers in brackets after words or phrases refer to the glossary in appendix B.

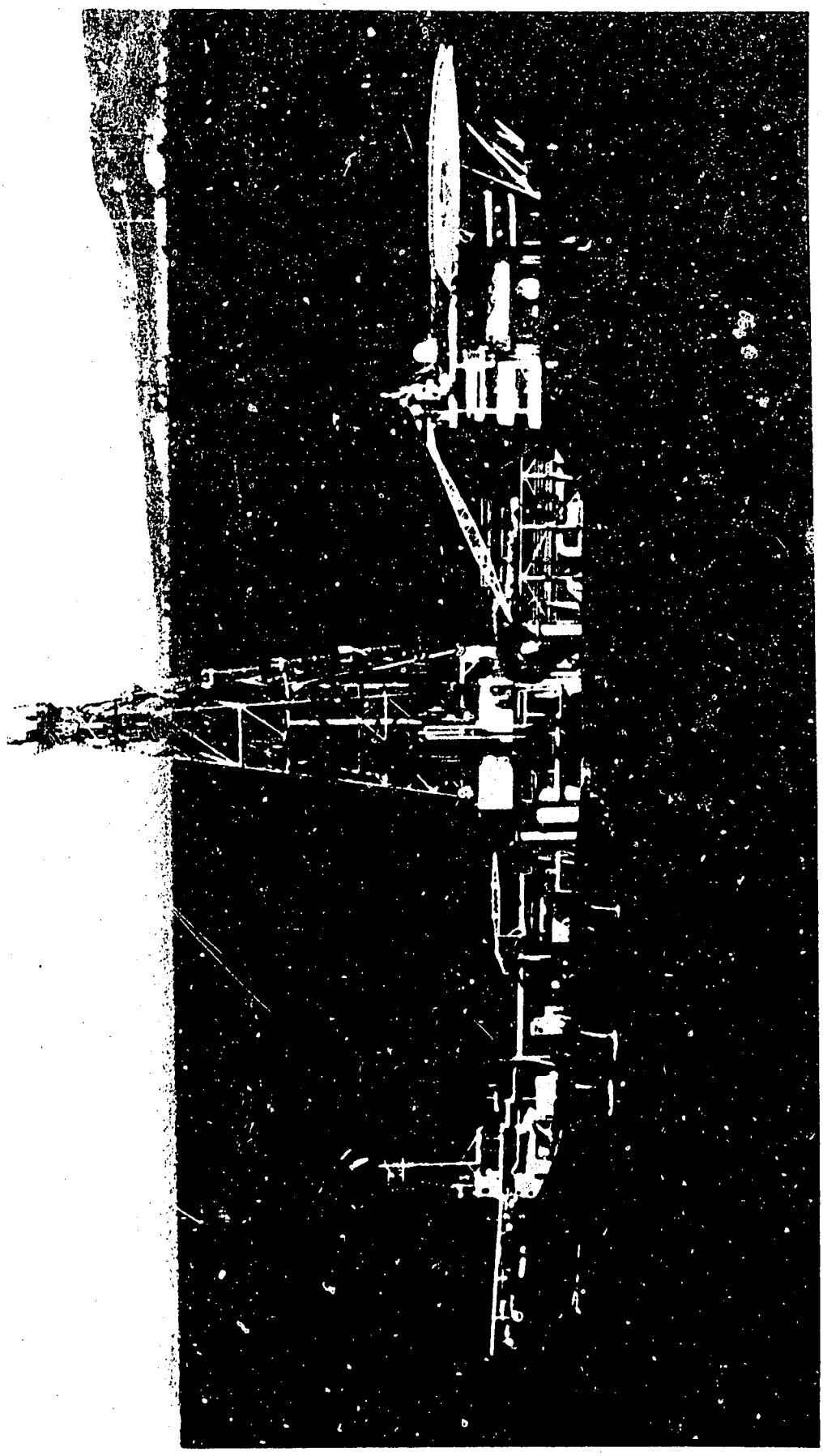


Figure 1.--The United States drillship GLOMAR JAVA SEA.

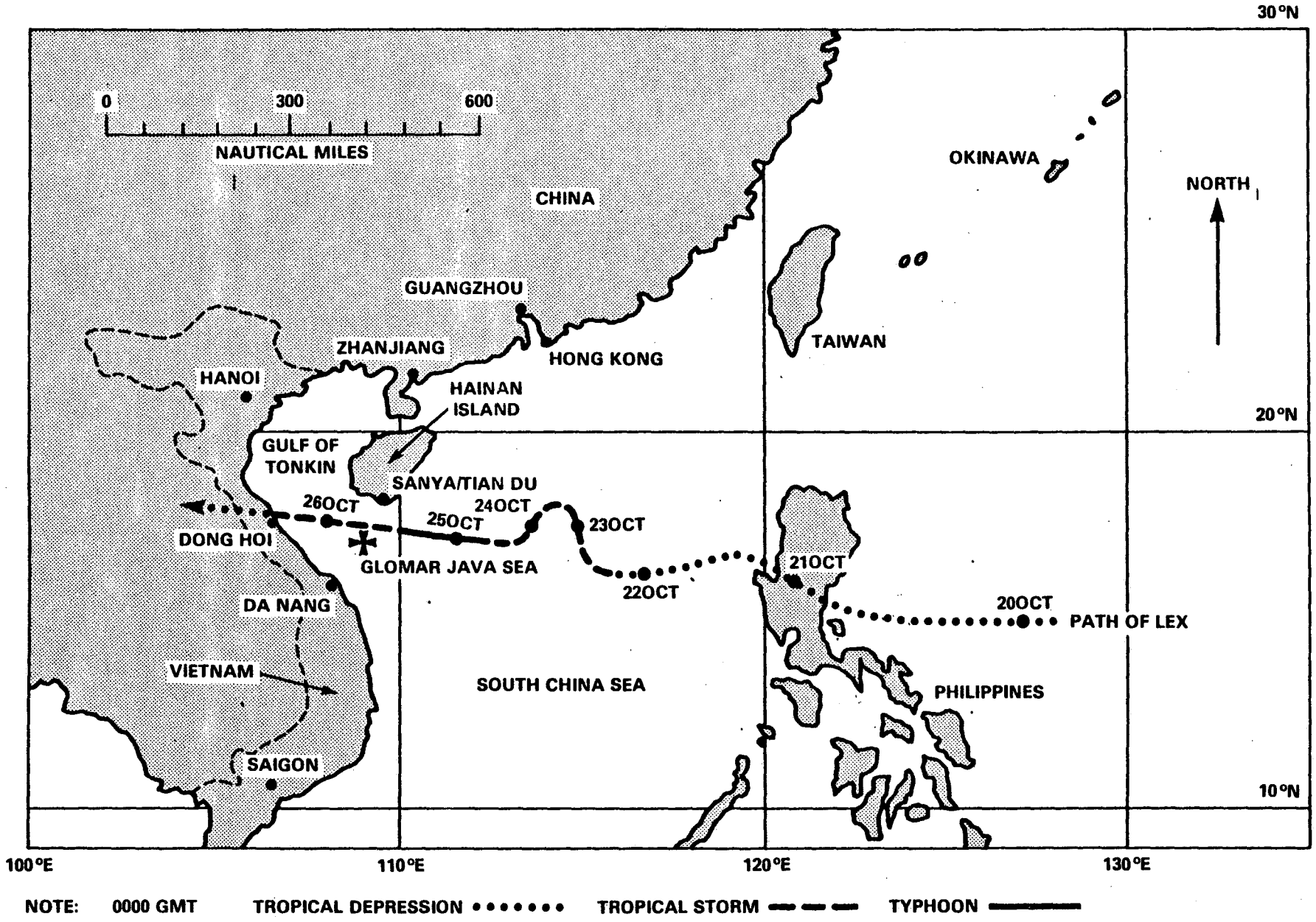


Figure 2.--Location of GLOMAR JAVA SEA and path of LEX (as reported by the U.S. Joint Typhoon Warning Center, Guam) during October 1983.

trip [8] to change the bit [1] on the approximately 10,500-foot drill string [3]. After changing the bit, they planned to run about 6,300 feet of drill string back into the hole to the level of the casing [2] and be hung off by midnight.

The 1800 METEO forecast stated that the tropical storm would have maximum winds of 50 kns, gusting to 60 kns. The forecast concluded with the statements, "The tropical storm will influence this operation area. Pay attention to it." At 0100 on October 23, the crew of the GLOMAR JAVA SEA began the second phase of preparing for the storm by disconnecting and pulling the marine riser [7] aboard the drillship. This process was completed at 1015. The 1030 METEO forecast stated that at 0800 the storm was located about 300 nmi to the east of the GLOMAR JAVA SEA moving west-northwest at 8 kns and that the center of the storm would pass to the north of Sanya about 1400 on October 24. At 1200, the weather at the drillship location was 9-kn winds from the north, 2-foot waves from the north, and 2-foot swells from the northeast.

On the morning of October 23, the storm took a northerly course and in the afternoon changed direction to a southwesterly course and slowed to 2 kns. The 1630 METEO forecast predicted that the storm would pass over the northern part of Hainan Island with winds of 40 kns gusting to 50 kns. The storm continued to move slowly to the southwest until 2000 on October 24 when it picked up speed to 7 kns and started moving due west. However, the METEO forecasts issued on October 24 continued to predict that the storm would pass over or near the northern part of Hainan Island. At 2000, Tokyo Weather Service, a Japanese weather service under contract to Global Marine to provide weather information to the GLOMAR JAVA SEA, upgraded the tropical storm (34 to 47 kns) to a severe tropical storm (48 to 63 kns). However, the crew of the GLOMAR JAVA SEA did not learn that the storm was heading west at 7 kns until they received the METEO forecast at 0730 on October 25. The forecast stated that at 0500, the storm was centered about 170 nmi east of the drillship, that it was moving west-northwest at 7 kns, that it would pass to the north of Sanya during the night, and that it would seriously influence the drillship's operation. The forecast predicted the conditions at the drillship during the upcoming night to be winds of 41 to 55 kns from the northwest, seas of 13 to 16 feet from the northwest, and a swell of 16 to 20 feet from the northwest. At 0800, the environmental conditions at the drillship location were 25- to 30-kn winds and 18- to 26-foot waves from the north-northwest; the drillship was rolling 14°.

About 0800, a Chinese meteorologist at the Nanhai West Oil Company (NHWOC) 7/ offices in Zhanjiang predicted that the tropical storm would pass near the GLOMAR JAVA SEA and would not turn to the northwest as predicted by METEO. The manager of the NHWOC liason office relayed this information to the ARCO drilling superintendent in Zhanjiang and suggested that ARCO move the drillship. The manager stated that the drilling superintendent replied that ARCO would not move the drillship because the METEO forecasts predicted the storm would turn to the northwest, and that besides there was nowhere for the drillship to seek shelter: Hainan Island to the northwest was where the center of the storm was predicted to go, to the southwest was the unfriendly territory of Vietnam, and to the southeast or northeast was the approaching storm. The drilling superintendent testified that although the NHWOC manager did discuss the weather situation with him on the morning of October 25, the request to move the drillship did not come until 1500.

7/ Nanhai West Oil Company was the local subsidiary of the China National Offshore Oil Company and was responsible for the joint management of the oil exploration with ARCO.

At 1100, the manager of Nanhai West Shipping Company (NHWSC) 8/ in Zhanjiang telephoned the ARCO logistics manager in Zhanjiang, who was a liaison official for the supply vessels contracted for by ARCO from NHWSC, and asked the ARCO logistics manager what measures ARCO was taking to protect the NANHAI 205, the supply vessel standing by 9/ the GLOMAR JAVA SEA, from the typhoon. The NHWSC manager said the ARCO logistics manager told him that the storm was not a typhoon (over 63 kns) but a tropical storm (34 to 63 kns), that the drillship was not intending to move off the well location or to evacuate any personnel, and that the NANHAI 205 was to stand by the GLOMAR JAVA SEA to give assistance if necessary.

The 1330 METEO forecast indicated that the storm, which at 1100 was about 120 nmi to the east of the GLOMAR JAVA SEA, would pass about 30 nmi to the north of the drillship during the night with 60-kn winds gusting to 75 kns. At 1600, the environmental conditions at the drillship were 45- to 50-kn winds from the north, 38-foot waves from the northwest, and 30-foot swells from the northeast. The drillship was rolling 15°, pitching 4°, and heaving 10/ 24 feet. At 1830, the ARCO drilling superintendent at Zhanjiang called the ARCO drilling supervisor aboard the GLOMAR JAVA SEA. The ARCO drilling superintendent testified as follows:

> The conversation was, the storm by the later weather forecast should pass over the vicinity of the GLOMAR JAVA SEA sometime during the night . . . at that time . . . the ARCO supervisor, said the rig [GLOMAR JAVA SEA] was riding good and was having no difficulties. And he felt comfortable or everyone felt comfortable.
>
> During this discussion, it came about where the work boat [NANHAI 205] was. He said it is standing by, it is standing by the rig. He didn't say any specific distance. And that they had their regular hourly radio communication.
>
> * * *
>
> And the end of the conversation ended up was that [if] the storm passed over and the sea conditions got too rough, and to think about the personnel they would do whatever was necessary to protect the people on board.

The ARCO drilling superintendent then went home for the night leaving the Chinese radio operator as the only ARCO employee on duty.

At 1900, the master of the NANHAI 205 talked to the GLOMAR JAVA SEA on VHF radio. The master of the NANHAI 205 made the following statement:

> At 1900 hour, I talked with JAVA SEA by VHF. JAVA SEA asked: "How far are you from us now?" I said 5 nautical miles. The first mate of my vessel asked the radio operator on board JAVA SEA: "How many degrees is your ship rolling?" The answer was 9 to 10 degrees.

8/ A subsidiary of Nanhai West Oil Company.
9/ ARCO had contracted with Nanhai West Shipping Company to provide two offshore supply vessels at all times. One supply vessel remained with the GLOMAR JAVA SEA at all times while the second vessel was in port loading supplies.
10/ Heave is the vertical movement of a vessel in waves.

At 2010, the master of the NANHAI 205 again talked to the drillship. He stated:

> When we talked to ... [the] interpreter onboard JAVA SEA, [the interpreter] said: "The rice bowls in the dining room can not keep stable. The ship is rolling about 20 to 30°." At that time, there was more than 12 scale [64 knots] of eddy wind, 8.6 to 11 meters of wave height. My vessel was rolling more than 40°, the vessel was up and down in the wave.

The Chinese radio operator in the ARCO office in Zhanjiang made the following statement:

> At 2100 to 2115 hour, I talked with the drillship and I relaid (sic) to the radio operator on board the drillship the requests of General Dispatch Office of Production and Operation Dept. of NHWOC of getting the weather information around the drillship. After that, I relaid (sic) to the General Dispatch Office the informations I got from the radio operator on board the drillship which read as follows: 10 scale [48 to 55 kns] of wind force with 11 scale [56 to 63 kns] of gust-wind, 330° of wind direction, 37 feet of wave height with maximum of 39 feet, 330° of wave direction 50° of swell direction, 30 feet of swell height. At about 2140 hour, the General Dispatch Office requested me to get the weather informations then around the drillship and then relaid (sic) to them. I said: "I just asked for this not long ago, the signal is not so good, I am afraid that the radio operator on board the drillship will not be happy if I call him frequently. Please wait for a moment." At about 2200 hour, I called the drillship, and I relaid (sic) to the radio operator on board the drillship the requests of the General Dispatch Office. After a while, the radio operator said that the weatherman did not start to record, had not idea then (sic). At about 2210 hour, I talked with the drillship, the main points of what the radio operator said are as follows: "The wind and wave are most heavy now, the ship is rolling and pitching. Waves are beating on the deck with sound like thundering. Please pay attention to keep contact." At 2220 hour the drillship called my radio. The radio operator on board the drillship said: "The captain had already asked for weather information. But the time for receiving weather forecast did not reach them and asked me to turn on the punching machine for automatic record when the time for receiving was reached (At 2230 hour to 2300 hour is the time for Guangzhou Meteorological Service company to release the weather forecast). At 2237 hour, I called the drillship and asked the radio operator on board the ship if necessary for me to resend the weather telex to him. He asked me waiting for a moment. At about 2250 hour, the drillship called me and the radio operator on board the vessel said that the weather telex had checked and had sent out (means had sent to the captain), and informed me not necessary to resend the weather telex. At 2255 hour, I talked with the radio operator on board the drillship, I asked how was him and the ship? He said the ship was still the same. Wind and wave were heavy and the ship was rolling and pitching very much. He himself was still OK. Also I asked him if he had any other things. When I learned there was not any other things, then concluded the conversation.

> At 2300 hour, just before I got off duty, I left a message on a piece of paper to next shift. The main points are: "[to the relief radio operator] there is typhoon at night, JAVA SEA was rolling very much, attention shall be paid to watch the drillship and TianDu [Sanya] Radio at night. If there is anything, please telephone the General Dispatch Office or related person in ARCO."

The Chinese radio operator at the ARCO Tian Du radio which is located near Sanya made the following statement:

> At 2300 hour, JAVA SEA called my Radio. [The radio operator aboard the JAVA SEA] said: "Wind and Wave are too heavy now, the drilling superintendent has asked us to put on lifejacket. Please pass this to Zhanjiang".
>
> At 2300 hour, I called ARCO Zhanjiang Radio, but there was not answer.
>
> At 2308 hour, I made a long distance telephone call to the operator who was on duty in telephone exchange of Nanhai West Oil Co. and asked him to look for ... the responsible person in charge of ARCO Tian Du employee Group. The operator said: "It is raining heavily. Only myself is now on duty, I can not leave and go out to look for him, but I can look for him by using telephone.
>
> At 2310 hour, I called JAVA SEA, but there was not answer, neither there was answer from Nanhai 205.
>
> At 2312 hour, I informed the above information to [the person in charge of the ARCO Tian Du Employee Group] by telephone.
>
> At 2315 hour, I called JAVA SEA for long time, but there was not answer, neither there was answer from "Nanhai 205".
>
> At 2316 to 2325 hour, I called ARCO Zhanjiang Radio and JAVA SEA continuously, but no answer. I told that to [the person in charge of the ARCO Tian Du Employment Group].

The master of the NANHAI 205 stated the following:

> At 2315 hour, wind force was 40M/S [78 kns], atmospheric pressure was 1001 MB. 11 meters of wave height. My vessel talked with JAVA SEA, and informed the radio operator on board JAVA SEA the No. 16 typhoon [LEX] warning issued by Hainan Weather Station. I asked the radio operator on board JAVA SEA "How are you?" The radio operator on board JAVA SEA said:" Still Ok," and then he let the interpreter talk with me. [The interpreter] said: "Do you have any requirement?" I said: "Wind and wave are heavy now, my vessel is rolling 30° to 40°. I am in a dilemma, the only way is to sail against wind." Then JAVA SEA asked my vessel to check the SSB, when found it was working normally, then it said it's better to use VHF to talk, in case if VHF was not clear, then switched to SSB. At that time, my vessel was 16.2 nautical miles away from JAVA SEA. At 2400 hour, my vessel's location was in 16° 58'7 N, 109°04'3 E, according to satellite positioning. We used VHF to call JAVA SEA, but there was not answer.

After talking to the GLOMAR JAVA SEA at 2315, the master of the NANHAI 205 turned off his vessel's SSB. When the assistant manager of NHWOC, who was on duty in the NHWOC offices, learned that radio contact was lost with the GLOMAR JAVA SEA, he sent someone to find a radio operator for ARCO's radio in Zhanjiang. The new operator came on duty at 2330 and also was unsuccessful in making radio contact with the drillship.

At 2341 (1041 c.d.t.), the Global Marine assistant rig manager, who normally was stationed in Zhanjiang but happened to be aboard the GLOMAR JAVA SEA, made a MARISAT call to his drilling group vice president in Houston, Texas. The drilling group vice president's administrative assistant, who overheard the conversation on a speaker phone, testified as follows:

> As best as I can recall, the initial communication was made by the radio operator on board the JAVA SEA. And when the connection was made, he indicated that he was making a call on behalf of [the assistant rig manager].
>
> After a slight pause, [the assistant rig manager] came to the radio and indicated to [the drilling group vice president] that they were experiencing a 15 degree starboard list and that he had not determined what the cause of that list was.
>
> He [the assistant rig manager then indicated to the drilling group vice president that] the winds are blowing approximately 70 to 75 knots over the bow.
>
> [The group vice president] said: "What do you mean that you can't determine the list, can't determine the reason for the list? Have you had your engineering people checking out the tanks and finding out if you are taking on water?"
>
> [The assistant rig manager]: "Yes, we have had the engineering people researching that. We have not found the reason."
>
> [The group vice president]: "Are they continuing to search?"
>
> [The assistant rig manager]: "Yes, they are."
>
> [The group vice president]: "What is your mud situation on the starboard tank?"
>
> [The assistant rig manager]: "We're dumping the mud."
>
> [The group vice president]: "Okay." And then at that time [2346] the transmission was cut off.
>
> [The group vice president] stayed on the line for some time afterwards, but we never could regain the contact. And then we hung up the phone at our end and the transmission was completed.

A later survey of the wreck of the GLOMAR JAVA SEA on the bottom of the South China Sea showed that two of the drillship's clocks stopped at 2355. Between 2351 on October 25 and 0016 on October 26, the drilling group vice president attempted unsuccessfully 28 times to reestablish contact with the GLOMAR JAVA SEA via

MARISAT. After 20 more attempts between 0017 and 0217, he called the U.S. Coast Guard (USCG) Rescue Coordination Center (RCC) in San Francisco at 0220 which, in turn, at 0357, notified the RCC at Kadena Air Force Base, Okinawa, Japan, of the loss of communication with the GLOMAR JAVA SEA.

Meanwhile, both the ARCO Tian Du and Zhanjiang radio operators were attempting unsuccessfully to contact the GLOMAR JAVA SEA and NANHAI 205 on SSB. At 0025 on October 26, the ARCO radio operator in Zhanjiang telephoned the ARCO interpreter who woke the ARCO operations manager and the ARCO drilling superintendent in their hotel rooms. The operations manager and drilling superintendent immediately went to the ARCO offices in Zhanjiang about 10 minutes away. At 0230, the operations manager telephoned the ARCO China vice president and general manager, who happended to be in Hong Kong, and notified him of the situation. The ARCO vice president then attempted unsuccessfully to contact the GLOMAR JAVA SEA through the MARISAT operator in Tokyo, Japan. About 0930, the ARCO vice president received a telephone call from his principal in Los Angeles, California, who told the vice president that Global Marine had been unable to contact the GLOMAR JAVA SEA and had contacted the USCG. A few minutes later, the ARCO vice president received a call from the Global Marine drilling group vice president concerning his MARISAT call at 2341 on October 25. The ARCO vice president then relayed this information to the ARCO drilling superintendent in Zhanjiang.

Search and Rescue Efforts

At 0357 on October 26, the USAF RCC at Kadena Air Force Base on Okinawa (see figure 2) was notified by the USCG in San Francisco that the GLOMAR JAVA SEA was listing 15° at position 17°17' N. latitude 108°53' E. longitude, was in the path of Typhoon LEX, and had not communicated with anyone since 2346 on October 25. About 0500, Kadena called Global Marine in Houston to obtain a detailed description of the drillship, the vessel's call sign--WFDS--and information on the drillship's radios and radio frequencies. After obtaining this information, Kadena issued an urgent marine information broadcast requesting any information regarding the GLOMAR JAVA SEA and attempted unsuccessfully to contact the GLOMAR JAVA SEA via a WC-130 airplane which was within 300 nmi of the last known position of the drillship.

At 0620, the master of the NANHAI 205 turned on his SSB radio after having attempted all night to contact the GLOMAR JAVA SEA on the vessel's VHF radio. At 0650, the ARCO Tian Du radio operator overheard the NANHAI 205 attempting to call the drillship and made contact with the NANHAI 205. At 0705, the NANHAI 205 was requested by ARCO and NHWOC to return to the well location and search for the GLOMAR JAVA SEA.

About 0830, both ARCO China and NHWOC requested that the ARCO Bell 212 helicopters in Sanya conduct a search for the GLOMAR JAVA SEA; however, at 0918 they were informed that the helicopters could not fly under the poor weather conditions. At 1020, the ARCO operations manager and the managing director of NHWOC met to discuss a search and rescue plan. It was decided that the ARCO operations manager, the ARCO drilling superintendent, the ARCO logistics manager, the NHWOC assistant manager, the NHWOC liaison office manager and several other representatives from both ARCO and NHWOC would proceed to Sanya to set up a search and rescue coordination center. Since the Zhanjiang airport was closed and Hainan Straits were closed to ferry traffic due to the typhoon, it was decided that the NHWOC assistant manager, the ARCO drilling superintendent, and the ARCO logistics manager would proceed to Sanya aboard the supply vessel NANHAI 209 and the others would follow when the Zhanjiang and Sanya

airports were open. The NHWOC then reported the situation to the China National Emergency Committee of the State Council of the PRC, which, in an emergency, has the authority to mobilize and coordinate a search utilizing the Chinese Navy, Air Force, and Army, and shipping companies and oil companies.

After the NANHAI 205 arrived at the well location and did not find the GLOMAR JAVA SEA, it reported at 1112 that "8 big buoys and 3 small buoys are found. Maybe drillship cut off chains and went away." This information was passed onto Kadena, and the PRC Navy was requested to begin a search for the drillship. At 1150, the NANHAI 205 found three lifejackets belonging to the GLOMAR JAVA SEA, and at 1300, the NANHAI 205 found a large rubber bumper belonging to the drillship. (See figure 3.) At 1400 as the weather and sea conditions improved, the PRC Navy activated four ships and an airplane to search for the GLOMAR JAVA SEA. When the NANHAI 205 returned to the well location at 1845, the crew found a fuel slick in the water and smelled fuel oil. About 1850 the first PRC Navy ship arrived at the well location.

At 0430 on October 27, a commercial airplane reported to the Hong Kong Marine Department that an intermittent distress signal on 121.5 mHz was heard at 2140 on October 26 about 60 to 70 nmi east of Da Nang, Vietnam. This information was passed on to Kadena. It was later determined that a distress signal transmitted from that location could not have come from the GLOMAR JAVA SEA's emergency position indicating radio beacon (EPIRB). At 0643 on October 27, Kadena alerted its search and rescue airplanes and at 0747 launched a P-3 airplane with an estimated time en route of 3 hours. The P-3 spent 6 hours searching the drill site using a 25-nmi track spacing at an altitude of 300 to 400 feet. The area covered was bounded approximately by 14°30' N. latitude on the south, 30 nmi off the Vietnam coast on the east, 18° N. latitude on the north, and 110° E. longitude on the west. Due to the poor weather conditions, most of the unsuccessful search was conducted by radar. During the afternoon of October 27, a Singaporean ship about 200 nmi southeast of Saigon, Vietnam (see figure 2), en route from Dubai, United Arab Emirates, to Kobe, Japan, reported to the Marine Department of Hong Kong that it had received a distress signal on 500 kHz at 1307 on October 27. The distress signal included the GLOMAR JAVA SEA's call signal, WFDS, and a position of 17.41° N., 107.42° E. (about 70 nmi to the northwest of the well location). (See figure 3.) A vessel was sent to locate the source of the signal, but it was not found.

At 1345, Kadena launched a second search airplane which spent 4.7 hours searching the drill site using a 16-nmi track spacing at an altitude of 500 feet. The area to the south and east of the well location was searched with negative results. About 1400, the NANHAI 205 began a fathometer survey of the ocean floor within the drillship's anchor buoys. At 1500, the weather conditions improved at Sanya and the ARCO operating manager flew on a British Petroleum Sikorsky 61 helicopter from Zhanjiang to Sanya. The NANHAI 209 with the other members of the search team arrived in Sanya about 1600, and the ARCO assistant manager arrived at 1700. About the same time, the NANHAI 205's fathometer survey had located a wreck about the size of the GLOMAR JAVA SEA about 1,400 feet to the southwest of the well location but within the buoy pattern. It was later determined that the wreck was actually 1,650 feet to the southwest. (See figure 4.) At 2023, Kadena was informed of the distress message on 500 kHz from a position northwest of the well location.

At 0615 on October 28, Kadena launched a third airplane which spent 11.5 hours searching using a 3.6-nmi track spacing at an altitude of 600 feet. The area searched was about 30 by 30 nmi near the reported position of the 500-kHz distress message with

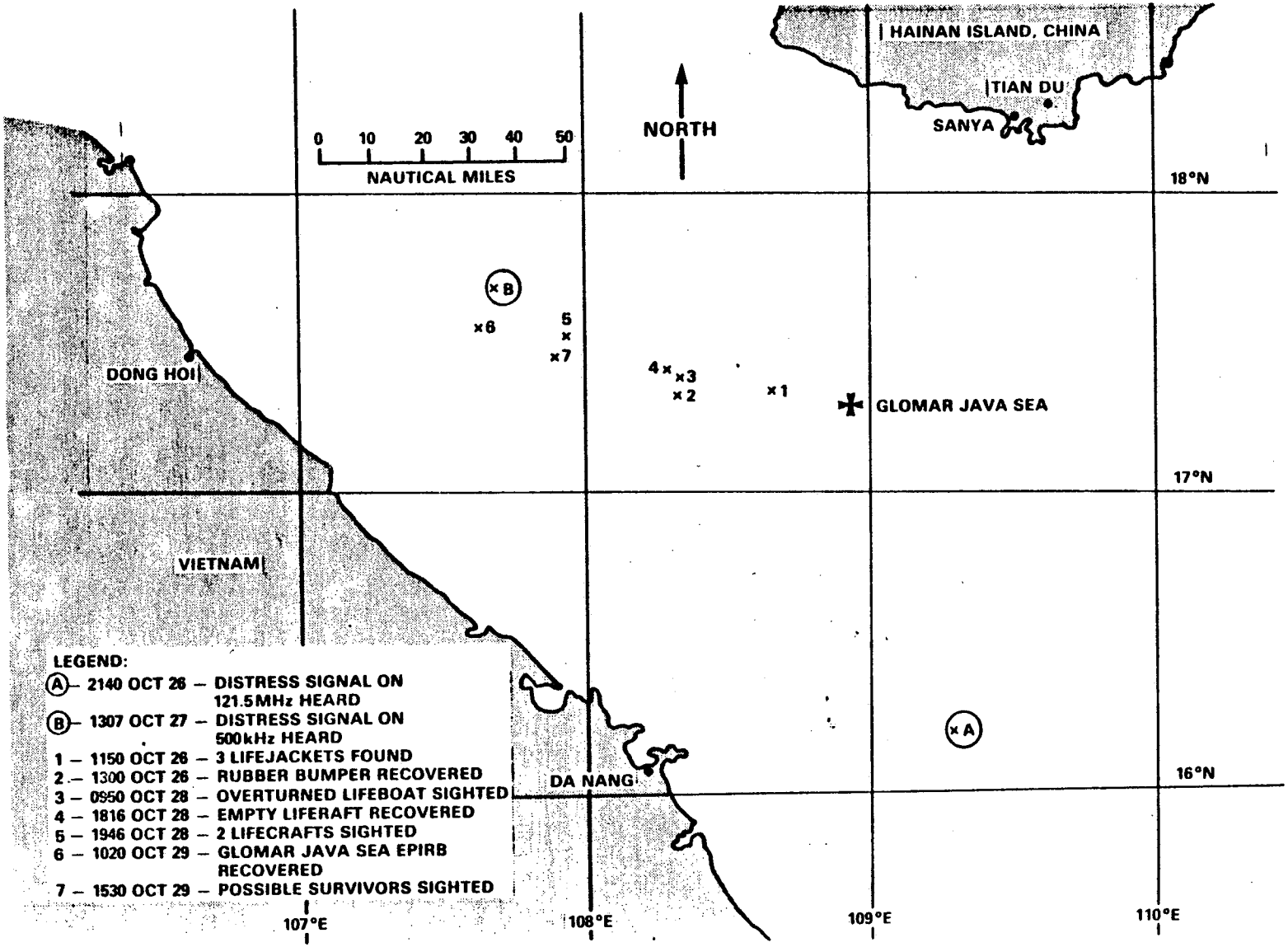


Figure 3.—Search and rescue effort from October 26 to October 29, 1983.

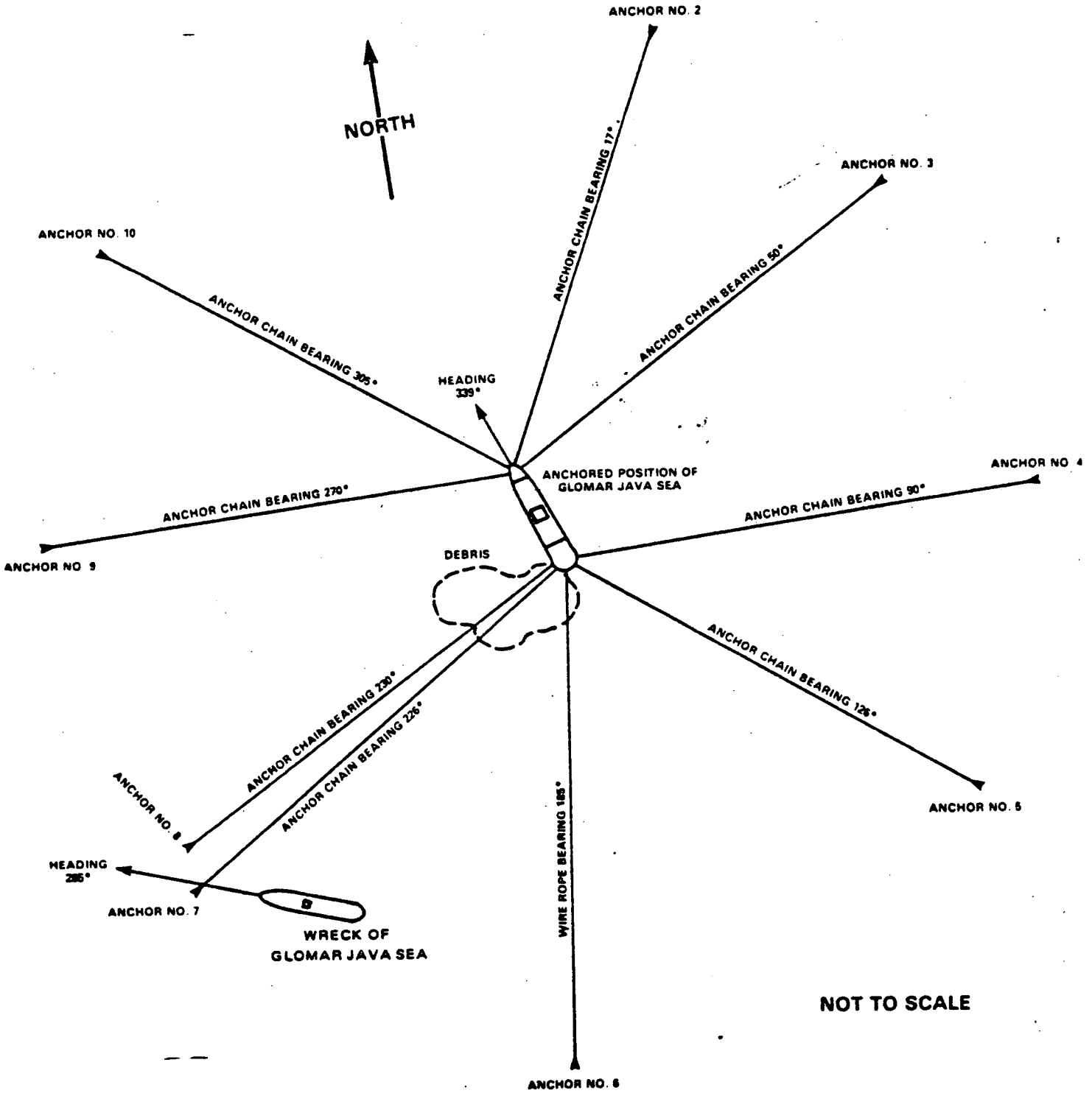


Figure 4.—Actual anchor pattern and position of wreck of GLOMAR JAVA SEA.

negative results. In the meantime, the weather had improved so that the ARCO Bell 212 helicopters and the British Petroleum helicopter began searching the area of the 500-kHz distress call. At 0950, one of the ARCO helicopters spotted an overturned white lifeboat with its propeller showing but no survivors visible in position 17°23' N. latitude, 108° 20' E. longitude about 40 nmi east-southeast of the 500-kHz reported position and 35 nmi west-northwest of the well location. ARCO immediately dispatched the NANHAI 209 to the overturned lifeboat. However, the lifeboat was not located again. At 1315, Kadena launched a fourth aircraft which spent 10.4 hours searching the drill site using a 2-nmi track spacing at an altitude of 400 feet. The area searched was about 40 by 40 nmi near the reported position of the overturned lifeboat. At 1816, the SUI JIU 201 recovered an empty liferaft belonging to the GLOMAR JAVA SEA in position 17°24' N., 108° E., and at 1946, a U.S. military airplane reported sighting flashing strobe lights and two liferafts in position 17°31' N., 107°56' E. A vessel was sent to the location of the strobe lights by the Hong Kong Marine Department but did not find any liferafts. About midnight, a side scan sonar from British Petroleum Company arrived in Sanya and was transferred to the NANHAI 205.

On October 29, Kadena launched six airplanes at 0047, 0715, 0904, 1150, 1943, and 2153. The areas searched were to the north and west of the well location. The total search time was about 50 hours. At 1000, the NANHAI 205 began a side scan sonar survey of the wreck. At 1020, the GLOMAR JAVA SEA's EPIRB, which had operated properly, was recovered by a PRC Navy ship in position 17'32' N, 107°38' E about 10 nmi southwest of where the 500 kHz distress signal was reported. At 1530, the helicopters which had been searching since daylight departed the area to return to Sanya because of bad weather. At 1709, a U.S. military airplane spotted a fresh dye marker and a possible survivor in the water in position 17°27' N, 107°54' E about 25 nmi west-northwest of the reported position of the overturned lifeboat. The SALVANQUISH reached the area at 1855 but found nothing. The next morning, the SALVANQUISH and the helicopters searched the area but found nothing. On October 30, Kadena launched two airplanes which searched for 21 hours with negative results. Also, on October 30, the side scan sonar was switched from the NANHAI 205 to the NANHAI 209.

On October 31, the search continued with three military airplanes from Kadena, the three helicopters from Sanya, the PRC Navy ships, and other vessels. Also, the side scan sonar survey was completed with the ARCO personnel confident that they had identified the wreck of the GLOMAR JAVA SEA. The active search continued until November 4 with one U.S. military airplane on November 1, three military airplanes on November 2, two military airplanes on November 3, and two military airplanes on November 4. The active search was suspended at 2007 on November 4 with U.S. military planes having conducted 23 search patterns, having flown over 238 hours, and having covered over 72,000 square miles of ocean. The PRC Navy searched with 22 vessels and 3 airplanes, and the Chinese fishing fleet around Hainan Island was mobilized to participate in the search. Kadena RCC determined the probability of detecting a lifeboat was over 90 percent and the life expectancy of a survivor in the water was 3 to 4 days.

From October to early December 1983, Global Marine in Houston maintained a 24-hour communications watch to coordinate all information received from ARCO China and Kadena RCC. The SALVANQUISH, under charter to Global Marine, continued searching until November 6.

Injuries to Persons

Injuries	Crew	Others	Total
Fatal	81	0	81
Serious	0	0	0
Minor/None	0	0	0
Total	81	0	81

Damage to Vessel

The GLOMAR JAVA SEA sank upside down in about 315 feet of water about 1,650 feet southwest of its anchored position over the well and is resting on the sea floor in an inverted position. Underwater videotapes of the sunken drillship were taken during November 1983 and March 1984. The videotapes showed a major structural failure amidships on the starboard side. The fracture ran from the main deck plating, down the starboard side shell plating, and into the bottom plating. The videotapes also showed a major deformation of the lower side shell plating for about 15 feet forward and 25 feet aft of the fracture and some damage to the shell plating near the bow. The drill tower was missing and the deckhouse was damaged. The value of the drillship was estimated at $35 million.

Crew Information

Pursuant to the contract between Global Marine Drilling Company and ARCO China Inc., Global Marine provided personnel for the GLOMAR JAVA SEA while at sea and during drilling operations. These personnel serviced a deck department, an engineering department, a steward's department, and a drilling department. The GLOMAR JAVA SEA's master headed the deck department, which included one radio operator, one boatswain, one able seaman, and one physician assistant--all U.S. nationals--and two interpreters, two radio operators, and two ordinary seamen—all PRC nationals. (See appendix C.)

The chief engineer headed the engineering department, which included two licensed assistant engineers and two oilers--all U.S. citizens--and one oiler trainee, a PRC national. A U.S. national headed the steward's department which included three cooks--one U.S. national and two PRC nationals.

The Global Marine drilling crew was headed by the drilling superintendent and included two toolpushers, two crane operators, two derrickmen, two assistant derrickmen, two drillers, one sub-sea engineer, one electrician, one electronic technician, one rig mechanic, two floormen, and one storekeeper--all U. S. citizens--and five utility men, four roughnecks, eight roustabouts, one assistant derrickman trainee, and one welder trainee—all PRC nationals. At the time of the accident, the Global Marine assistant rig manager, who normally was based in Zhanjiang, was on board the drillship making him the most senior Global Marine management person on the GLOMAR JAVA SEA.

The contract between ARCO China Inc., and the CNOOC required that PRC nationals be hired in entry level positions and trained for various positions on drill rigs. ARCO also employed contractors who provided support services i.e., supply vessels, helicopters, weather forecasting services, and sub-contractors, such as mud loggers, mud engineers, and divers. ARCO China's representatives included a senior drilling supervisor,

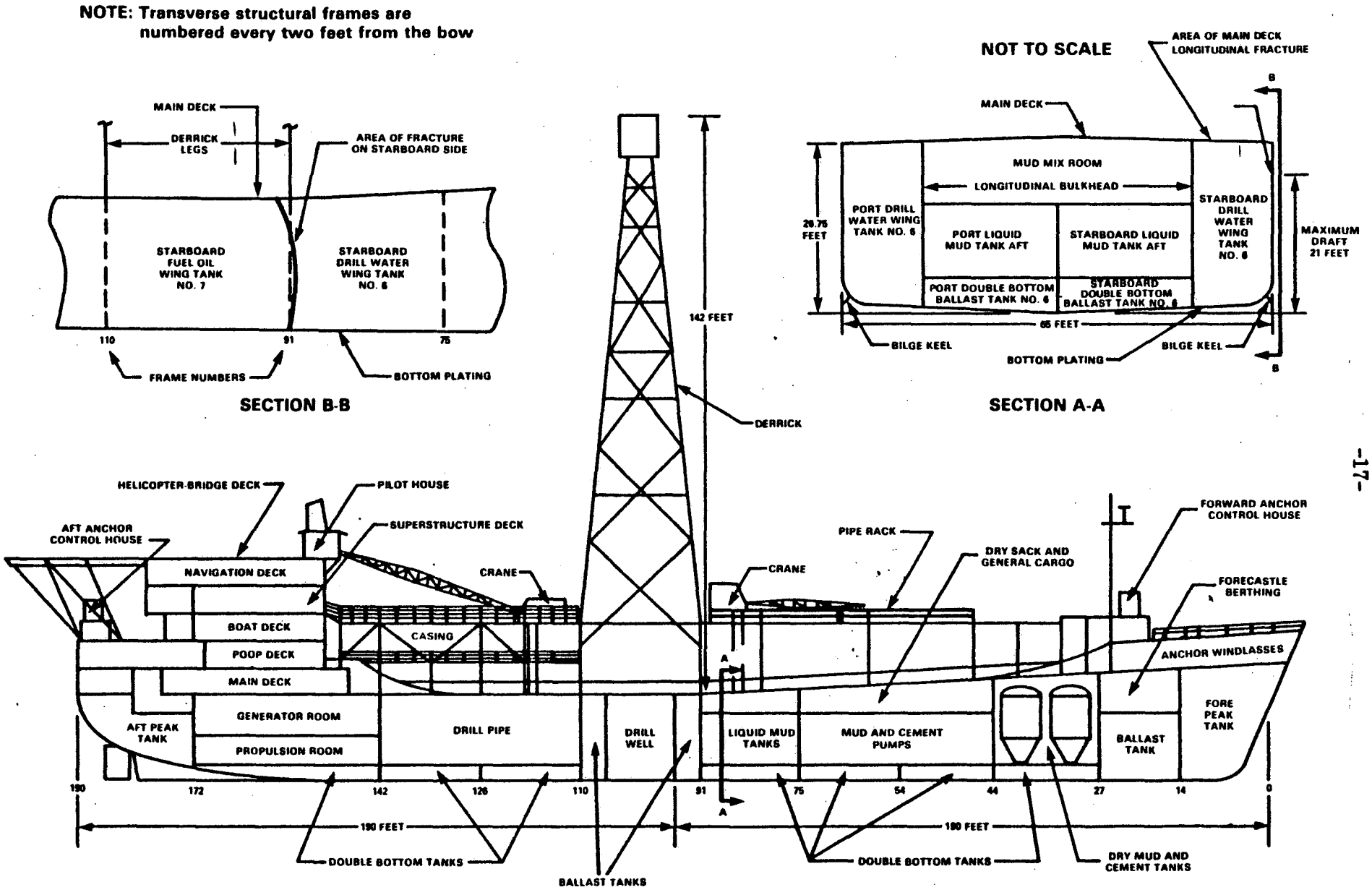


Figure 5.--Inboard profile of GLOMAR JAVA SEA.

who also held a valid USCG license as master of column stabilized or self-elevating mobile drilling vessels with a radar endorsement, a senior geologist, and a senior drilling engineer. A PRC geologist also was aboard.

At the time of the accident, 81 persons were on board the GLOMAR JAVA SEA. Each person aboard the drillship, except the master, chief engineer, Global Marine drilling superintendent, and ARCO personnel, worked a 28-day tour, working 7 days a week, 12 hours each day, and then rotated off the vessel for 28 day's vacation. The master, chief engineer, Global Marine drilling superintendent, and ARCO personnel worked similar tours except they were on 24-hour call. About 25 percent of the crew rotated for vacation each week on Thursday.

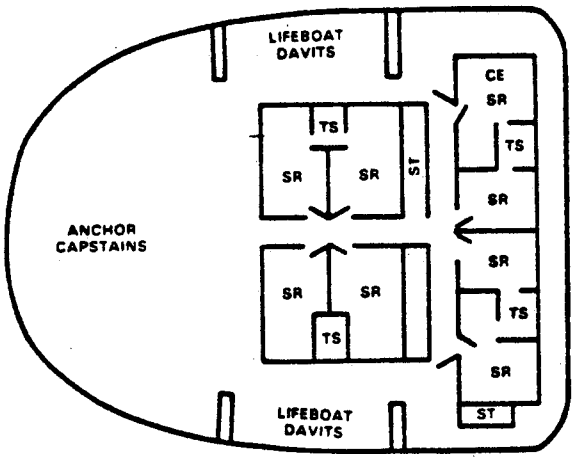
Vessel Information

Description.--The 400-foot-long GLOMAR JAVA SEA entered into service in 1975 as the sixth and final drillship in a series of similar designs beginning with the GLOMAR GRAND ISLE, which was built in 1967. All six vessels were designed as drillships by Global Marine, Inc., and were built by Levingston Shipbuilding Company of Orange, Texas. The vessels were U.S. registered, certificated by the USCG, and classed by the American Bureau of Shipping (ABS). The GLOMAR GRAND ISLE met the structural requirements contained in the 1967 ABS Rules for Building and Classing Steel Vessels and approval under the 1967 Rules was extended to the other vessels in the series, including the GLOMAR JAVA SEA, after account was taken of any modifications to the basic design.

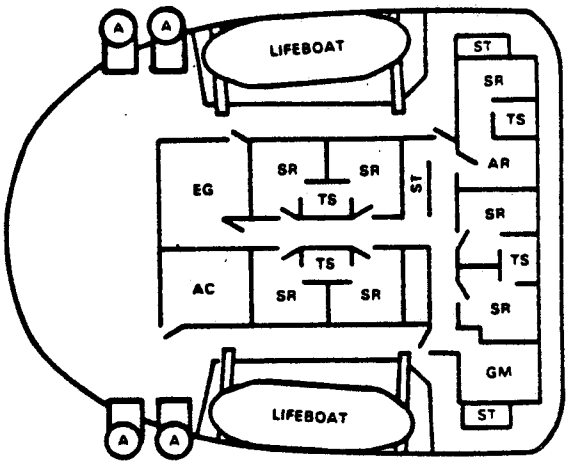
The GLOMAR JAVA SEA was a drillship of conventional hull form. (See figures 5 and 6.) The stern section contained a deckhouse on the main deck and above and machinery spaces located below the main deck. The main deck level of the deckhouse contained crew staterooms for about 26 persons, the ship's hospital, a welding shop, steward's stores, an electric shop, a machine shop, and small parts stores. The poop deck level was located one level above the main deck and contained the crew's messroom, lounge, galley, and refrigerated stores. The boat deck, located one level above the poop deck, was comprised entirely of crew staterooms for about 26 persons; the ship's two lifeboats, one on the port side and one on starboard, could be boarded on the boat deck just outside the deckhouse. The superstructure deck was located one level above the boat deck and contained spaces for the emergency diesel generator, air conditioning machinery, offices and staterooms for the Global Marine drilling superintendent and the ARCO drilling supervisor, and crew staterooms for about 12 persons. The navigation deck was the next level up and contained the radio room, the radio operator's stateroom, the chart room which contained the mooring system master controls, crew staterooms for about 10 persons, 11/ and the master's office and stateroom. The next level contained the helicopter-bridge deck; the pilothouse (bridge) was situated at the forward end of this deck and contained the vessel's steering controls, engine order telegraph, radar, and ship-to-ship radio. A helicopter platform 83 feet wide and 94 feet long was located aft of the pilothouse. Two inflatable liferafts with hydrostatic releases were installed on the outboard sides, one port and one starboard, of the helicopter platform.

The machinery spaces were situated on the two deck levels below the main deck and contained the propulsion motors, ship's service and propulsion diesel generator sets, switchboards and distribution panels, engineering control room, and pumps and valve manifolds for the fuel oil, drillwater, bilge, and ballast piping systems.

11/ Additional berthing for 10 crewmembers was contained in the forecastle, one deck below the main deck.

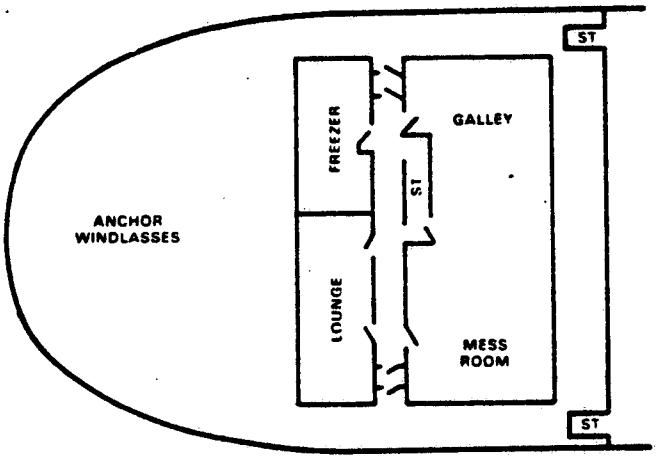


BOAT DECK

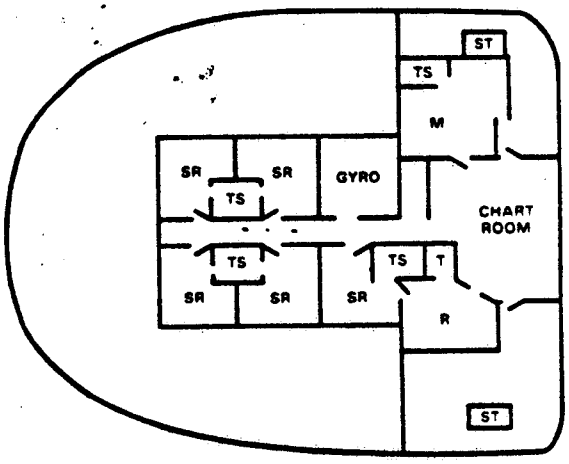


SUPERSTRUCTURE DECK

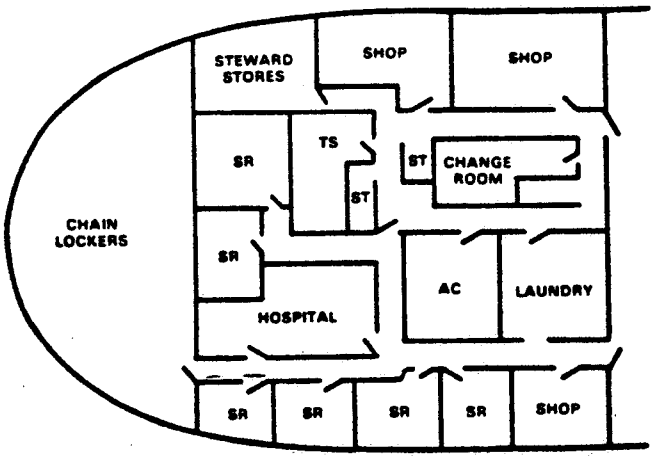
NOT TO SCALE



POOP DECK



NAVIGATION DECK



MAIN DECK

LEGEND:

- SR – STATEROOM
- TS – TOILET AND SHOWER
- ST – STAIRS
- AC – AIR CONDITIONING MACHINERY ROOM
- CE – CHIEF ENGINEER
- A – ANCHOR BUOY
- AR – ARCO OFFICE
- GM – GLOBAL MARINE OFFICE
- EG – EMERGENCY GENERATOR
- M – MASTER'S STATEROOM AND OFFICE
- R – RADIO ROOM

Figure 6.--GLOMAR JAVA SEA accomodation areas aft.

Located forward of the machinery spaces was the tubular steel drill pipe storage area. It extended from the engineroom's forward bulkhead to just aft of the drill well [4] and from the ships tank top up to the underside of the main deck. Above the drill pipe storage area and forward of the deckhouse at the boat deck level was the casing rack storage platform area which extended forward from the deckhouse to just aft of the drill well. The derrick structure and associated drilling machinery were located midships above the drill well beginning at the main deck and extending 142 feet high. Two pedestal mounted, diesel driven cranes were located on the port side, one aft of the derrick structure drill floor and one forward of the drill floor. Forward of the derrick structure at the superstructure deck level and extending forward to the forecastle was the drill pipe racking machinery and drill pipe storage area. Forward of the drill well at the tank top level were the liquid mud tanks and forward of the tanks, the mud pumps and cement pump room. Just aft of the forecastle were six dry mud and cement storage tanks. Above the mud pumps was the dry sack and general cargo storage room.

Except on the sides of the machinery space area, all internal spaces were protected from flooding by an inner hull. The bottom of the ship consisted of double bottom tanks for fuel oil, drill water, and ballast water. The sides of the ship were protected by wing tanks for fuel oil, drill water, and ballast water. Ballast tanks were located around the drill well. Although the bottom of the engineroom was protected by double bottom tanks, the machinery spaces extended laterally to the shell of the vessel. Appendix D contains detailed information concerning the GLOMAR JAVA SEA's characteristics and tank arrangements.

Ballast Procedures.--The GLOMAR JAVA SEA's pumps, controls, and tank valve manifolds for the bilge/ballast, drillwater, and fuel oil systems were located in the lower machinery space at the tank top level in an area called the ship's pump and propulsion room. The drillship's bilge/ballast system was similar to a conventional motor cargo ship bilge/ballast system. Ballasting was accomplished primarily with an all purpose pump and interconnecting piping which carried suction from the sea or any ballast tank and transferred sea water through the ballast system tank valve manifold to discharge into any other ballast tank. Sea water in the ballast system could be transferred from port to starboard and from forward to aft, or vice versa, or the sea water could be discharged overboard. Interconnecting piping also connected the bilge pump to the ballast tank valve manifold for use in the event the all purpose pump was out of service. Similarly, the bilge system valve manifold was connected to the all purpose pump for use in the event the bilge pump was out of service.

The ballast system was the primary method used to maintain the vessel level and to maintain a level drill floor over the well although the drillwater system also was used. Transverse and longitudinal clinometers located in the engineroom indicated the vessel's trim and list. The drillwater pump could pump chemically treated drill water from any drillwater tank through the drillwater system's interconnecting piping and transfer it through the drillwater tank valve manifold to any other drillwater tank. When the drillwater pump was out of service, the ballast system all purpose pump could be isolated from the ballast system by closing certain valves and could be connected to the drillwater system by opening other valves. Drill water then could be transferred through the drillwater piping and tank valve manifold from any drillwater tank to any other drillwater tank.

The fuel oil system pumps, piping, and tank valve manifolds could transfer fuel oil from any fuel oil tank to any other fuel oil tank. The GLOMAR JAVA SEA seldom transferred fuel oil for levelling purposes but rather maintained various tank levels in certain designated fuel oil tanks. Some tanks were kept slack (nearly empty), some were kept pressed up (full), and other tanks were used to fuel the drillship's diesel engines and their level constantly changed.

Loading.--The alternate master testified that he was required to submit a stability report only once a month during his 4-week tour aboard the GLOMAR JAVA SEA but, that whenever the drillship loaded or discharged cargo, drill water, or fuel oil, or shifted heavy weights, he would perform a preliminary stability calculation. He also stated he obtained drill water and fuel oil information from the watch engineer and drilling fluids information from the mud engineer.

The alternate chief engineer, who had departed the GLOMAR JAVA SEA on October 20, testified that the watch engineer was required to shift liquids about once an hour to maintain the drillship level. He testified also that he decided in mid-October 1983 to move the residual fuel oil from fuel oil wing tanks Nos. 7 port (P) and starboard (S) to Nos. 8 P and S fuel oil wing tanks because tanks Nos. 7 P and S were getting low. The No. 6 S drill water wing tank was emptied to compensate for some deck loading. The alternate chief engineer stated that the condition of fuel oil and water tanks was reported once a week to the master on crew change day but before any fuel oil or drill water was loaded from the supply vessel. He stated he normally did not find it necessary to discuss with the master the amount of liquid which could be loaded without exceeding the vessel's allowable draft although the masters were very conscious about the requirement not to exceed the allowable draft.

A former master testified that he also performed a stability calculation once a month while aboard the drillship. He stated that the Global Marine drilling superintendent did not consult with him on how much drill pipe or liquids could be loaded. The former master testified that when the supply vessel "came out was when I would find out what they had on there to give to us. Sometimes we would offload it all, and sometimes we would have to hold him off until we could take it."

The former master stated the maximum roll that he remembered the GLOMAR JAVA SEA sustained was 5° in 12- to 15-foot seas with 40-kn winds. He also stated that he did not know whether the GLOMAR JAVA SEA met any subdivision or damage stability standards and that there was no information about stability standards in the drillship's operating manual.

Stability.--The GLOMAR JAVA SEA was designed and built to the requirements contained in the USCG regulations for Cargo and Miscellaneous Vessels (46 CFR subchapter I) as modified by USCG Merchant Marine Technical (MMT) Note No. 6-66-Floating Drill Rigs, dated July 13, 1966. (See appendix E.) The drillship also met the stability requirements contained in the ABS Rules For Building and Classing Mobile Offshore Drilling Units, dated 1973. (See appendix F.)

On December 4, 1978, the USCG published regulations for Mobile Offshore Drilling Units (MODU) (46 CFR Subchapter I-A) which specified intact and damage stability standards for new vessels similar to the GLOMAR JAVA SEA. On December 15, 1978, the USCG published a Navigation and Vessel Inspection Circular which stated that existing vessels, such as the GLOMAR JAVA SEA, might continue to meet the stability standards under which they were originally designed except that an operating manual had to be prepared in accordance with 46 CFR 109.121(d). (On November 4, 1983, the operating

manual regulations for MODU's were transferred to 46 CFR 170.110 and 170.130.) On January 11, 1980, the USCG approved an operating manual for the GLOMAR JAVA SEA which contained the required GM 12/ curve for compliance with the 1973 ABS Rules. Since the 1973 ABS Rules also required an approved operating booklet (Section 1. 11), the ABS approved the revised operating manual on February 8, 1980.

In a letter dated January 11 1980, the USCG stated that the following information was to be added to the operating manual:

> a. In addition to the deck loads and capacity particulars you must include a maximum hook load.
>
> b. You must state the wind limitations for each vessel at each of your different operating conditions.
>
> c. You must include an Anchoring Procedure for your transient condition. This does not include your mooring on location.
>
> d. A paragraph stating that the Master [should] determine the cause of any unexpected heel or trim before taking corrective action must be placed in the Operating Manual.

There is no evidence that the information was added to the vessel's operating manual. Furthermore, the operating manual did not address the standard of subdivision or damage stability to which the drillship was designed, general guidance and precautions regarding unintentional flooding, or specific information for preparing for the passage of a severe storm. However, the operating manual did contain guidance on writing a heavy weather procedure plan, including hurricane preparedness in case a hurricane, typhoon or significant low pressure developed within 1,000 miles of the drilling operation. The operating manual also stated:

> The vessel's Master must have a thorough knowledge of the Trim and Stability Booklet. Each Global Marine drillship Captain must, one time each month, work out the stability for his ship. The work sheet and results are to be forwarded to Marine Department, Houston.

The Trim and Stability Booklet was a part of the operating manual.

Typhoon Plan.--A typhoon [15] plan, which was developed by the alternating masters of the GLOMAR JAVA SEA, the Global Marine rig manager and drilling superintendents, and ARCO China representatives, was approved by the vice-president and general manager of ARCO and the GLOMAR JAVA SEA drilling group vice-president at Global Marine in Houston. The typhoon plan, dated May 19, 1983, stated, in part, that when the typhoon is 1,200 miles away:

> o The ARCO representative and Global Marine senior drilling foreman will prepare a plan for securing the well and drilling equipment along with a time schedule and begin securing the well.

12/ GM is the distance between a vessel's vertical center of gravity and its transverse metacentric height and is a measure of the vessel's ability to right itself after being subjected to overturning forces.

- The master will prepare a plan for letting go and buoying off anchors Nos. 2, 5, 7, and 10. (See figure 4.)

- The master will keep a running plot of the center of the storm based on current weather reports and weather FAX 13/ received.
- The master will prepare a list of non-essential personnel to be evacuated by helicopter.

- The master will place personnel on board to comply with USCG manning requirements for the drillship while underway, if possible.

When the typhoon center is 1,000 miles away, the typhoon plan states, in part, that:

- If work boats and anchor crews are on location, breast anchors Nos. 3, 4, 8 and 9 are to be taken in.

- Buoy off Nos. 5 and 7 anchor chains and pick up and stow Nos. 2 and 10 anchors.

- All non-essential personnel put ashore.

The typhoon plan did not specify what individuals were nonessential. In their testimony, the alternate master and Global Marine and ARCO management personnel did not agree on what personnel were classified as nonessential personnel other than the ARCO subcontractors. The Global Marine rig manager made the following statement:

> Well, first of all, we'll never force a man to leave the rig. If he elects to stay, he has the prerogative to stay.
>
> * * *
>
> And I know from verbal conversations with some of the expats [non-Chinese] they felt safer on the rig than they did in Sanya.

The alternate master made the following statement:

> The decision would have been made primarily by the various department heads who would have considered [for evacuation] who were the personnel not required, both in the industrial and in the marine crew. And then possibly or probably the extra personnel such as mud loggers and survey people that were not required aboard.
>
> * * *
>
> However, I would like to point out that when evacuation does or did take place, most of the personnel elected to stay aboard.

The Global Marine drilling group vice president for the GLOMAR JAVA SEA stated that it was Global Marine's policy not to require any crewmember to evacuate a drillship even if the master had determined that nonessential personnel should be evacuated.

13/ A fascimile machine which reproduces meteorological weather maps and printed reports.

In a memorandum dated May 19, 1983, the alternate master noted that the GLOMAR JAVA SEA was to expect "little to no assistance" from the Chinese supply vessels in the event of a typhoon because the supply vessels would seek safe refuge. However, prior to the typhoon season (June through November), the Chinese supply vessels agreed to stand by the GLOMAR JAVA SEA in case of a typhoon until released by ARCO. The alternate master testified that:

> Well, sir, most of the typhoons approach from the east. And if possible and if the typhoon was not of tremendous force, then I would probably like to remain where I was and ride it out.
>
> If I had to run, I wasn't left with many choices in which to run. I was virtually in irons. I was landlocked. And I couldn't run east in the track of the typhoon. I wouldn't run north because that is the traditional curve that the typhoon would take after its springs. I certainly couldn't run to the west because I would be putting myself in Vietnamese territorial waters. I was virtually locked into running south by the Paracel Islands, Triton Island and numerous islands and inlets which are strewn throughout the waters of South Vietnam.
>
> So I made the decision that in the event that I did run, that I would move up on the northwest side of Hainan Island in the [35 fathom] patch 14/ and be within easy range of Chinese protection.

The helicopter pilots would not state the maximum wind force and wave height in which the helicopters would operate and land on the drillship in case evacuation was necessary. The contact between the Chinese Helicopter Corporation and ARCO China stated that the minimum weather conditions for flying were 650 feet cloud cover height, 9,850 feet of visibility, and maximum winds of 39 knots.

On July 11, 1983, in anticipation of typhoon TIP, the alternate master of the GLOMAR JAVA SEA evacuated 23 of the 84 persons aboard; 9 persons were evacuated by helicopter and the rest by the NANHAI 205 to Sanya. The persons evacuated consisted of ARCO subcontractors and some CNOOC representatives. The maximum winds experienced by the drillship were 40 kns, the maximum waves were 4 feet, and the maximum swell was 9 feet. On July 12, the typhoon turned to the northwest and passed to the north of Hainan Island. On July 13, the crewmembers were returned to the drillship by the NANHAI 205 boat.

Mooring System.--At the time of the accident, the GLOMAR JAVA SEA was moored in a 35°/70° pattern on a heading of 339° T to provide a lee for the supply vessel which offloaded cargo on the drillship's port side where the cargo cranes were located. The prevailing wind was from the northeast. The drillship's actual mooring arrangement on October 25, 1983, is shown in figure 4. One of the alternating masters testified that the No. 6 wire rope anchor was used during the vessel's last move because the No. 7 anchor windlass had malfunctioned. The No. 7 anchor was placed between the Nos. 6 and 8 anchors; wire rope anchor No. 1 was not used. Anchors Nos. 2, 3, 4, 5, 7, 8, 9, and 10 were connected to the drillship by anchor chains while anchors Nos. 1 and 6 had wire ropes. Global Marine Drilling Company's "Procedures Manual 5-Marine Operations" states that the 35°/70° pattern is the most commonly used pattern and that it allows the vessel's heading to be changed approximately 30° to either side of the base heading. The alternate

14/ An area of deep water.

masters and drilling crew, however, testified that they had not known of any occasion when the GLOMAR JAVA SEA changed its heading except for a few degrees using the anchors.

The procedures manual recommended several methods to the master for unmooring. One method recommended that the supply boat pick up one anchor at a time while the drillship pulled in the anchor chain using the ship's windlass. This method could take several hours to complete, and the supply vessel could not handle the anchors in severe weather. Another method recommended that one of the buoys located near the end of the anchor chain be attached and that the chain be released. In an emergency, the anchor chains could be cut or the anchors could be released without attaching the buoys.

Radio Communications.--The GLOMAR JAVA SEA's radio room was located on starboard side of the navigation deck. The following equipment was owned and operated by Global Marine. The main radio, consisted of an ITT MacKay radiotelegraph and an ITT Mackay radiotelephone marine console which included an intermediate frequency (410 to 500 kHz) transmitter with a range of 500 nmi, a high frequency (2 to 22 mHz) transmitter with a range of 6,000 to 8,000 nmi, an emergency transmitter (400 to 500 kHz) with a range of 150 to 200 nmi, an intermediate frequency receiver, a high frequency receiver, and an emergency receiver capable of picking up signals from 2 to 22 mHz. If a distress signal was received, an automatic alarm which monitored 500 kHz sounded on the bridge, in the radio room, and in the radio operator's stateroom. The main radio also was capable of transmitting an automatic distress signal by activating the automatic distress signal switch after first manually setting the radio on 500 kHz. Power was supplied to the main radio and all radio units in the radio room from the ship's service generator system and the emergency diesel generator system. The main radio console emergency transmitter and receiver and a VHF radio telephone also were powered by the emergency battery power supply. An ITT MacKay VHF/FM radiotelephone with a 20-nmi range was used for bridge-to-bridge communications to and from the supply vessels using channel 16 (156.8 mHz) to coordinate the loading of drill water, fuel oil, and various stores. Global Marine also outfitted the radio room with an SSB transceiver radio-telephone which utilized a PRC assigned frequency of 6521.8 kHz and was capable of operating from 2 to 22 mHz over a range of 5,000 nmi.

The radio room also was equipped with a MARISAT satellite communications terminal which was owned by ARCO China, Inc. The MARISAT terminal had voice and teleprinting capabilities with a remote hand set located in the ARCO supervisor's office. Communications with the United States, Singapore, Japan, and China were carried through MARISAT's Pacific satellite. Calls could be dialed directly, as on a telephone, or could be placed by contacting the MARISAT operator. Distress signals could be sent by activating a red pushbutton protected by a plastic cover, or by setting the unit to an emergency mode and pushing the call button for the operator. The MARISAT operator would be alerted that the calling unit was in distress and that no other data would be transmitted. ARCO also had installed an SSB transceiver with teleprinter with a 300-nmi range. This unit was known as the "company radio" and was used to accomplish the dispatch of morning and afternoon reports, to conduct normal daily communications with base personnel at Zhanjiang and Sanya, and to communicate with supply vessels.

An emergency portable lifeboat radio was secured in the radio room on a bulkhead-mounted rack for storage and ready access. For transmitting, the lifeboat radio could be operated in the automatic or manual mode. By turning the radio handcrank to generate transmitting power and setting the unit in the automatic mode, a distress signal was transmitted continuously on 500 kHz and automatically switched periodically to a

distress frequency of 8364 kHz. Operating instructions were printed on the inside front cover of the radio. No radio training was needed to operate the radio in the automatic or manual mode. In the manual mode, signals were sent using the hand operated keyer. The International Morse Code was printed on the inside front cover. Depending on weather conditions and the placement of the radio antenna, the maximum range of the unit normally was 50 nmi. An emergency position indicating radio beacon (EPIRB) also was part of the vessel's permanent radio equipment. It was stowed in a float-free holder mounted on the aft exterior bulkhead of the helicopter bridge deck bridge house. When the unit was activated, it transmitted distress signals on 121.5 and 243 mHz. Both the lifeboat radio and the EPIRB were tested during each fire and boat drill.

The vessel had three licensed radio operators: the senior operator was a U.S. citizen licensed by the USCG and Federal Communications Commission and the other two were PRC nationals, licensed by the PRC. The PRC radio operators worked in 12-hour shifts from noon to midnight and midnight to noon. The senior radio operator worked from 0600 to 1800. He was responsible for making the morning weather observation, checking anchor buoy locations and anchor tensions from the remote readouts on the master mooring control panel, recording this information in the vessels deck log, inspecting the radio room, reading the radio log from the preceeding night, and transmitting the weather data observed at the drill site to ARCO's office in Zhanjiang.

As part of his administrative/clerical duties, the senior radio operator maintained an up-to-date crew list. He also prepared a manifest of people departing the vessel by helicopter and signed in new crewmembers aboard the GLOMAR JAVA SEA. After signing in with the radio operator, the new men and returning regular crew were met by the ship's physician assistant or a member of the steward's department and shown to their room and bunk. There was a life preserver stowed at the foot of each bunk and a bunk card which indicated the man's emergency station during fire and boat drills. New personnel were shown their lifeboat and then taken to their immediate supervisor to check in. The PRC radio operators handled most of the voice communications using interpreters when necessary from the GLOMAR JAVA SEA to Zhanjiang, Tian Du, helicopters, and the supply boats. The captains and crews of the supply vessels and the pilots of the helicopters were Chinese nationals who did not speak English. The supply vessels NANHAI 205 and NANHAI 209 were both outfitted with SSB radios, VHF radio telephones, and emergency radios.

Helicopter operations were based at Tian Du Base, Sanya. The radio station was manned by a supervisor, four radio operators working around the clock, one interpreter, and one driver--all PRC nationals. Communications with Zhanjiang, the GLOMAR JAVA SEA, and the supply vessels were by SSB radio on an assigned frequency of 6521.8 kHz.

ARCO China's base radio at Zhanjiang was outfitted with an SSB radio with teleprinter and a radio facsimile receiver. The SSB was operated on a frequency of 6521.8 kHz, a frequency assigned to ARCO by the PRC government for use during exploration operations. This SSB frequency was a common link between the GLOMAR JAVA SEA, supply boats, Tian Du, and Zhanjiang. The radio operators and the interpreter at the base radio were PRC nationals. Radio operators were not on duty from 0600 to 0700 and 2300 to midnight at ARCO'S Zhanjiang office. The ARCO drilling superintendent in Zhanjiang stated that the normal radio procedure at night was for the radio operators at Zhanjiang and Tian Du and aboard the GLOMAR JAVA SEA to call every half hour on a rotating system.

Survival Systems.--The GLOMAR JAVA SEA was equipped with two USCG-approved Marine Safety Equipment Corporation fibrous glass reinforced plastic, enclosed, motorized lifeboats rated for a maximum of 64 persons each. The lifeboats, one port and one starboard, were housed in USCG-approved gravity davits 15/ at the superstructure deck level of the deckhouse. The drillship also was equipped with two USCG-approved B.F. Goodrich 20 person inflatable liferafts and one USCG-approved Switlik 15-person inflatable liferaft. One liferaft was located on the port side of the helicopter deck, just aft of the navigating bridge; one liferaft was on the starboard side; and one liferaft was located on the port side of the main deck forward, just aft of the forecastle. All three liferafts hydrostatic releases were housed to float free. At the time of the accident, a fourth liferaft was off the ship for its yearly servicing. However, three liferafts were always maintained aboard the vessel. The vessel was equipped with a USCG-approved EPIRB, 158 USCG-approved lifepreservers, 6 USCG-approved buoyant work vests, 12 USCG-approved ring buoys, and a portable emergency radio.

The GLOMAR JAVA SEA was certificated under 46 CFR subchapter I - Cargo and Miscellaneous Vessels. Title 46 CFR 94.10-10 requires that the GLOMAR JAVA SEA have sufficient lifeboats on each side to accommodate all persons on board and sufficient liferafts to accommodate at least 50 percent of the persons on board. The USCG Certificate of Inspection (COI) limited the total number of persons on board while navigating to 64. (See figure 7.) However, while moored, although still considered in navigation, the number of persons allowed on board the drillship was increased to 110 without any increase in the required lifeboat capacity. The 1978 Mobile Offshore Drilling Regulations, 46 CFR Subchapter I-A, requires that the number of lifeboats on a new vessel similar to the GLOMAR JAVA SEA must accommodate all personnel on board (46 CFR 108.503) and that there must be sufficient liferafts to accommodate at least 100 percent of the persons allowed on board (46 CFR 108.505) although lifeboats in addition to those required may be substituted for inflatable liferafts. Navigation and Vessel Inspection Circular No. 3-78-Inspection and Certification of Existing Mobile Offshore Drilling Units states that although existing certificated mobile offshore drilling units may continue to meet the equipment standards which were applicable when the units were contracted for, each unit must have lifesaving equipment for 200 percent of the total persons allowed on board.

ARCO contracted with the NHWSC to provide two supply vessels to service the GLOMAR JAVA SEA. One supply vessel remained with the drillship until relieved by the second supply vessel. At the time of the accident, the 203-foot-long NANHAI 205 was on standby duty at the drillship and the 203-foot-long NANHAI 209 was in Zhanjiang. ARCO contracted with the Chinese Helicopter Corporation to provide two 15-passenger Bell 212 helicopters at Sanya for transportation of personnel to and from the drillship. The supply vessels and helicopters were all under the control of ARCO. Although ARCO had participated in developing the typhoon plan with Global Marine, ARCO did not have any shoreside contingency plan of its own. However, the General Manager of ARCO China stated that ARCO had discussed with their Chinese partners what support ARCO could expect in case of an emergency and that their Chinese partners had assured ARCO the Chinese Navy would aid ARCO. The General Manager further stated that ARCO had had no discussions with the U.S. government concerning aid in case of an emergency.

15/ Once the restraining lines (gripes) and the safety pins are released, the lifeboat can be launched by one person.

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

This Certificate Expires 8 October 19 83

Certificate of Inspection

16711/16017

VESSEL	OFFICIAL NUMBER	CLASS
GLOMAR JAVA SEA	568 182	Drill Ship

GROSS TONS	NET TONS	LENGTH	HOME PORT
5,930	3,930	374'	Galveston, Texas

YEAR BUILT	PLACE BUILT	YEAR REBUILT	HULL CONSTRUCTED OF
1975	Port Arthur, Texas	-	Steel

OPERATOR	OPERATOR'S ADDRESS
Global Marine, Inc.	7500 San Felipe, Houston, Texas 77210

OWNER	OWNER'S ADDRESS
Global Marine, Inc.	7500 San Felipe, Houston, Texas 77210

The inspection of the above named vessel having been completed at Los Angeles/Long Beach, California on the 8th day of October, 1981, I hereby certify that said vessel is in all respects in conformity with the applicable vessel inspection laws and the rules and regulations prescribed thereunder. The following complement of licensed officers and crew is required to be carried; included in which there must be 7 Certificated Lifeboatmen and - Certificated Tankermen.

1 Master	- Master & 1st Class Pilot	4 Able Seamen	1 Chief Engineer	- Firemen/Watertenders
1 Chief Mate	- Mate	2 Ordinary Seamen	1 1st Assistant Engineer	3 Oilers
1 2d Mate	1 Radio Officer	- Lamptenders	1 2d Assistant Engineer	- -
1 3rd Mate	- - Operator(s)	- -	1 3rd Engineer(s)	- -

In addition the vessel may carry 10 other persons in the crew - passengers, - persons in addition to the crew, and 36 Industrial Personnel Total persons allowed 64

Route permitted and conditions of operation: OCEANS.

When navigating 16 hours or less between drilling locations the following complement of Licensed Officers and crew is required:

1 Master 3 Able Seamen 1 Chief Engineer 2 Oilers
1 Chief Mate 1 Ordinary Seamen 1 1st. Asst. Engineer 1 Radio Officer (As required by FCC)

In addition the vessel may carry 10 other persons in the crew and 43 Industrial Personnel. Total Persons Allowed 64.

While moored on a drilling location the following complement of Licensed Officers and crew is required: 1 Master 2 Able Seamen 1 Ordinary Seaman 1 Chief Engineer 2 Oilers

In addition the vessel may carry 10 other persons in the crew and 93 Industrial Personnel provided:
(a) Persons in excess of the number of berths will be on board on a daily visit basis and not quartered on board. Total Persons Allowed 110.

U.S. - WFDS DWT: 5,180

EQUIPMENT AND INSPECTION DATA

Lifesaving equipment provided for 64 persons, viz:
1 Motorboat or lifeboat for 61 persons
1 Lifeboat or inflatable liferaft for 64 persons
2 Motor lifeboats (included in total lifeboats)
3 Inflatable liferafts for 55 persons
- Life floats for - persons
- - persons
12 Ring life buoys - Buoyant lifejackets
Life preservers and - - children

Stability letter issued 3 October 1975 (P)
Underwater hull Extended to March 1982
Tail shaft drawn December 1979 P/S
Propulsion Diesel - Electric
Main engines 4500 each Diesel
Pressure vessels examined December 1979

- - BOILERS: Records at -
Number - Year built - Type -
Mfr. -
Mountings opened -
Mountings removed -
Hydrostatic test -
Maximum steam pressure allowed -

Fire extinguishing systems: Fixed (1)CO2-GR,MR; (2)CO2-ER; (3)Foam-Heliport (4)Foam-Drill Well
Semiportable (1)Heliport-CO2 DC BV; GR, MR CO2 BV

Fire extinguishers
No. 11 Type AII
3 BII
17 CII

Fire hose, total length 1350 ft.
8 Fire axes
2 Fire -

Inspected and approved for the carriage of: -
Capacity: -

PERIODIC REINSPECTIONS

DATE	INSPECTION ZONE	SIGNATURE
7OCT82	LOS	

J. H. GUEST, Captain, U.S. Coast Guard
(Officer in Charge Marine Inspection)

Los Angeles/Long Beach, California
(Inspection Zone)

Figure 7.—GLOMAR JAVA SEA USCG certificate of inspection.

Two former masters stated that weekly fire and boat drills were conducted on board the GLOMAR JAVA SEA. During the boat drills, the lifeboat's would be lowered to the boat deck; some crewmembers would board the lifeboat and instructions would be given by the master on lowering the boats to the water and releasing the boats from the falls. The boats were not actually lowered to the water and released because of the difficulty of reconnecting the boats in open water. Special training was provided the Chinese crewmembers and signs were printed in both English and Chinese to indicate the location of the lifeboats.

History.--ARCO contracted for the services of the GLOMAR JAVA SEA from Global Marine Drilling Co. shortly after the newly built vessel was delivered; the contracted service was in effect at the time of the accident. The contract betwen ARCO and Global Marine required ARCO to pay Global Marine about $40,000 per day whether the vessel was in drilling operations or secured for weather. The drillship had been operated mainly in the Gulf of Mexico and briefly off the coast of Santa Barbara, California, drilling exploratory wells for ARCO. Before departing for China to commence drilling in the South China Sea, the drillship was drydocked at Triple A Shipyard in San Francisco and inspected by the ABS and USCG between November 18 and 30, 1982. During this time, an ABS surveyor conducted a drydock survey which included examination of the outside hull plating, propellers, shafting, rudders, and sea valves. The outside hull plating was found to be in satisfactory condition following completion of minor steel repairs to damaged areas of the port side sheer strake plating caused by contact with offshore supply vessels. Repairs also were completed to areas of minor steel corrosion in the lower four corners of the drill well. An internal examination of the ship's ballast, drillwater, and fuel tanks was not made at the time nor was one required by current ABS rules. However, the surveyor did enter the No. 8 port aft wing fuel oil tank and the No. 7 port and starboard ballast deep tanks surrounding the drill well to examine completed steel repairs.

A modification was made during the drydock period to the No. 5 port and starboard double bottom tanks and wing drillwater tanks. Internal framing and plating, together with the drillwater piping, were modified by installing and welding a 6-inch-diameter equalizing pipe and valves between the wing and double bottom tanks. The surveyor entered the No. 5 port and starboard wing tanks to inspect and witness the testing of the modification. All parts of the drydock survey, repairs, and modifications were found satisfactory and approved by the ABS surveyor.

An annual survey of hull and machinery was conducted by the ABS surveyor and included examination of all watertight doors and steel hatch covers; closing and securing appliances, vents, anchoring, and mooring equipment; a general examination of the main and auxiliary machinery, and an operational test of the steering system. All items of the hull and machinery surveys were found satisfactory. The annual load line inspection was conducted and the International Load Line Certificate was endorsed.

The ABS also conducted a mandatory annual survey in accordance with International Maritime Organization (IMO) requirements of the Protocol of 1978 relating to the International Convention for the Safety of Life at Sea, 1974 (SOLAS 74). The survey, which included examination of the hull, machinery, and electrical plant, was conducted simultaneously with the ABS hull and machinery surveys. An attachment to the permanent Cargo Ship Safety Certificate was issued and endorsed at the satisfactory completion of the mandatory annual survey. The attending surveyor testified that in his opinion the overall condition of the drillship was very good.

A USCG inspector conducted a drydock examination of the GLOMAR JAVA SEA. The USCG inspector also entered and inspected the forepeak tank and the No. 2 port and starboard ballast deep tanks. He inspected the repairs made to the No. 7 port and starboard ballast deep tanks. No other tanks were entered and inspected at this time nor was it required by USCG regulations that the other tanks be entered and inspected.

On only one occasion were all of the drillship's tanks (except the fuel oil and lube oil tanks) entered and examined. This inspection occured during the first part of a two-part ABS special periodical survey No. 1 at Alabama Drydock and Shipbuilding Co. in Mobile, Alabama, on November 30, 1979. At that time, 35 ballast and drillwater tanks were cleaned, gas freed, examined, and found in satisfactory condition. USCG inspectors normally do not inspect tanks unless there is an outstanding ABS survey requirement, a tank is opened for other reasons, or the USCG inspector suspects some problems.

After successful completion of all ABS surveys, USCG inspections, and required repairs, the GLOMAR JAVA SEA departed San Francisco on December 1, 1982, en route to China. The only major storm encountered during the voyage occurred on December 12, as the vessel approached the Hawaiian Islands. At the height of the storm, the GLOMAR JAVA SEA sustained winds of 42 knots gusting to 60 knots, waves of 8 feet, and swells of 20 to 25 feet. According to the deck log for that date, the vessel was proceeding on various courses and reduced speeds due to very rough high seas and deep swells. The drillship safely weathered the storm and arrived and anchored at the first well site about January 7, 1983.

On January 10, the GLOMAR JAVA SEA sustained minor damage to the vessel's port side. The offshore supply vessel NANHAI 209 was maneuvering to come along the port side of the moored drillship to offload supplies to the GLOMAR JAVA SEA when the supply vessel came into contact with the drillship and indented the port shell plating and bulwark in various locations.

The coordinator of Global Marine's Safety and Training program for the GLOMAR JAVA SEA conducted an annual safety and training inspection of the drillship from July 25 to August 5, 1983. His responsibility was to monitor and maintain the goals of safety and on-the-job training (OJT) set by his department. During the 7-day inspection, he observed the operations of the crew and held informal meetings to review safety procedures and to hear the crew's recommendations on drilling operations, procedures, equipment, work hours, safety around the drill floor, and OJT progress. At the conclusion of the inspection visit, the coordinator issued a report to the rig manager, the manager of the safety and training department, and the GLOMAR JAVA SEA's drilling group vice-president. Except for some minor discrepancies concerning communication problems with the Chinese crewmembers of the drilling crew, the coordinator's safety inspection found the crew and drillship to be in a satisfactory condition.

On August 23, as the NANHAI 209 was attempting to off-load supplies on the port side of the GLOMAR JAVA SEA, the supply vessel sharply collided with the moored drillship. Damage was more extensive than the January 10 incident although no hull penetrations were made and immediate repairs and drydocking were not required.

As part of it's management policy, Global Marine had an annual in-house drillship/drill rig inspection program. The rig inspection supervisor was responsible for setting up the inspection program, scheduling and attending inspections, and issuing a report at the completion of each inspection. According to the supervisor, the inspection focuses primarily on machinery to insure that equipment is properly maintained and that followup repairs are completed. All equipment on the GLOMAR JAVA SEA was included

on a 123-page checklist divided into seven main sections: administration, BOP equipment (see appendix B), drilling systems, electrical/electronic systems, engineering systems, hull and deck equipment, and lifesaving and firefighting equipment. A team of four inspectors from Global Marine Houston conducted an inspection on board the GLOMAR JAVA SEA during August 28 to 31, 1983. Each man in the inspection team was assigned a main section to examine according to his background and experience. The inspection supervisor handled the examination of lifesaving/firefighting equipment, hull and deck equipment, and administration (such as ships documents and certificates). One team member examined the electrical/electronic systems, one examined the BOP equipment, and one examined the drilling and engineering systems. During the drillship's inspection, the heads of the deck, engine, steward, and drilling departments assigned personnel from their respective departments to attend the inspection of their equipment and to note any discrepancies that required repairs as a result of the inspection. A list of all discrepancies was given to the rig manager by the inspection supervisor so that repairs could be made and discrepancies corrected.

The discrepancy list developed as a result of the rig inspection contained items of equipment mostly dealing with the drilling system, derrick, and associated machinery. No major discrepancies were found that required immediate attention outside the repair/maintenance capability of the rig crew excepting the port side damage caused by the NANHAI 209. Portside shell plating and bulwark damage was inspected and discrepancies noted for repair. None of the drillships ballast, drillwater, or fuel oil tanks were entered or examined as a part of the inspection. The rig inspection supervisor said that Global Marine's inspection list was more comprehensive than the USCG or ABS requirements because both the USCG and ABS inspection items are incorporated into Global's inspection and additional equipment inspections not required by either the USCG or ABS are a part of the Global Marine inspection program. According to Global Marine policy, the drillship rig manager must complete an inspection followup report and address each discrepancy. The followup report for the GLOMAR JAVA SEA, which was due on October 28, 1983, was never prepared. Although the discrepancy followup repairs were being made on the drillship, at the time of the accident the rig manager had not yet accomplished his followup responsibilities to determine what discrepancies had been rectified.

At the end of September 1983, the GLOMAR JAVA SEA's radio-station license, radio equipment, and emergency lifeboat radio were inspected by a representative of the Registry of Shipping of the Peoples Republic of China in accordance with IMO requirements of SOLAS 74. All were found satisfactory and the vessel was issued a full term Cargo Ship Safety Radiotelegraphy Certificate on October 3, 1983.

On October 9, 1983, while tropical storm GEORGIA passed to the north of the GLOMAR JAVA SEA, the drillship rolled about 10° to starboard and remained heeled in that position for about a minute. The master told the alternate chief engineer that the heel was due to "three freak waves" crashing on deck so that there was a "five-foot wall of water on the starboard side." The drillship came back to a level position after the water from the three waves drained from the deck.

On October 13, 1983, an ABS surveyor from Hong Kong and a USCG inspector, were flown by helicopter to the drillship to conduct a 5-day inspection and survey of equipment aboard the drillship. Global Marine had requested the ABS to survey the GLOMAR JAVA SEA and the USCG inspector was sent from the USCG Marine Safety Office in Buffalo, New York, to conduct a biennial inspection of the drillship, which was required to maintain the vessel's Certificate of Inspection. During the inspection process, the ABS

surveyor and the USCG inspector were accompanied by the drillship's master, chief engineer, and a Global Marine representative from its marine inspection department in Houston.

To avoid duplication of effort, the ABS surveyor and the USCG inspector together conducted the vessel inspection of the areas that had been damaged by the supply boat NANHAI 209. At the conclusion of the inspection, the ABS surveyor and the USCG inspector recommended that the port side damage be re-inspected and that all repairs be completed during the drillship's next drydocking.

After completing their joint surveys, the ABS surveyor proceeded to conduct the annual hull, machinery, cargo gear, load line, and mandatory annual IMO surveys; all items were found in a satisfactory condition. Except for the forepeak tank and afterpeak tank, none of the drillships tanks were entered and examined internally during the surveys. The surveyor recommended that the vessel be retained as classed by ABS.

The USCG inspector inspected all pressure vessels, piping, main and auxiliary machinery, electrical systems, pollution systems, the vessel's structure, lifesaving equipment, firefighting and navigation equipment, and reviewed the vessel's documents, personnel licenses, and other certificates. All survival equipment was removed from the vessel's two lifeboats and examined and the exterior and interior surfaces of the lifeboats were inspected. All equipment was found or placed in satisfactory condition, and no damage or deterioration was found on the surfaces of the lifeboats. The disengaging apparatus, cable, and winches were examined and each lifeboat was weight tested. Each lifeboat was lowered to the boat deck by gravity and then raised and restowed. Each lifeboat diesel engine was test run and found to operate properly.

The three inflatable liferaft's were checked to verify that they had been manufactured by a USCG-approved facility, that the capacity information was correct, and that the rafts were serviced and examined at a USCG-approved facility as scheduled. The rafts were found to have been serviced at the nearest USCG-approved facility in Singapore and were found to be in satisfactory condition. All life preservers were inspected for material condition, reflective material, whistles, required markings, and lights. Three life preservers were found to be damaged and were discarded; all other life preservers were found in satisfactory condition. The vessel carried twice the number of life preservers required by USCG regulations. The portable emergency lifeboat radio and the EPIRB were found to be operating satisfactorily. Fire hoses, fire pumps, the fire main piping, and fire stations were examined, tested, and found in satisfactory condition. The gyro compass, magnetic compass, internal communication systems, control systems for steering, engine order telegraph, navigation lights, and signals were checked and found to be operating properly.

The hull, including accessible areas of the hull plating, deck plating, oil tight and watertight bulkheads, cable and pipe pentrations, watertight doors, and closures were examined and found to be in satisfactory condition. Except for the forepeak and afterpeak tanks, the vessel tanks were not gas free; therefore, no attempt was made to enter and examine them. The vessels bilge system and ballast system pumps and piping were examined and found to be operating properly.

The vessels main propulsion machinery and controls were checked. The primary machinery was diesel-electric and provided power for main propulsion, hotel services, and drilling operations. All systems were checked, tested, and found to be operating satisfactorily. The electrical system, which included the drillship's six diesel generator

sets, the diesel generators' overspeed protection devices, the low lube oil pressure protection devices, and the reverse power relays were tested and found to be operating properly. Fire closures and dampers in the ventilation systems were checked as were the mooring gear windlasses, winches, controls, and brakes; all were found to be in satisfactory condition.

The vessel's emergency diesel generator was operated for 2 hours under load during the fire and lifeboat drill and checked for proper operation, ventilation, and auto start capability. All items were found in satisfactory condition as were the main and emergency switchboards. The USCG inspector stated that he considered the overall condition of the drillship to be very good. At the conclusion of the inspection, a temporary Certificate of Inspection was issued. The permanent certificate was to have been issued when the USCG inspector returned to the United States. The ABS surveyor, the USCG inspector, and the Global Marine representative departed the vessel by helicopter on October 17.

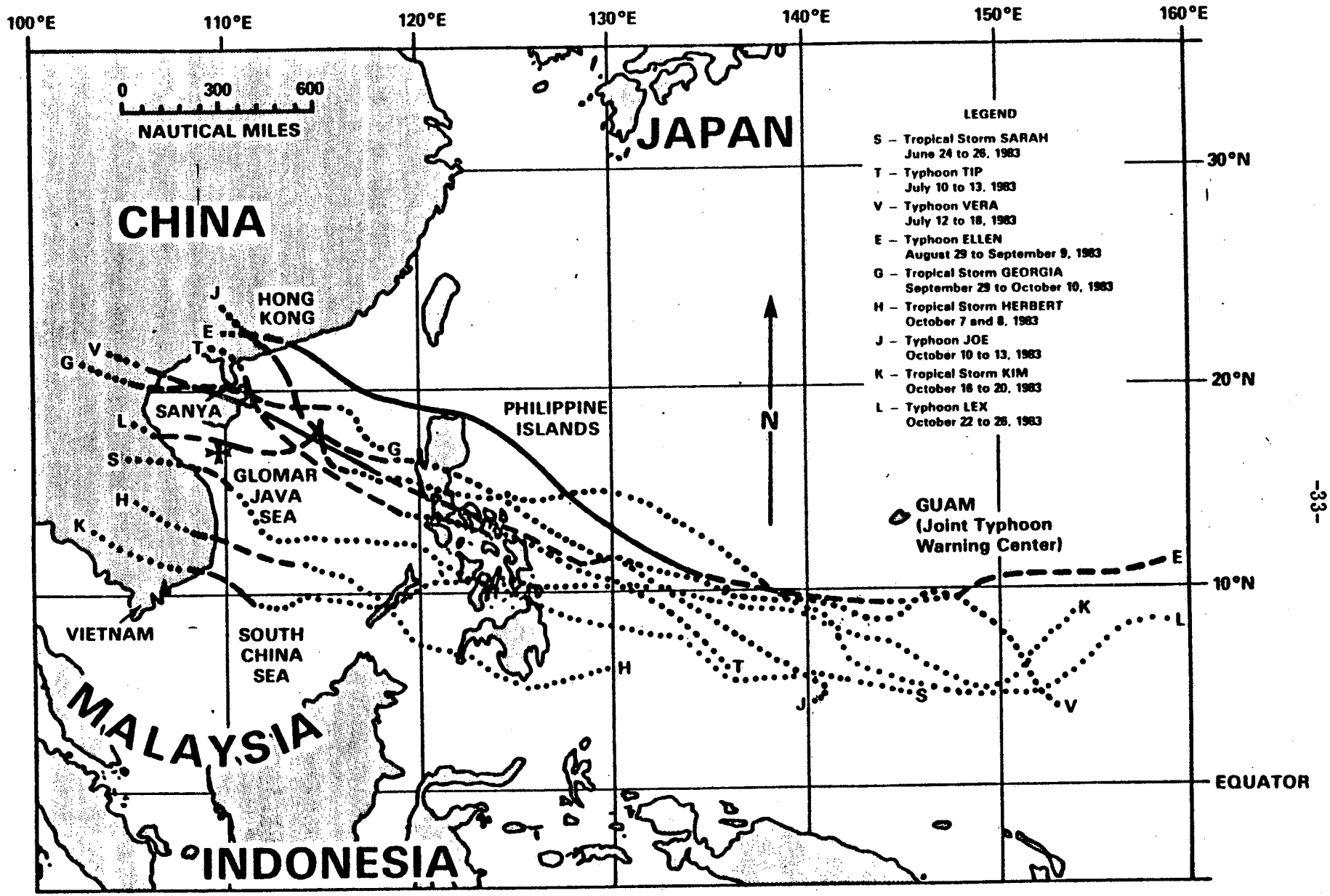
Waterway Information

The South China Sea is bounded on the east by the Philippine Islands, on the south by Malaysia, on the west by Vietnam, and on the north by the People's Republic of China. (See figure 8.) About 150 nmi to the east-southeast of the drill site were the Paracel Islands, an area of shoal waters. Within this region, sea currents of 0.8 to 1.5 knots are prevalent and are affected by the constant currents of both the Indian and Pacific Oceans. However, far more effect is created by the prevailing southwest monsoons 16/ of summer causing a northeast current flow and the northeast monsoons of winter and its associated southwestern current flow. Sea water temperatures range from 74° to 82° F. Large populations of sharks and poisonous sea snakes are indigenous to the area.

The South China Sea is considered by many in the oil industry to be the last frontier for new oil and gas reserves. China's offshore oil and gas exploration program is active and expanding in the northern portion of the South China Sea. From 1979 to 1981, oil companies from around the world conducted seismic surveys covering over 160,000 square miles in the South China Sea to evaluate the hydrocarbon potential of this area. Over 400 prospective areas were identified, and reserve estimates have been in the range of 20 to 50 billion barrels of oil. The PRC has divided the northern South China Sea into two offshore oil exploration zones, Nanhai East and Nanhai West. At the time of the accident, the GLOMAR JAVA SEA, was engaged in exploratory drilling at a wellsite within the Nanhai West zone, about 65 nmi south of Hainan Island. On April 5, 1983, the GLOMAR JAVA SEA made what is believed to be the first commercial discovery in the area.

Many oil companies world-wide, have submitted bids on the contract areas selected by the PRC, and in December 1983, the latest contracts were awarded to groups involving 27 oil companies from 9 nations. Presently, oil companies that have not commenced exploratory drilling in the region are actively engaged in extensive seismic research and analyses with plans for drilling deep test wells in the region. During 1984, many types of MODU's, including other drillships, were working in the area and many more are expected in future years. An estimated 18 to 24 mobile offshore units will be needed to drill the exploratory wells planned through the end of 1984 and a great deal of movement of people and equipment will take place as the oil industry builds up its China operations. The oil industry is expected to spend an average of $300 to $500 million dollars per year over the next 5 years on exploratory wells.

16/ Monsoon - a constant wind system that influences large climatic regions and reverses direction seasonally.



NOTE: Direction of the movement of the storms is from East to West

KEY: ——— = Typhoon / – – – = Tropical Storm / ••••• = Tropical depression-disturbance

Figure 8.—Tracks of nine typhoons in the South China Sea from June to October 1983.

Meteorological Information

Typhoons [15] in the western North Pacific Ocean occur in every month of the year. However, 90 percent of the typhoons occur between June and November. Most are found north of 15° N latitude and follow west to west-northwest track lines when passing through the South China Sea.

The drilling location of the drillship GLOMAR JAVA SEA was in an area of the South China Sea known locally as "typhoon alley." Chinese jack-up drilling rigs [6] working in this area are ordered to port from June to November by the PRC offshore oil companies as a precautionary measure to protect crews and equipment from exposure to the dangers of the tropical cyclones [11]. However, a number of non-Chinese MODUs, including jack-up rigs, drillships, and semi-submersible rigs, have continued offshore drilling operations during this period.

ARCO contracted Oceanographic Services, Inc., to prepare a detailed climatological and meteorological research study in preparation for exploratory drilling operations offshore Hainan Island in the South China Sea. The study, entitled "Hindcast Study of Offshore Hainan Island South China Sea" was completed in December 1980. The study showed the frequency of typhoons and other severe storms in the South China Sea. Weather reporting and forecasting information concerning the current and predicted state of the environment is available from weather service organizations located world-wide. Weather forecasting and reporting services within China was provided, by contract to Arco China, Inc., by METEO of the Nanhai Oil Union Service General Company. METEO forecasts and reports were transmitted via SSB radio on 6960 kHz from the weather observatory in Guangzhou, China, to receiver/teleprinters at ARCO's office in Zhanjiang and to the drillship GLOMAR JAVA SEA.

During calm weather conditions, weather reports were transmitted to the drillship twice each day at 0800 and 1800. Each report contained a summary of the large scale [10] weather situation at the time of the report and elemental forecasts [9] for the specific location of the GLOMAR JAVA SEA at six future periods; 0-6 hours, 6-12 hours, 12-24-hours, 24-36 hours, 36-48 hours, and 48-72 hours. When weather conditions warranted, specific weather warnings were issued for important weather developments occurring within an area from 0° to 25° N latitude and between 100° and 130° E longitude. The warnings were issued with the weather forecasts until the storm moved out of the defined area or dissipated. Warnings contained the location, intensity, direction, and speed of the storm, the radius of over 30-kn and over 50-kn winds in the previous 6 hours, and the forecast position and intensity of the storm for the next 12-, 24-, 36- and 48-hour periods.

When weather conditions deteriorated and a tropical storm [14] or typhoon was formed or observed within an area defined by the four coordinates--22° N. 113° E., 22° N. 130° E., 08° N. 130° E., 08° N. 113° E. (see figure 2)--then additional forecasts and reports were issued at 0430, 1030, 1630, and 2230 each day. If the center of the storm entered the area defined by the four coordinates--20° N. 106° E., 20° N. 117° E., 13° N. 117° E., and 13° N., 109° E.--then additional forecasts were issued daily at 0130, 0730 (in lieu of the 0800 forecast), 1330, and 1930.

Global Marine Drilling Company contracted with a Tokyo, Japan, weather reporting service which provided weather reports directly to the GLOMAR JAVA SEA by satellite. The weather reports were received on board the drillship by the "Weather Fax" facsimile machine. The printed reports contained storm warnings; the location, speed, direction,

and maximum winds of the storm, including a radius of over 30-kn winds; and a summary of high and low pressure locations for a large scale area. There was no information concerning wave or swell. The Tokyo weather service provided four reports each day at 0200, 0800, 1400, and 2000 hours.

LEX was the sixteenth tropical cyclone of the 1983 season. In the 4-month period prior to the accident, there were eight other tropical cyclones in the South China Sea (see figure 8):

Tropical Cyclones	Dates	Distance from Drill Site
Tropical storm SARAH (No. 1)	6-24 to 6-26	100 nmi south on a westerly track
Typhoon TIP (No. 2)	7-10 to 7-13	250 nmi northeast on a northwesterly track
Typhoon VERA (No. 3)	7-12 to 7-18	150 nmi northeast on a west-northwesterly track
Typhoon ELLEN (No. 9)	8-24 to 9-9	370 nmi northeast on a west-northwesterly track
Tropical storm GEORGIA (No. 11)	9-29 to 10-10	180 nmi north on a westerly track
Tropical storm HERBERT (No. 12)	10-7 to 10-8	270 nmi south on a west-northwesterly track
Typhoon JOE (No. 14)	10-10 to 10-13	320 nmi northeast on a northwesterly track
Tropical storm KIM (No. 15)	10-16 to 10-20	420 nmi south on a west-northwesterly track

The tropical disturbance [12] which became Typhoon LEX was extremely slow in developing. It formed on October 20, 1983, about 300 nmi east of the Philippines. (See figures 2 and 8.) The initial warning of LEX was issued on October 20 when the cloud bands associated with the system were taking on a comma-shaped appearance as viewed from weather satellite photographs. Although LEX was designated as a tropical depression [13] on the initial warning, it was up-graded on October 22 to tropical storm status as it began to build and intensify while moving west-northwestward away from the Philippine Islands. (See appendix G.)

At 1800 on October 22, the storm center was 395 nmi to the east of the drillship and moving west-northwest at 10 kns with sustained wind speeds of 35 kns. Tropical storm LEX was expected to continue intensifying slowly and move west-northwestward toward Hainan Island and the drillship. By 1630, on the following afternoon, LEX was about 280 nmi east of the GLOMAR JAVA SEA with maximum sustained winds of 40 kns and gusts of 50 kns near the center of the storm. LEX began to move slowly northward and then southwesterly resulting in a counterclockwise curving track approximately 250 nmi east of the drillship. LEX resumed a westward track at 2000 on October 24, having grown in size and intensity.

About 0700 on October 25, LEX was about 155 nmi east of the drillship and was moving steadily west-northwest at 7 kns. Maximum sustained winds had increased to 60 kns with 75-kn winds near the storm center and a 300-kilometer radius of over 30-kn winds. LEX continued to intensify, while moving westward toward the drillship. During the late evening of October 25 and early morning of October 26, the center of the storm passed about 15 nmi north of the GLOMAR JAVA SEA. Over the next 24 hours, the storm

gradually weakened. Satellite photographs showed that the interaction of the storm system with the rugged terrain of Hainan Island had a pronounced weakening effect on the storm. LEX weakened further while transiting the Gulf of Tonkin and by 1600 on October 26 it was near Dong Hoi, Vietnam, with winds of 50 kns. LEX dissipated rapidly over the terrain of central Vietnam after causing extensive damage to low lying areas in its path. According to reports from Vietnam, areas near Dong Hoi were devastated by the high winds and torrential rains associated with LEX. Damage was extensive as rivers rose 6 feet, resulting in widespread flooding. Hundreds of people were killed and injured, 17,000 homes were destroyed, and six hospitals were seriously damaged.

On October 20, the U.S. Joint Typhoon Warning Center (JTWC) at Guam began monitoring LEX as a tropical disturbance through all stages of a tropical storm status. The JTWC classified LEX as a typhoon at 1400 on October 25 when LEX had wind speeds of 65 kns.

According to the Sailing Directions for Southeast Asia, 17/ the location in which the GLOMAR JAVA SEA was anchored has been shown to have a 42-percent probability for the occurrence of a tropical cyclone at least once during the month of October in any given year.

Wreckage

Underwater surveys of the wreck of the GLOMAR JAVA SEA were conducted during November 1973 and March 1984. The surveys examined the entire shell plating and some of the main deck plating of the drillship. Except for a large transverse fracture on the starboard side amidships and an 18-inch L-shaped fracture about 40 feet aft in the side shell plating, the hull was intact with some buckling of the bottom plating near the bow and at frame 146. There was a 5-foot longitudinal fracture in the main deck plating where the forward starboard derrick leg intersected the main deck. The surveys showed the drillship resting on the bottom in an inverted position about 1,650 feet southwest of the well. The wreck was on a heading of 285° (see figure 4) with its starboard side about 20 feet lower than the port side. There was an 8-foot mound of mud just forward of the bow. Both the port and starboard lifeboat davits were buried in the mud. The deckhouse was buried in the mud up to the superstructure deck. The side scan sonar survey conducted during March showed an area of debris between the drillship and the well about 230 feet wide and ranging from 120 to 300 feet from the well consisting mainly of drill pipe. The side scan sonar survey also showed a large object about 150 feet northeast of the drillship.

The GLOMAR JAVA SEA's nine anchor buoys were found and two breakaway buoys, 18/ partially crushed, were found attached to the stern of the wreck. The only debris recovered from the drillship during the postaccident search were one B. F. Goodrich liferaft, three lifejackets, the EPIRB, and one breakaway buoy with its spool of line and a rubber bumper. Neither lifeboat has been found.

Rescue Efforts

The ARCO chief geophysicist, who was left in charge of the ARCO offices in Zhanjiang and monitored the entire search and rescue effort, testified as follows:

17/ Publication 160, 1st Edition 1979, Defense Mapping Agency.
18/ Buoys used to mark the drillship end of the anchor chains if the anchor chains are disconnected.

As far as the contribution of U.S. military, it would be hard for me personally to give them the amount of thanks that I think we owe them. It is an extremely hazardous operating area. The weather conditions, as I have already told you, were extreme. They were operating, as you can see from the flights list of altitudes of three to six hundred feet through rain squalls. It is really difficult to explain any more than that the contribution that they made. And they were obviously in waters that were not the best, that were not the most friendly.

* * *

As far as the Chinese navy was concerned, early on they were notified on the morning of the 26th of the emergency. Over the next several days through communication with the Zhanjiang office and the Chinese side there, we were able to gain a good working relationship with the Chinese Navy. At first they were a little reluctant to take sightings by U.S. Military aircraft to send their navy vessels to them as you can well imagine. That was not something they were generally used to in the post World War II times anyway.

But once they realized that we were all working together and that these planes were, in fact, doing the job they were, they were rushing all over the place to try to get to the locations as soon as possible.

We had to deal in a kind of roundabout way which is due to the communications primarily. We would tell the members of the Chinese side that we were working with in Zhanjiang about a particular happening and they would contact their radio dispatcher who would then contact the navy operations dispatcher. And they would contact the ships. And it went in this way. But sometimes there were delays. But nothing unusual that you would — in fact, not as many as you would expect.

So we, at any one time we had the 205 and the 209 supply boat. We had the SAL VANQUISH vessel. We had several Chinese navy vessels of which one that kept popping up was the 950. We had two or three ARCO directed helicopters. And we had the U.S. military planes.

* * *

This effort went on for several days, as you know, from the 26th on through the early part, or the first week of November. And it went on 24 hours a day. The military planes were there almost all the time even throughout the night. The supply boats were at sea in weather conditions which were far more than severe. They were life threatening.

Medical and Pathological Information

No bodies or survivors were recovered until the second diving survey in March 1984 when 35 bodies were found on the wreck of the GLOMAR JAVA SEA and 31 bodies were recovered. All but one of the bodies recovered was fully clothed and most were wearing lifejackets. The first body, wearing a lifejacket and having a line tightly wraped around its right leg, was found outside the deckhouse on the starboard side of the poop deck. Divers then entered the starboard door on the poop deck and found nine bodies in the

lounge but no bodies in the galley or mess area. Next, the divers entered the boat deck by the starboard door and found one body about 5 feet inboard in the passageway and a second body at the junction of the thwartship passageway with the fore and aft passageway. The divers then entered the eight staterooms on the boat deck. They found four bodies in one, four in the second, three in the third, two in the forth, and two in the fifth which was the chief engineer's room. They did not find any bodies in the other three rooms. The divers then entered the seven staterooms and two offices on the superstructure deck and found no bodies in the ARCO supervisor's stateroom or office and the Global Marine's stateroom or office. One body was found in a third stateroom and another in the bathroom between that stateroom and the adjoining stateroom. No bodies were found in the adjoining stateroom, but one body was found in a stateroom on the superstructure deck. All the above bodies were eventually recovered.

While the divers were searching the superstructure decks, the lead diver proceeded to the navigation deck, which was completely under the mud, using the interior stairwell. He found one body in the master's cabin, one body outside the radio room, and two bodies inside the radio room. However, because of the danger involved, the diving supervisor would not permit any divers to return to the navigation deck to recover the bodies or to search the four other staterooms on that deck.

The divers then began a search of the main deck staterooms where most of the Chinese crew were quartered. Only one body, which appeared oriental, was found in the steward's stores. Two personnel lockers in the staterooms were opened and found empty except for an empty flight bag. The forward forecastle quarters, although badly damaged, were searched but no bodies were found. The engineroom and other below deck spaces were not searched.

The bodies could not be identified by stateroom because the only list showing crewmember stateroom assignments remained aboard the wreck. However, each body was identified as to its location when found and any significant data relating to the body. The bodies were then transported to Hong Kong for further forensic analysis.

The forensic analysis was completed on June 22, 1984. Fifteen U.S. citizens were identified, including the ARCO senior geologist, one toolpusher, the electrician, both floormen, one assistant derrickman, one crane operator, the storekeeper, the physician assistant, the cook, the steward, one assistant engineer, two oilers, and the boatswain. In addition, there were 11 PRC citizens, 3 British citizens, 1 Singapore citizen, and 2 unknown. Because of the severe decomposition of the bodies, the causes of death could not be determined. (See appendix A.)

Tests and Research

Loading.--The Global Marine Drilling Company (GMDC) in Houston, Texas, performed a weight study 19/ to determine the GLOMAR JAVA SEA's loading condition on October 25, 1983. The weight study was based on the drillship's daily reports, interviews with alternate crewmembers, and shoreside documentation. The results of the weight study were as follows:

19/ Estimated loading condition for GLOMAR JAVA SEA on October 25, 1983, prepared by J. M. Duke, Global Marine Drilling Company, dated January 25, 1984.

Displacement	10,191 long tons
Mean Draft	19 feet 4 inches
Vertical Center of Gravity	23.36 feet
Longitudinal Center of Gravity	3.64 feet aft
Free Surface Correction	0.69 feet

Table I shows the distribution of liquids from the weight study. See appendix D for tank arrangement.

Table I.--Liquid loading of the GLOMAR JAVA SEA on October 25, 1983.

Tank	Purpose	As Loaded Long Tons	Capacity Long Tons
No. 1 DT *	Ballast	35	252
No. 2P DT **	Ballast	50	388
No. 2S DT **	Ballast	0	388
No. 3P DB *	Drill water	84	84
No. 3S DB	Drill water	0	84
No. 3P WT *	Ballast	110	245
No. 3S WT	Ballast	110	245
No. 4P DB	Drill water	75	75
No. 4S DB	Drill water	0	75
No. 4P WT	Fuel oil	170	241
No. 4S WT	Fuel oil	170	241
No. 5P DB	Drill water	81	81
No. 5S DB	Drill water	81	81
No. 5P WT	Drill water	214	283
No. 5S WT	Drill water	216	309
No. 6P DB	Ballast	38	83
No. 6S DB	Ballast	0	83
No. 6P WT	Drill water	288	289
No. 6S WT	Drill water	0	291
No. 16P Fwd ***	Mud	62	124
No. 16P Aft	Mud	78	124
No. 16S Fwd	Mud	0	124
No. 16S Aft	Mud	70	124
Active and Reserve	Mud	110	564
No. 7P DT	Ballast	57	238
No. 7S DT	Ballast	0	237
No. 7P WT	Fuel oil	0	252
No. 7S WT	Fuel oil	0	277
No. 8P DB	Drill water	158	158
No. 8S DB	Drill water	158	158
No. 8P WT	Drill water	0	163
No. 8S WT	Drill water	0	163
No. 8P WT	Fuel oil	108	132
No. 8S WT	Fuel oil	108	132

* DT = Deep Tank: DB = Double Bottom; WT = Wing Tank.
** P = Port; S = Starboard.
*** Fwd = Forward Aft = After.

Stability.--The USCG Marine Technical and Hazardous Materials Division in Washington, D.C., performed intact and damage stability calculations 20/ to determine the GLOMAR JAVA SEA's intact stability on October 25, 1983, and to investigate certain assumed flooding conditions. The assumed loading condition was based on the GMDC weight study. The intact stability calculations showed that the GLOMAR JAVA SEA met the USCG intact stability standard contained in MMT Note 6-66 which required the drillship to withstand the overturning force of a 100-kn beam wind and also the 1973 ABS rules which required the vessel to withstand a 70-kn wind during drilling and a 100-kn wind under storm conditions. The damage stability calculations showed that the drillship met the damage stability standard contained in the 1973 ABS rules. (See appendixes E and F.)

Four additional flooding cases were assumed. Case 1 assumed the No. 6 starboard drill water wing tank was flooded. Case 2 assumed the No. 6 starboard drill water wing tank and the No. 7 starboard fuel oil wing tank were flooded. Case 3 assumed the two tanks of Case 2 flooded plus the No. 6 starboard ballast double bottom tank. Case 4 assumed all the tanks of Case 3 plus the No. 7 starboard ballast deep tank were flooded. The calculations assumed calm seas, the loading condition from the weight study, and port beam winds of 50 and 70 kns. The results of the assumed flooding are contained in table II.

Table II.--Assumed flooding cases.

Case	Winds Speed (knots)	Heel Angle (degrees)
1	0	6
1	50	9
1	70	12.5
2	0	14.5
2	50	19
2	70	Ship capsizes
3	0	15
3	50	20
3	70	Ship capsizes
4	0	18
4	50	Ship capsizes
4	70	Ship capsizes

Structure.--The USCG Marine Technical and Hazardous Materials Division performed structural calculations 21/ to determine if the GLOMAR JAVA SEA met the longitudinal strength requirements of the 1967 ABS Rules. The results of the calculations are contained in table III.

November Diving Survey.--On October 27, 1983, Global Marine contracted to have the 150-foot-long SCHMIDT MANILA, an offshore supply vessel converted into a salvage vessel to serve as a platform for an underwater survey of GLOMAR JAVA SEA. Global Marine also contracted with Taylor Diving and Salvage Co., Inc. to perform the

20/ "GLOMAR JAVA SEA Casualty Investigation Intact and Damage Stability Calculations" 9 March 1984.
21/ "GLOMAR JAVA SEA Casualty Investigation Structural Calculations" 22 March 1984.

underwater surveys. The SCHMIDT MANILA, which was located in Singapore, was equipped with a decompression chamber and diving bell and departed Singapore at 0130 on October 30 and arrived at the wreck site about 1830 on November 4 with the NANHAI 207 from Sanya. The alternate master of the GLOMAR JAVA SEA was aboard the SCHMIDT MANILA.

Table III.--GLOMAR JAVA SEA section moduli. 22/

	Deck Section Modulus in^2 ft	Bottom Section Modulus in^2 ft
1967 ABS Rule Requirement	15,536	16,002
At Frame 101 Within drill well	19,060	19,274
At Frame 90 forward of drill well	18,064	17,466

Anchor buoys Nos. 3, 4, 5, 6, 7, 8, and 9 were in place while anchor bouy No. 2 had been dragged to the west and anchor buoy No. 10 had been dragged to the southeast. (See figure 4.) The bow of the wreck was directly under anchor buoy No. 8. (During the March 1984 survey, it was determined that the position of the anchor buoys had not been accurately determined in November 1983.) On November 5, a side scan sonar survey of the wreck was conducted; however, bad weather forced the SCHMIDT MANILA to return to Sanya on November 6. The vessel returned to the site on November 9 and commenced the diving survey of the hull. Both lifeboats were missing, the vessel was inverted, and there was a large transverse fracture on the starboard side near the bulkhead at frame 91. (See figure 5.) The main deck was fractured where the starboard forward leg of the derrick was connected to bulkhead 91, one small fracture was found in the starboard side shell plating near the bulkhead at frame 110, and a 17-inch crack was found where the main deck and starboard side shell plating meet at frame 100. However, before the divers could examine the forward portion of the hull or enter the deckhouse, they had to return to Sanya on November 15 for more diving gas. They returned to the site on November 19 but were unable to do any further surveys due to the bad weather. After several more unsuccessful attempts, they departed the site permanently on November 30.

March Diving Survey.--During December 1983 and January 1984, Global Marine searched for a better platform to resume the diving survey. On January 19, the Norwegian diving support vessel TENDER CARRIER departed Norway for Singapore under contract to Global Marine. On March 1, the TENDER CARRIER departed Singapore after having been equipped with a dynamic positioning system, side scan sonar, and a saturation living habitat for 10 men. In addition to the crew, onboard were 9 divers and 14 diver support personnel from Taylor Diving and Salvage, a USCG officer, the GLOMAR JAVA SEA drilling group vice president, the Global Marine engineering vice president, the

22/ Section modulus is mathematically defined as the moment of inertia of a ship's midship section about its neutral axis divided by the distance from the neutral axis to the upper deck or bottom plating. The larger the section modulus for a given bending moment, the lower the stresses in the upper deck or bottom plating.

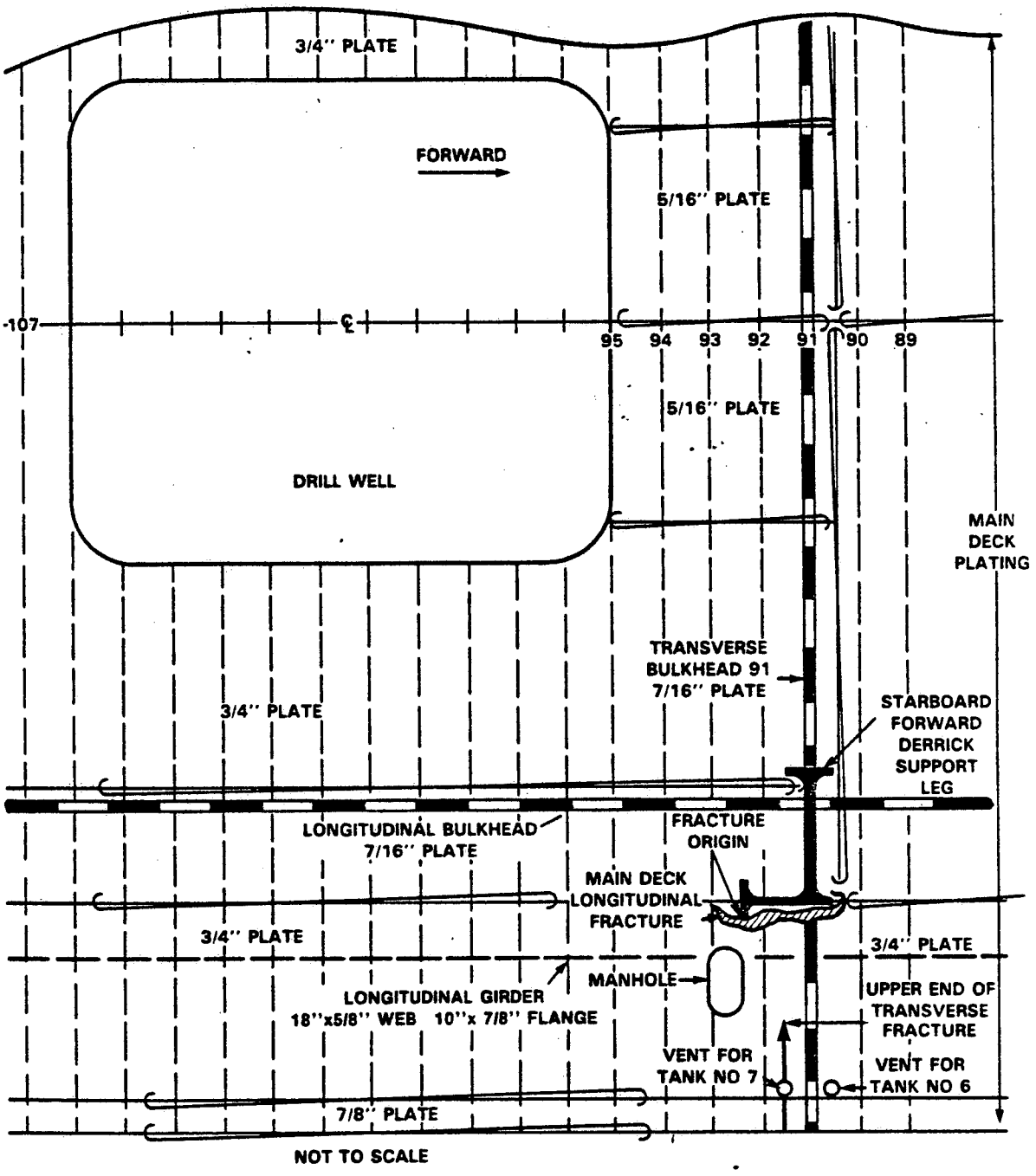
alternate master, and representatives from NHWOC. Also aboard the support vessel was a one-man submersible acompanied by two pilots, an electronics technician, and a technical director.

The support vessel arrived onsite on March 7 and began a survey of the BOP which was found undamaged, except two of the four guide posts on top were slightly bent. A survey of the hull forward of frame 59 showed numerous buckles in the bottom plating and side shell, a deep buckle at frame 8 where the keel meets the stem plate, a 6-foot deep dent on the port side at frame 59, and a 6-foot deep dent on the port side near frame 50. A longitudinal fold in the port sheer strake about 8 feet deep extended from the dent at frame 59 to frame 140. The liferaft cradles on the port and starboard sides forward were empty. An 8-foot deep dent was found on the port side near frame 91. An examination of the four substructure legs of the derrick at frames 91 and 110 showed that the port after leg was undamaged, that the port forward leg was cracked along its base, that the starboard after leg was undamaged, and that the deck near the starboard forward leg was fractured. (See figure 9.) A longitudinal fracture about 5 feet long and 8 inches wide extended across the bulkhead at frame 91 so that both starboard wing tanks Nos. 6 and 7 were opened to the sea at the main deck level. At frame 146, there was a transverse buckle about 30 feet long in the bottom plating. No damage to the drill well structure was observed. All main deck openings were closed, except the door at frame 83 leading to the reserve mud pit room and the door on the port side at frame 125 to the spare parts storage which were missing and the door at frame 135 to the casing storage which appeared to have been blown out by pressure. The air vent to starboard drill water tank No. 6 was undamaged, and the air vent to starboard fuel oil tank No. 7 had been damaged by the large transverse fracture on the starboard side.

The starboard lifeboat davits and falls were examined but only the forward davit arm was found in the mud. The davit arm showed no distortion or damage to the sheaves. 23/ The tricing pendant 24/ was attached to the davit arm and showed no evidence of distortion. Attempts to recover the blocks 25/ buried in the mud were unsuccessful. The gripe pelican hooks 26/ were hanging open with no damage or distortion. The drums for the starboard lifeboat showed the cable lying in 25 of the grooves with 5 grooves empty. The boat winch emergency disconnect switch was seized in the on position. Neither port lifeboat davit arm was found. Attempts to pull the port lifeboat falls 27/ and blocks from the mud were unsuccessful. The forward fall was broken when pulled from the mud with the end deteriorated and showing corrosion indicating it had broken some time before. The after fall broke while being pulled from the mud. The forward gripe pelican hook was broken and the after hook was badly distorted. Several wraps of cable were on the drum in the grooves and several more were around each drum outside the groves and in disarray.

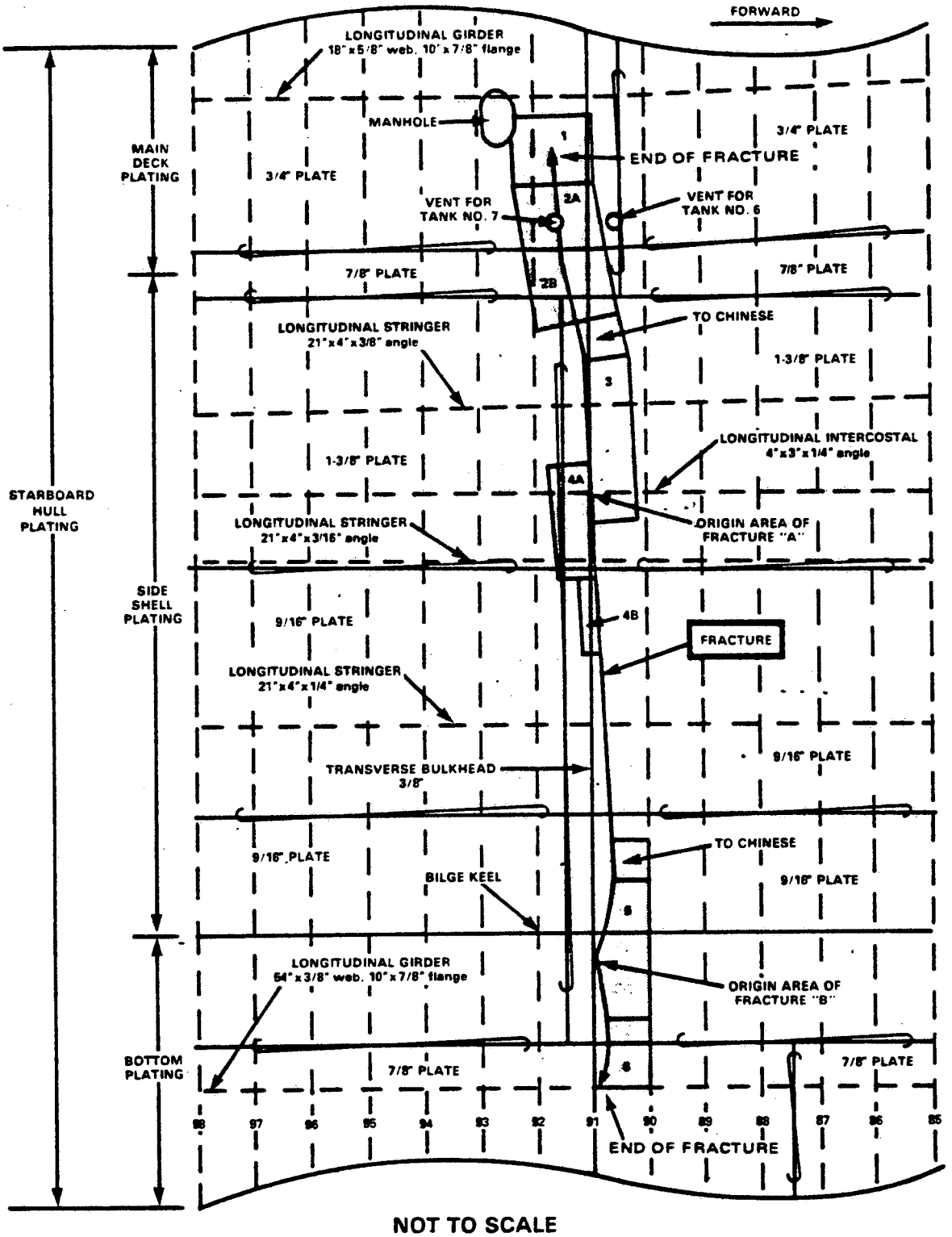
The fracture on the starboard side and the internal surface of both drill water tank No. 6 and fuel oil tank No. 7 were examined. (See figure 10.) The 1 3/8-inch shell plating forward and aft of the fracture was set in while the 9/16-inch plating below the 1 3/8-inch plating was accordioned with smooth folds. The longitudinal bulkhead was holed between frames 88 and 86 about 12 feet below the main deck by a transverse strut

23/ Sheaves are the grooved wheels over which the falls are led on the davit arms.
24/ Tricing pendant is the wire rope that holds the lifeboat against the side of the vessel during boarding.
25/ Blocks are the pulleys on the ends of the davits which facilitate lowering.
26/ Pelican hook is a quick release clamp.
27/ Falls are the wire ropes supporting the lifeboat.



Note: Transverse Frames 89 Through 107 are 6"x3 1/2"x3/8" on 2 Ft Centers

Figure 9.—GLOMAR JAVA SEA main deck plating showing longitudinal fracture and end of transverse fracture.



NOT TO SCALE

NOTES: 1. Transverse frames 85 through 98 are 7" x 4" x 3/8" on 2 ft centers

2. Numbered plates indicate coupons recovered during March 1984

Figure 10.--GLOMAR JAVA SEA starboard plating showing fractured area and recovered coupons during March 1984.

within the No. 6 wing tank. The side shell at frame 110 was holed about 6 feet above the bilge keel by a transverse strut in the No. 7 wing tank. The fracture had two origins. The origin of fracture "A" was about 8 feet below the main deck in the 1 3/8-inch-thick side shell plating where it met the transverse bulkhead at frame 91 and where a longitudinal intercostal was welded to the shell plating and the bulkhead. Fracture "A" extended toward the main deck on the aft side of bulkhead 91, through the 7/8-inch thick sheer strake, into the 3/4-inch thick deck plating, around the fuel oil vent opening,and ended about 4 feet inboard in the deck plating. The bulwark near frame 91 did not show extensive damage. Fracture "A" extended toward the bilge keel on the forward side of bulkhead 91 into the 9/16-inch thick plating and ended near the bilge keel. The origin of fracture "B" was just below the bilge keel at bulkhead 91, and it extended toward the main deck until it intercepted the first fracture just above the bilge keel and ran about 2 feet into the 7/8-inch thick bottom plating and stopped. The fracture surfaces showed no evidence of battering or of striking each other. The divers cut coupons of the fracture about 2 feet wide and 6 feet long along the fracture surface for metallurgical analyses. Ten coupons were taken to the surface, cleaned, and preserved for shipment. Eight coupons were shipped to Failure Analysis Associates (FAA) in Houston, Texas, and two were given to the Nanhai West Oil Company.

The deckhouse was examined both externally and internally. The exterior doors were closed, except the door to the emergency generator room on the superstructure deck which was found hooked open. Three ship clocks were found: one read 10:47 and two read 11:55. One wristwatch was found which read 11:37 and a wind up clock read 8:45.

Metallurgical Tests.—On April 24, 1984, the eight coupons taken from the wreck of the GLOMAR JAVA SEA were examined in the Houston office of FAA by a group of metallurgists including a Safety Board metallurgist. Examination of the hull fracture surfaces on the various pieces confirmed that the fracture in the side plating of the ship had two areas of initiation. Fracture features over most of the break emanated from an origin on the starboard side of the ship, approximately 8 feet below the main deck and approximately 0.5 inch forward of the plate for bulkhead 91. The origin area was on the inside surface of the 1 3/8-inch hull plate where an intercostal had been welded to the hull and to bulkhead 91. The length of cracking which initiated from this origin area was about 28 feet.

The second origin which was located in the hull plate several feet below the bilge keel, also was on the inside surface of the hull plate and was directly adjacent to the forward face of the plate for bulkhead 91 in the heat affected metal adjacent to the fillet weld connecting the plates. The crack from this origin was about 5 feet long.

The majority of the fracture surface, including both origin areas, consisted of brittle fracture intersecting the plate surface at a 90° angle. Both fractures terminated in ductile fractures intersecting the fracture surface at a 45° angle.

The coupons from the main deck to the bottom plating were labeled 1, 2A, 2B, 3, 4A, 4B, 5, and 6, with the origin of fracture "A" on coupon 3 and 4A and the origin of fracture "B" in coupon 5. (See figure 10.) After examining and photographing the coupons, representative test specimens were cut from coupons 1, 2A, 3, 4A, 5, and 6 and sent to Coffer Laboratories, Inc., of Houston, Texas for further testing. Tables IV and V contain a comparison of the test specimen's chemical composition, tensile strength, and elongation to the 1973 ABS standards for Grade C steel.

Table IV.--Chemical composition
(percent content).

Specimen	Carbon	Manganese	Phosphorus	Sulphur	Silicon
1(a)	0.14	0.79	0.016	0.01	0.23
1(b)	0.13	0.80	0.017	0.01	0.25
2(a)	0.11	0.84	0.013	0.01	0.27
3	0.17	0.75	0.004	0.03	0.23
4(a)	0.12	0.78	0.016	0.02	0.23
4(A)	0.12	0.80	0.017	0.02	0.25
5	0.13	0.79	0.019	0.01	0.25
6	0.19	0.99	0.015	0.03	0.05
ABS Standard	0.23 maximum	0.60-0.90	0.05 maximum	0.05 maximum	0.10-0.35

Table V.-- - Tensile strength and elongation.

Specimen	Tensile Strength lbs per sq inch	Elongation percentage in 2 inches
1(a)	74,000	23.2
1(b)	72,100	23.7
2(a)	69,800	29.8
3	69,300	29.1*
4(a)	not tested	not tested
4(A)	not tested	not tested
5	74,500	25.2
6	74,000	31.1
ABS Standard	58,000 to 71,000	24 minimum

*ABS standard for 1 3/8-thick plate 22.5 minimum.

In accordance with ASTM Standard E 23 Charpy V-notch tests were conducted at 83° F, the assumed water temperature. Charpy V-notch tests indicate the amount of energy necessary for a fracture to propagate in the material. The higher values mean more energy is needed. Table VI contained the results of the tests.

Limited drop weight tests showed the nil-ductility-transition temperature was 30° F for coupon 3 and 50° F for coupon 5. The nil-ductility-transition temperature is the temperature at which the mode of fracture of a material changes from ductile to brittle. The lower the transition temperature, the more energy necessary for a fracture to propagate. Dimensional thickness measurements showed little or no decrease from design requirements.

To determine if there were any preexisting defects at the two fracture initiation areas, extensive metallurgical examinations were conducted including Auger electro spectroscopy, metallography, and scanning electron microscopy. The results of these tests and examinations showed no preexisting fractures or defects at either location.

Table VI.--Charpy impact tests.

Coupon	Specimen	Energy Absorbed (foot - lbs)
1	1-1	52.0
1	1-2	72.0
1	1-3	54.0
2A	3-1	124.0
2A	3-2	110.0
2A	3-3	134.0
3	4-1	17.5
3	4-2	15.0
3	4-3	11.5
5	5-1	94.0
5	5-2	64.0
5	5-3	105.0
6	6-1	45.0
6	6-2	43.0
6	6-3	47.0

Motions and Loads—To determine the magnitude of the loads experienced by the GLOMAR JAVA SEA on October 25, 1983, the USCG and the Safety Board requested the ABS to perform certain structural and motion calculations. 28/ These calculations were based on a worst case scenario with the following assumptions:

- 50-knot wind from 350°
- 38-foot significant wind wave height from 315° with a period of 10 seconds
- 30-foot swell height from 050° with a period of 12 seconds
- the vessel both moored with nine anchors out and free floating on the same heading as the moored vessel.

The stillwater hull girder shear force and bending moment calculations showed that the free floating maximum shear force of 743 long tons and a maximum bending movement of 76,700 tons-feet was slightly larger than the moored maximum shear force of 660 long tons and the maximum bending movement of 70,300 tons-feet.

To calculate the dynamic stresses amidships under the assumed combined wind and swell wave conditions, a combined wind and swell wave point spectrum was produced by the U.S. Navy David W. Taylor Naval Ship Research and Development Center. The significant values of motions of the drillship under this assumed sea condition were calculated and compared to the observed heave, pitch, and roll reported by the crew of the GLOMAR JAVA SEA. The computed significant heave amplitude of 32 feet and computed roll amplitude of 16° compared well with the observed values of 24 feet of heave and 15° roll. However, the computed pitch amplitude of 8° was twice the observed value of 4°. These higher computed motion values resulted in higher computer stress values than the drillship probably experienced. The stress calculations also were

28/ American Bureau of Shipping Technical Report OED-84009, "Motions and Load Effects Analysis of the GLOMAR JAVA SEA for Marine Board of Investigation" June 13, 1984.

computed using only the 30-foot swell and the 38-foot significant wind waves. The stillwater and dynamic stresses amidships were then combined. Table VII summarizes the calculated vertical bending stress near frame 91 for both the moored and free floating cases and compares these values to the actual yield strength of the material tested during the metallurgical analyses. The stress level in side shell plating would decrease from the values in table VII the farther the side shell plating was from the main deck or bottom plating.

Table VII.--Dynamic stress at frame 91.

	Moored (tons per sq inch)	Free Floating (tons per sq inch)
Combined Sea		
Main Deck Plating	9.4	10.0
Bottom Plating	10.1	10.7
Swell Only		
Main Deck Plating	4.6	5.0
Bottom Plating	4.9	5.3
Wind Waves Only		
Main Deck Plating	9.3	9.9
Bottom Plating	10.0	10.6
Yield Strength		
Coupon 1	25.1	25.1
Coupon 2A	23.6	23.6
Coupon 3	20.4	20.4
Coupon 5	28.0	28.0
Coupon 6	23.6	23.6

Lateral and torsional bending moments at frame 91 also were calculated for the combined sea, swell only, and wind wave only cases. The calculated lateral bending moments were less than half the vertical bending moments. Since the lateral section modulus of the drillship was about twice the vertical section modulus, the lateral stress in the shell plating would be about one-fourth the vertical stress. The torsional bending moments at frame 91 were only 3 percent of the vertical bending moments for the combined sea and would contribute little to the tensile stress in the shell plating.

Calculations prepared on behalf of Global Marine indicated that the stresses at the connection of the derrick substructure to the main deck plating would be about 4.4 ksi with the vessel rolling about 40°. A finite element analysis prepared on behalf of Global Marine showed that an area of high stress could exist near the origin of fracture "A" as a result of hydrostatic pressure as the vessel sank. An expert witness hired by Global Marine testified that fracture "A" occurred as a result of hydrostatic pressure as the vessel was sinking and that the longitudinal fracture in the main deck near the derrick substructure occurred when the vessel struck the bottom. Another expert witness testified that the transverse fracture at bulkhead 91 could have been caused by the impact of a 30-foot breaking wave against the vessel's shell. This witness also stated that the stresses in the deck at the derrick substructure due to rolling of the GLOMAR JAVA SEA were small.

Other Information

MODU Manning Standards.--Under the conditions of operations as set forth in the GLOMAR JAVA SEA's COI (see figure 7), when the drillship was navigated for more than 16 hours in a 24-hour period, the minimum crew required was one master, one chief mate, one second mate, one third mate, one radio officer, four able seamen (AB), two ordinary seamen (OS), one chief engineer, one first assistant engineer, one second assistant engineer, one third assistant engineer, and three oilers. Title 46 CFR 97.14-10 requires that seven of the minimum crew required must be certificated lifeboatmen--four lifeboatmen for one of the two 64-person capacity lifeboats and one lifeboatman for each of the drillship's three inflatable liferafts. Total personnel allowed on board was limited to 64.

When the drillship was navigated for less than 16 hours in a 24-hour period, the minimum crew required was one master, one chief mate, three able seamen, one ordinary seaman, one radio officer, one chief engineer, one first assistant engineer, and two oilers. Total personnel allowed on board the drillship was still limited to 64 and the required number of certificated lifeboatmen was the same.

While moored on a drilling location, the minimum crew required was one master, two able seamen, one ordinary seaman, one chief engineer, and two oilers. The COI still required only seven certificated lifeboatmen even though the total persons allowed on board the drillship was increased by 72 percent to 110 persons since the USCG did not consider the GLOMAR JAVA SEA subject to 46 CFR 97.14 when moored so as to trigger a requirement for additional lifeboatmen. On the other hand, if the MODU regulations (46 CFR 109.323) which became effective in 1979 were applicable to the GLOMAR JAVA SEA, the drillship would only have been required to have two lifeboatmen for each lifeboat and none for the inflatable liferafts, or a total of four lifeboatmen.

The GLOMAR JAVA SEA was manned according to the terms and conditions set forth in the drilling agreement between the operator (Global Marine) and the contractor (ARCO). This agreement specifically listed the number and type of marine personnel to be on the drilling unit available and fit for work in addition to the operational crew requirement. The drilling agreement called for one master, two able seamen, three ordinary seamen, one chief engineer, two assistant engineers, and two oilers to man the drillship during moored drilling operations. This agreement exceeded the minimum moored crew requirements as set forth on the vessel's COI. Information gathered from the crew list and personnel background histories provided by Global Marine indicated there were nine certificated lifeboatmen on board the GLOMAR JAVA SEA on October 25, 1978, to satisfy the requirement of the COI.

Current USCG regulations do not address the minimum manning standards and qualifications required for the operation of MODU's except the minimum number and qualifications of certificated lifeboatmen. In the USCG Marine Safety Manual (CG-495), Chapters 50, Part 50-8, and 55 are reserved for future manning requirements for MODU's. At the present time, manning requirements for individual MODU's are established by local USGC marine inspection offices.

While self-propelled MODU's that navigate continuously for more than 16 hours but less than 72 hours must have a master with an unlimited license, all other deck and engine licensed personnel need only to have USCG "industrial licenses." Industrial licenses are not defined in USCG regulations, and there are no published standards regarding their issuance. However, the USCG Notice of Proposed Rulemaking (NPRM) dated

August 8, 1983, which is a comprehensive revision of all USCG license regulations, contains proposed standards for masters, mates, and engineers on mobile offshore units. Presently, licenses are issued by individual USCG Marine Inspection Offices to experienced industrial personnel 29/ so that those personnel can satisfy the licensed manning requirements of the USCG Certificate of Inspection for certain modes of operation. For voyages over 72 hours, both the master and mates are required to have unlimited licenses.

Command of self-propelled drilling units, such as the GLOMAR JAVA SEA, alternates between the master and the drilling superintendent, depending on whether the drillship is in transit or moored over a drilling site. Traditionally the master of a vessel is in command, regardless of its location, whether the vessel is underway or moored. Moored MODU's, on the other hand, are regarded as engaged in an industrial activity by the USCG and the person-in-charge is not required to have a maritime background or possess a license or document attesting to his experience either on ships or MODU's.

The master of the GLOMAR JAVA SEA was a licensed person with knowledge of the marine aspects of the MODU. Many masters aboard MODU's are older, possibly retired seafarers who, because of their expertise and maritime experience, are employed to command MODU's when in transit. When the MODU's are on the drilling site, however, the marine operation becomes secondary to the drilling activity. The command structure changes and the drilling superintendent becomes the person-in-charge. When the alternate master of the GLOMAR JAVA SEA was asked, "to whom do you report?" He answered, "I reported to, initially, [the Global Marine] drilling superintendent, the area manager and then the vice president of operations." The alternate master testified that in the event of heavy weather or an upcoming storm he would "consult with both the [Global Marine] drilling superintendent and the [ARCO] drilling supervisor." The alternate chief engineer of the GLOMAR JAVA SEA, who holds a USCG issued chief engineer license for steam and motor vessels of any horse power, testified that "the [Global Marine drilling] superintendent" is his immediate supervisor.

USCG regulations which established the requirement for MODU's were first adopted and published in 1978. However, the manning standards for these drilling units have never been addressed, other than the requirement that self-propelled units shall have a licensed master and that a minimum number of persons aboard be able seamen, ordinary seamen, and certified lifeboatmen. In 1978, the USCG completed a 2-year study of MODU operations 30/ to provide a basis for establishing marine-related qualification requirements for MODU personnel which included drillships, such as the GLOMAR JAVA SEA. On August 8, 1983, the USCG issued an NPRM in which it proposed establishing personnel qualification standards for MODU's; however, the NPRM did not address MODU manning standards except that the master shall be in charge. Presently, the USCG is considering proposing further regulations for manning standards and is working on policy guidelines for USCG Officers-In-Charge of Marine Inspection to use in establishing manning standards for MODU's. The USCG is planning many revisions of its NPRM but will not publish a revised NPRM before 1985; the proposals dealing with MODU's will not be revised until mid 1985.

29/ A term used to describe individuals who are not seamen nor passengers in the traditional sense but are on board for the sole purpose of carrying out the industrial business or function of the MODU.

30/ Report No. CG-0-76-78, Functional Job Analysis of Mobile Offshore Drilling Unit Operations, Vols. I thru III.

USCG Overseas Inspection Program.--Beginning in the 1970's, the USCG began to station personnel permanently in certain overseas locations to carry out commercial vessel safety activities. Because of budgetary constraints, however, on April 1, 1982, the USCG closed its overseas Marine Inspection Offices in Rotterdam, the Netherlands, Kobe, Japan, and Singapore, and their functions and personnel were reassigned to offices within the United States. Currently, the Marine Safety Office (MSO) in Honolulu, Hawaii, is responsible for inspection activities in the Far East, the Pacific Basin, and the Indian Ocean as far as the Arabian Sea.

From time to time the USCG makes a service wide call for volunteer inspectors for temporary overseas assignments usually of about 30 days duration. When the local USCG MSO needs additional inspector manpower to carry out required scheduled inspections, the MSO contacts USCG Headquarters, Office of Merchant Marine Safety, Overseas Inspection Program Office and informs it of the ships, their overseas locations and the required inspections to be handled by the additional inspectors. Then the USCG assigns individual officers to temporary inspection duty under the authority of the requesting MSO. The USCG officer who inspected the GLOMAR JAVA SEA between October 13 and 17, 1983, was sent from the USCG's Buffalo MSO to temporary assignment out of the Honolulu MSO to inspect the GLOMAR JAVA SEA in the South China Sea. He was a qualified hull and machinery inspector although he previously had not conducted a biennial inspection of a drillship or any MODU. He stated that the item that made the GLOMAR JAVA SEA different from a classic cargo or other ship was the drilling system. The hull configuration, navigation, propulsion, and piping systems were the same and the general layout was common to all vessels.

When a ship owner needs a USCG inspection while overseas, he must make a written application (at least 60 days in advance of the inspection due date) to the USCG MSO responsible for his overseas geographical area. Application was made by Global Marine to the USCG MSO in Honolulu on August 16, 1983, for a biennial inspection of the GLOMAR JAVA SEA, which was completed on October 17, 1983, in accordance with the USCG's Overseas Inspection Program.

Drydock Inspections.—The USCG has proposed extending the drydock inspection period for U.S. vessels in salt water service from 24 to 30 months in recognition of the introduction of improved exterior hull coatings which prevents corrosion. ABS presently requires vessels to be drydocked every 30 months and IMO is proposing 30 to 36 months as a standard. USCG regulations, 46 CFR 107.261, permit MODU's to have a special underwater inspection in lieu of drydocking. Similarily, the ABS rules for MODU's permit special underwater surveys in lieu of drydocking.

Stability Standards.--The USCG, the ABS, and the IMO all have stability standards for MODU's. All have very similar requirements for the design of the vessels to withstand accidental flooding. Column-stabilized units, such as the OCEAN RANGER, 31/ are required to withstand flooding of any two adjacent compartments in the columns near its operating drafts but the standards do not address the flooding of lower hulls. Self-elevating units, such as the OCEAN EXPRESS, 32/ are required to withstand the flooding

31/ 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).
32/ 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-79-5).

of one compartment between watertight bulkheads. Similarly, surface units like the GLOMAR JAVA SEA are required to withstand flooding of one compartment between watertight bulkheads. (See appendix F.)

Emergency Radio Frequencies/Signals.—The EPIRB is a small buoyant, battery-powered, VHF radio transmitting device which automatically transmits signals simultaneously on aeronautical emergency frequencies of 121.5 mHz and 243 mHz to facilitate search and rescue operations by indicating the position of a vessel in distress. The frequency 121.5 mHz is monitored by commercial and private aircraft, and the frequency 243 mHz is monitored by military aircraft. Each U.S. vessel in ocean and coastwise service must have a USCG-approved EPIRB stowed in a manner so that it will float free if the vessel sinks.

The second set of amendments to the International Convention for the Safety of Life at Sea, 1974 (SOLAS 74), were adopted by the Maritime Safety Committee of IMO on June 17, 1983 and are scheduled to become effective July 1, 1986. The new amendments effects a total revision of Chapter III-Life Saving Appliances and Arrangements and changes to Chapter IV-Radiotelephony and Radiotelegraphy. The revised regulations in Chapter III require the carriage of an additional manually activated survival craft EPRIB and a two-way radiotelephone for each survival craft. On August 8, 1984, the Federal Communications Commission (FCC) issued an ANPRM to propose new rules in Part 83 of Title 47 of the Code of Federal Regulations (CFR) prescribing the general design requirements for the new EPIRB and the survival craft two-way radiotelephone apparatus required by the revised Chapter IV.

The frequency 2182 kHz is the international calling and distress frequency for ship radiotelephone stations operating in the 1605 to 3500 kHz band. The stations must maintain an efficient radio listening watch on 2182 kHz while the station is open and not communicating on other frequencies. All ship stations in the 2000 to 3000 kHz band also must be capable of transmitting on 2182 kHz. The USCG maintains a listening watch on 2182 kHz for 3 minutes immediately after the hour and 3 minutes after the half hour, the internationaly prescribed watch periods for all but emergency communications on this frequency.

The emergency lifeboat radio is designed so that it can be used by a person who may not be trained as a radio operator. The radio, when operated on automatic, will send out distress signals on 500 kHz and 8364 kHz. The twelve 4-second dashes followed by three SOS groups in Morse Code are sent on 500 kHz and are intended to activate the auto alarm of any ship in the vicinity not standing a radio watch. Three groups of SOS followed by a 30-second dash are then transmitted on 8364 kHz. There is no requirement for an auto alarm on this frequecny. The lifeboat radio can be operated manually for two-way keyed Morse Code communication between the lifeboat and rescue vessels on 500 kHz and 8364 kHz. There are a number of marine calling frequencies, but 8364 kHz is the only one prescribed for use by airplane survival craft, lifeboats, and other survival craft for communication with stations of the maritime mobile service.

All U.S. vessels on an international voyage must be provided with a portable radio apparatus complying with the requirements of the FCC unless at least one lifeboat on each side of the vessel is fitted with a fixed radio installation. All vessels at sea are required to observe radio silent periods twice each hour on 500 kHz. During these periods, the radio operators are not permitted to transmit but must listen for radio distress signals. The silent period on 500 kHz is from 15 to 18 minutes past the hour and from 45

to 48 minutes past the hour. Channel 16 (156.8 mHz) is the calling and distress frequency for ship VHF radiotelephone stations in the 156 to 158 mHz band, and these stations must maintain a listening watch and be capable of transmitting on 156.8 mHz. There are no internationally prescribed silent periods on frequency 156.8 mHz.

MARISAT satellite communication terminals, such as the one that was on board the GLOMAR JAVA SEA, are equipped with a distress alarm capability. A distress "telex" (printed mode) or telephone call can be initiated from this type of terminal. Activating the distress call feature overrides all other traffic and assures an immediate frequency assignment based on the communications mode (telex or telephone) selected by the ship. The ship may then direct dial the desired telephone number or key in the telex number or wait momentarily for operator assistance. In any case, an audible alarm is sounded at the coast earth station and the call also is connected to a MARISAT operator in the event assistance or further coordination is required.

MARISAT routinely distributes Ship Earth Station User Guides which conspicuously list the telephone and telex numbers of the RCC associated with the coast earth station. For the GLOMAR JAVA SEA, the coast earth station was located in Japan.

Lifeboats.--Title 46 CFR 108.519 states that each MODU must have a portable radio apparatus that meets the requirements of the Federal Communications Commission. Title 46 CFR 108.506 states that each lifeboat and liferaft must be capable of being launched to the water when the unit has an adverse list up to 15° or trim up to 10°.

GLOMAR CORAL SEA.--On February 1, 1984, two Safety Board investigators visited the GLOMAR CORAL SEA in Mobile, Alabama. The GLOMAR CORAL SEA is a Global Marine drillship similar in design to the GLOMAR JAVA SEA but was built 1 year before the JAVA SEA at Levingston Shipbuilding Co. The purpose of the visit was to become familiar with the drillship's arrangement. One significant difference between the two vessels is that the GLOMAR CORAL SEA had open lifeboats while the GLOMAR JAVA SEA had enclosed lifeboats. The master of the GLOMAR CORAL SEA lowered the port lifeboat to the boat deck level. It was observed that cable remained in 25 of the grooves on the drum and 5 grooves were empty.

Heavy Weather Plans.--Global Marine provided the master and drilling superintendent of the GLOMAR JAVA SEA with two sets of similar instructions concerning heavy weather safety procedures. One set of instructions was contained in the drillship's "Operating Manual" and the second set in Global Marine's "Critical Procedures" manual. The "Operating Manual" recommended that the master have absolute responsibility and authority for the safety of the crew and ship and that the senior drilling department member have responsibility for the safety of the well and drilling equipment. The "Critical Procedures" manual states, in part:

- The master has absolute responsibility and authority for the safety of the crew and ship.
- The Senior Drilling Department member aboard is responsible for the safety of the well and drilling equipment.
- It is the Master's responsibility to offer the Superintendent the best possible advice, and to recommend appropriate action.

- Until such time that the Master is of the opinion that the ship or the crew are or may become endangered, the Superintendent is in charge and responsible for drilling equipment.

- Prior to taking sole command, consult with the Superintendent.

- Whenever it is apparent that the ship or crew are or may become endangered you must declare a state of emergency and assume sole command and responsibilty.
  a. Sounding of the general alarm declares a state of emergency.

The "Operations Manual" states that a heavy weather procedures plan shall be compiled by the drilling superintendent and the master and approved by the operator (ARCO). The "Critical Procedures" manual states that the hurricane or typhoon procedures should be in three phases. During phase 1, when the typhoon or tropical storm is within 1,000 miles of the drillship's location, the drilling superintendent and ARCO representative are to prepare a plan for securing the well and drilling equipment while the master is to prepare a schedule for retrieving anchors. During phase 2, when a typhoon or tropical storm is within 750 miles of the drillship's location, all nonessential personnel are to go ashore, and the anchors, except Nos. 2 and 10, are to be made ready to let go. During phase 3, when a typhoon or tropical storm is within 500 miles, the guide wires to the BOP are to be buoyed and anchor chains Nos. 3, 4, 5, 7, 8, and 9 are to be disconnected and buoyed.

ANALYSIS

Capsizing and Sinking

There were no survivors to relate the events which occurred aboard the GLOMAR JAVA SEA in the South China Sea on the night of October 25, 1983, while the drillship was experiencing the effects of Typhoon LEX. The only indication that there was a serious problem came at 2341 when the Global Marine assistant rig manager aboard the drillship called his drilling group vice president in Houston, Texas, via MARISAT and said that the drillship had a 15° starboard list and that they could not determine the cause of the list. The assistant rig manager also radioed that the engineers were checking the tanks for flooding and that they were dumping the starboard mud tanks in an attempt to reduce the list. An examination of the clocks aboard the wreck during the diving survey in March 1984 indicates that the GLOMAR JAVA SEA sank about 2355 on October 25, 1983, or about 9 minutes after the last transmission was cut off at 2346.

During the March 1984 diving survey, most of the bodies were found in staterooms with lifejackets on, indicating that although the crew were prepared for an emergency, the capsizing occurred suddenly and unexpectedly perhaps before the crew were directed to abandon the drillship. In analyzing the cause of the 15° list and the eventual sinking of the GLOMAR JAVA SEA, the Safety Board considered three possible causes: (1) the effects of the storm on the anchored vessel, (2) a weight shift to the starboard side, and (3) asymmetrical flooding of the vessel. Each possible cause is discussed separately in the following paragraphs.

Storm Effects.--The GLOMAR JAVA SEA was moored on a northwesterly heading of 339° T to provide a lee for the supply boats from the prevailing northeast winds. As the storm approached the drillship at 2100, on October 25, 1983, the crew reported 48- to 55-kn winds from 330° T, 37-foot high waves from 330° T, and a 30-foot high swell from

050° T. Although the roll angle was not reported at that time, the drillship had reported 15° rolls for most of the day, and at 2210 the Chinese radio operator aboard the GLOMAR JAVA SEA reported that the "waves are beating on the deck which sounds like thunder." At 2341, when the 15° starboard list was reported, the Safety Board's weather hindcast indicates the winds had increased to 60 kns from 330° T with 38-foot waves but the swell from 050° T had decreased to about 10 feet as the storm passed near Hainan Island. (See figure 2.) These storm conditions alone would not have produced the 15° list reported at 2341. Between 2100 and 2355 on October 25, the wind was blowing over the bow of the drillship and would have produced an insignificant heeling moment. The swell coming from 70° off the starboard bow would have produced a port list in addition to the 15° roll but the swell decreased from about 30 feet at 2100 to about 10 feet at 2355 with a corresponding decrease in energy. Thus, the port list caused by the swell at 2100 should have been greater than the port list at 2341, and the 15° list reported at 2341 was not caused by the swell.

Weight Shift.--To compensate for some asymmetrical cargo weight, drillwater tanks No. 3 starboard double bottom and the No. 6 starboard wing were empty while the corresponding port tanks were full. In addition, several other starboard wing tanks were empty. If the engineer on watch had inadvertently shifted liquids from port to starboard, this shift could have caused the reported 15° list, but he should have been immediately aware of his error by watching the clinometers in the engineroom, even with the drillship rolling 15°. However, the 2341 MARISAT conversation indicated that the engineers could not determine the cause of the problem.

Since the drillship was reported rolling 15° under the sea conditions, it is possible that some cargo broke loose, such as the drill pipe, causing the reported 15° list. However, the roll angle should have decreased as the swell decreased between 2100 and 2341 and the chance of cargo breaking loose also should have decreased. The location of the drill pipe on the sea bottom to the southwest of the well location indicates that the drill pipe broke loose after the drillship capsized. The GLOMAR JAVA SEA's anchor system provided a damper to the vessel's roll motion. If the drillship's port anchors either had dragged or broken, the vessel would have rolled more to starboard than to port, and appeared to the crew as a starboard list. However, the assistant rig manager did not report any broken chains when he called Houston at 2341, and during the diving surveys after the accident, the anchors were found to be in position.

Asymmetrical Flooding.--Stability calculations performed after the accident showed that if the empty starboard drillwater wing tank No. 6 and the empty starboard fuel oil tank No. 7 had been flooded by sea water, the GLOMAR JAVA SEA would have taken on about a 15° list. Even with only one tank flooded, the drillship would have experienced about a 6° list. With the waves crashing on deck from the starboard side, it is possible the air vent to one or both of these tanks was fractured and the tank(s) began taking on water. Since the drillship was rolling 15°, the crew may not have noticed the list immediately but as the vessel heeled, the water would have entered the tank(s) faster. At 2341, the swell had subsided but the list would have increased so that the 10-foot waves still would have been crashing on deck, and the deck edge would have been submerged at about 11° list. Further flooding then could have occurred through deck openings, such as the vent to the machinery spaces and the drillship would have capsized and sunk. However, during the March survey, the air vent to starboard drill water wing tank No. 6 was found undamaged; while the starboard fuel oil wing tank No. 7 air vent was damaged when the large transverse fracture on the starboard side occurred. Moreover, the engineer on watch should have become aware of a list from flooding through a small opening, such as an air vent, by observing the clinometers and should have taken some

action to determine the cause of the list before 15° was reached. Although there were no remote reading gauges in the engineroom, the engineer if he determined there was a permanent list could have taken suction on the empty starboard tanks to determine if there was any flooding. The drillship had sufficient pumping capacity to dewater any tank that was flooding through a small opening, such as a vent. However, soundings of the tanks to determine the liquid level would have had to have been taken by crewmembers through the main deck sounding tubes which would have been extremely difficult and dangerous with the waves washing on deck. Therefore, the Safety Board believes that Global Marine should install remote gauging devices in the enginerooms on all its drillships to provide constant monitoring of tank levels and an immediate indication of any liquid level change in the tanks due to damage or during severe weather conditions. The remote gauging devices would also facilitate day-to-day liquid movements.

An underwater videotape survey of the wreck performed shortly after the accident showed a 40-foot-long transverse fracture in the starboard side and a separate longitudinal fracture in the deck plating of wing tanks Nos. 6 and 7. If the large transverse fracture occurred while the vessel was afloat on the surface, starboard wing tanks Nos. 6 and 7 would have flooded and could account for the undetermined 15° list reported at 2341 since the drillship's pumps would not have been able to overcome the subsequent rate of flooding. The Safety Board examined a number of factors which could have caused this fracture. A review of the videotapes did not show any evidence of an external explosion. Thus, sabotage by outside interests or a stray mine that had come adrift was ruled out. Because the hull plating was deformed inwardly, a deliberate or accidental internal explosion also was rejected. A deliberate ramming or accidental collision by another vessel was considered. The fracture showed no evidence of a collision with a steel vessel, and no vessel was reported as being in the area at the time of the accident. However, a wooden vessel such as a fishing vessel could have hit the GLOMAR JAVA SEA during the storm. The sharp blow of the wooden vessel striking the drillship could have initiated the fracture while not leaving any visible damage to the hull. However, the likelihood of a wooden vessel operating near the GLOMAR JAVA SEA during Typhoon LEX is remote.

The longitudinal fracture about 5 feet long and 8 inches wide in the main deck where the forward starboard leg of the derrick connected into the bulkhead at frame 91 also could account for the 15° list reported at 2341. The fracture was large enough to lead to rapid flooding of starboard wing tanks Nos. 6 and 7 with the waves washing over the deck. As the vessel heeled, the rate of flooding would have increased, and the drillship's pumps probably could not have kept up with the flooding. The fracture could have occurred before or after the vessel capsized.

Structural Failure

The metallurgical analysis of the transverse fracture near frame 91 (see figure 10) and the shell plating adjacent to the fracture showed no preexisting fractures or defects in the two fracture origin areas. Therefore, the two fractures probably were not the result of any local corrosion fatigue or material defect, but probably were caused by a high tensile stress in the material. The shell plating had a yield strength about twice the load stress calculated by the ABS, and the motion and load calculations performed by the ABS showed moderate stress levels in the shell plating of the GLOMAR JAVA SEA under the assumed severe sea conditions. Thus, while moored, the drillship should have been able to withstand the bending and twisting of its hull due to the wind waves and swell it experienced on October 25, 1983, based on its structural strength.

The GLOMAR JAVA SEA experienced damage on its port side from supply vessels offloading cargo on two different occasions, in January and August 1983. The USCG inspector and the ABS surveyor who inspected the drillship in October 1983 agreed that the temporary repairs were sufficient until the GLOMAR JAVA SEA's next required drydocking. Because the drillship listed to starboard and the evidence indicates that the damage on the port side of the wreck was not related to the earlier damage caused by the supply vessels, the Safety Board believes this damage did not contribute to the accident.

The 5-foot longitudinal fracture near frame 91 at the connection of the derrick substructure with the main deck plating could have been the result of the dynamic stresses in the deck caused by the motion of the derrick. However, calculations showed that the stresses in the main deck plating at the connection with the derrick substructure were small, even with the vessel rolling 40°. Therefore, this fracture probably occurred when the derrick hit the bottom of the ocean as the vessel was sinking.

The sudden capsizing and sinking of the GLOMAR JAVA SEA suggests that a structural failure might have occurred while the drillship was on the surface. Fracture "A," initiated about 8 feet below the main deck in the 1 3/8-inch thick side shell plating, may also have occurred as a result of an impact load or secondary or tertiary stresses near frame 91. A large log, a wooden boat, or other wooden debris of substantial mass could have caused fracture "A" if it had been thrown against the side of the drillship by the swell. A wooden object would not necessarily leave any evidence of impact on the shell plating. The forces associated with wave impact also may have raised the localized stress level sufficiently to cause fracture "A."

The location and orientation of the debris on the bottom leads to the conclusion that the starboard bow moorings broke before the vessel capsized, thus allowing it to turn broadside to the seas and drift southwest to a location above the debris before capsizing. If the side shell had fractured as a result of wave impact while the vessel was afloat, it is likely that the two fracture surfaces would have struck each other repeatedly as a result of the vessel working in the seas, at least in those areas where the surfaces were close together. Also, if a series of waves struck the GLOMAR JAVA SEA's side shell with sufficient force to cause the damage observed at bulkhead 91, it is likely that the bulwark would have shown extensive damage. The fracture surfaces did not show evidence of striking each other, and the bulwark at frame 91 did not show extensive damage, indicating that the fracture probably did not occur from wave impact while the vessel was afloat. Accordingly, the Board believes that fracture "A" and the damage at starboard wing tanks Nos. 6 and 7 probably resulted from hydrostatic pressure after the vessel sank.

Since the 15° list did not result from the fracture at bulkhead 91 on the starboard side, its cause cannot be determined with certainty. The list might have been caused by a shift of drill pipe and/or casing, or intentional or unintentional flooding of other spaces. In either case, the crew should have been aware of the cause — a shift of drill pipe would have been accompanied by significant noise, and a gradual flooding of intact spaces should have led to the recognition of the list and the search for its cause long before the list reached the magnitude of 15°. Regardless of the cause of the list, the list would have made the vessel more vulnerable to capsizing to starboard as it rolled in the heavy seas. The Board believes that the vessel capsized to starboard as a result of severe rolling while experiencing a 15° list in the heavy seas.

Metallurgical Tests

The drop weight tests indicated that coupon 3 had a superior resistance to brittle fracture when compared to coupon 5. The Charpy tests indicated the reverse. However,

both tests suggested that the hull plate pieces had sufficient resistance to brittle failure under the loads calculated to have been imposed on the drillship on October 25. Although the steel used in the GLOMAR JAVA SEA was not required by ABS to meet any Charpy V-notch testing standard, coupon 3, under the present rules, would not have met the minimum toughness requirement of 20-foot-pounds at 32° F for steel over 1-inch thick.

Stability and Loading

A weight study conducted after the accident showed that the GLOMAR JAVA SEA as loaded on October 25, 1983, had a mean draft of 19 feet 4 inches, which was less than its maximum allowable draft of 21 feet 1/4 inch and indicated that the vessel was not overloaded. The stability calculations conducted after the accident showed that the GLOMAR JAVA SEA met all intact and damage stability standards required by ABS and USCG. However, calculations performed in connection with this investigation indicate that there are several areas where the safety of similar drillships could be improved regarding stability and loading and these will be discussed below.

Under current USCG, ABS, and IMO standards, drillships similar to the GLOMAR JAVA SEA are required to be designed to withstand the accidental flooding of one wing tank. Calculations showed that the flooding of both starboard wing tanks Nos. 6 and 7 could have led to the capsizing and sinking of the drillship. If the GLOMAR JAVA SEA had been designed to withstand the flooding of two wing tanks or if an operational restriction had been placed on the vessel not to have two adjacent wing tanks empty, such a situation could not occur. There is a need for the USCG, the ABS, and the IMO to revise their stability standard for drillships to require drillships to withstand the flooding of two adjacent wing tanks.

Neither the operating manual approved by the ABS or the USCG gave the master of the GLOMAR JAVA SEA any guidance on the degree of survivability 33/ to which the drillship was designed. If the master had known that the GLOMAR JAVA SEA was designed only to withstand the flooding of one wing tank, he might not have permitted the chief engineer to have two adjacent wing tanks empty. The ABS no longer approves operating manuals and states that this is the responsibility of the owner. The Safety Board believes that the USCG should insure that the operating manuals of all MODU's contain information on the degree of survivability from flooding and that Global Marine should revise its existing operating manuals to include this information. Global Marine also should make it a policy that adjacent wing tanks on drillships not be empty.

Testimony from alternate masters and engineers indicate that the responsibility for loading the GLOMAR JAVA SEA was split between the drilling superintendent, the master, and the engineers. The drilling superintendent was responsible for supplies, such as drill pipe and drill water for the drilling operation. The master was responsible for completing a stability calculation on each tour, and the engineers were responsible for keeping the drillship level and providing the master with tank soundings once a week prior to the supply vessel delivery. One master testified that he would not find out what supplies were to be put on board the drillship until the supply vessel arrived and that sometimes all the cargo could not be offloaded at one time without overloading the drillship. The loading and distribution of weights on a drillship is critical to the safe operation of the vessel. Global Marine should designate one person to be responsible

33/ Survivability indicates how many tanks or compartments can be flooded without the drillship capsizing or sinking.

for the ordering, loading, and distribution of fuel and supplies and that person should be the master. Global Marine had made the master of the GLOMAR JAVA SEA responsible for maintaining the stability of the vessel at a safe level, but the master was not consulted as to what supplies could be loaded safely. Furthermore, the engineer routinely transferred liquids at the request of the driller without consulting the master concerning the safety of the vessel.

Survival Factors

The Safety Board considered a number of factors which may have contributed to the large loss of life including: (1) the decision by ARCO and Global Marine not to evacuate nonessential personnel; (2) the decision by ARCO and Global Marine to keep the GLOMAR JAVA SEA anchored; (3) the lack of an ARCO contingency plan; and (4) ARCO's radio procedures in Zhanjiang.

The typhoon plan for the GLOMAR JAVA SEA clearly states that when the typhoon center was 1,000 miles away all nonessential personnel were to be put ashore. When the METEO weather reporting service issued its forecast at 1630 on October 22 that the tropical depression had been upgraded to a tropical storm and was moving west-northwest toward the GLOMAR JAVA SEA, the storm was less than 500 miles away. Various witnesses testified that Typhoon LEX was only a tropical storm and not a typhoon (over 64-kn winds); however, the ARCO supervisor and Global Marine superintendent began the process of securing the well in accordance with the typhoon plan. This process was completed at 1015 on October 23, but the evacuation of nonessential personnel was never instituted. Under the terms of the drilling contract between ARCO and Global Marine ARCO was required to pay Global Marine about $40,000 for each day whether drilling or secured for weather. The evacuation of personnel to shoreside facilities would delay the resumption of drilling operations and increase the cost to ARCO. Although, METEO never declared LEX a typhoon, the Safety Board believes that ARCO and Global Marine should have implemented their typhoon plan completely on the basis of the tropical storm warning by METEO. The Joint Typhoon Warning Center did classify LEX as a typhoon at 1400 on October 25 but neither ARCO nor Global Marine was aware of the JTWC classification. Typhoons, hurricanes, and other storms with winds of over 64 kn normally develop over a period of time from less severe storms. (See figure 8.) The purpose of the typhoon plan was to provide adequate time for the crew of the GLOMAR JAVA SEA to prepare the vessel for a severe storm and to evacuate personnel.

While ARCO and Global Marine acted quickly to protect their drilling equipment from the possible effects of the storm, they appear to have hesitated to evacuate crewmembers. The alternate master testified that about a month or two before the accident, nonessential personnel had been evacuated in preparation for a storm but the storm turned northward and did not pass near the GLOMAR JAVA SEA. On October 23, there was no impediment to beginning to evacuate nonessential personnel at any time after about 1015 when the marine riser was brought on deck. The 1030 METEO forecast indicated that LEX would pass within 100 nautical miles of the GLOMAR JAVA SEA, and that forecast alone should have provided sufficient impetus to begin the evacuation. The onscene evaluation of when to begin the evacuation should have included consideration of the existing weather conditions and vessel motions at the drilling site, the forecasts pertaining to LEX, and the uncertainty of the ultimate track and strength of the storm, so that the evacuation could be completed before the conditions deteriorated sufficiently to make evacuation dangerous.

Although the master had the final authority to order evacuation, several crewmembers and management personnel testified that this was normally a joint decision of the ARCO supervisor, the Global Marine drilling superintendent, and the master, who normally served in an advisory capacity to the Global Marine drilling superintendent. Furthermore, only the ARCO supervisor had authority to order the helicopters or the supply vessel to carry out the evacuation. The Safety Board believes that the failure of ARCO and Global Marine to evacuate nonessential personnel in accordance with the typhoon plan may have resulted in the loss of many lives. The only essential personnel on the GLOMAR JAVA SEA, after the drill string had been hung off and the marine riser secured on deck, were those in the marine department and perhaps some Global Marine and ARCO supervisory personnel. The marine department would have been needed for disconnecting anchors Nos. 3 through 9, hauling in anchors Nos. 2 and 10, and for getting underway. About 55 to 65 of the 81 persons in the GLOMAR JAVA SEA crew would have been saved if the master and Global Marine and ARCO management personnel had not waited for the storm to be officially declared a typhoon before evacuating nonessential personnel. Since none of the Global Marine management personnel who testified could identify the nonessential personnel on the GLOMAR JAVA SEA, there is a need for Global Marine to better define nonessential personnel in their operating manuals to eliminate confusion as to which crewmembers should be evacuated.

The typhoon plan provided that when the typhoon center was 1,000 miles away, anchors Nos. 3, 4, 8, and 9 were to be taken in; then, anchors Nos. 5 and 7 were to be buoyed off; and finally, anchors Nos. 2 and 10 were to be picked up. This process takes several hours to carry out so it needs to be accomplished well in advance of a storm before conditions become too rough for the supply vessel to pick up the anchors. The GLOMAR JAVA SEA's motion in a seaway, like any conventional vessel, was dependent upon its heading. To minimize its motions, a conventional vessel underway will slow down in a storm and head into the wind and waves. The Safety Board believes that on October 24, with LEX heading toward the drillship, but before the seas became too rough for the supply vessel to work the anchors, anchors Nos. 3, 4, 7, 8, and 9 should have been picked up and anchors Nos. 5 and 6 buoyed. This would have permitted the master to maneuver the GLOMAR JAVA SEA to minimize its motion and would have allowed the vessel to pick up bow anchors Nos. 2 and 10 if necessary without the aid of the supply vessel. By remaining anchored with all nine anchors out, the GLOMAR JAVA SEA experienced the full force of the 30-foot swells on its starboard side, resulting in 15° rolls and waves crashing on deck. If the vessel had been free to maneuver to minimize its motions, it would have been less likely to capsize.

If the drillship had been prepared to get underway on October 24 by picking up seven of its nine anchors, the GLOMAR JAVA SEA could have sought shelter when it received the 1330 forecast on October 25 that LEX was to pass near the drillship. Since the GLOMAR JAVA SEA was capable of about 11 kns under full load, the drillship could have either attempted to seek shelter on the western side of Hainan Island about 9 to 12 hours sailing time away or sailed to the southeast away from the storm. There were no shoal areas within 150 nmi of the drillship to the southeast.

The GLOMAR JAVA SEA's typhoon plan may have been unrealistic in respect to the proximity of a storm which could trigger the decision to evacuate nonessential personnel or to disengage anchors. The typhoon plan required the drilling superintendent to begin securing the well and the drilling equipment when the storm was 1,200 miles away or about 400 nmi to the east of the Philippine Islands (see figures 2 and 8) before he knew whether the storm would turn north or enter the South China Sea. Evacuation and the letting go of anchors by the master was to be accomplished at a storm center distance of

1,000 miles, i.e., before the storm crossed the Philippines and entered the South China Sea and with the center of the storm about 3 to 4 days away from the drillship's position. Since the South China Sea is an area of many tropical storms and typhoons with a 42-percent probability during the month of October for the occurrence of a tropical cyclone but in which only few actually affect the GLOMAR JAVA SEA's operating area, the crew was reluctant to evacuate personnel and disengage anchors every time a tropical storm or typhoon entered the South China Sea. There is a need for Global Marine's management personnel in Houston to review individual drillship heavy weather plans and set realistic guidelines for the evacuation of personnel and the moving of the vessel off location due to the approach of a tropical storm, a hurricane, or a typhoon.

Although ARCO participated in the development of the GLOMAR JAVA SEA's typhoon plan, ARCO itself did not have any contingency plan in case the GLOMAR JAVA SEA or any of the Chinese supply vessels or helicopters encountered difficulties. Since ARCO controlled the drillship, the supply vessels, the helicopters, and the radio communications, it was ARCO's responsibility to develop a contingency plan for an emergency. ARCO personnel knew that Typhoon LEX was predicted to pass near the drillship during the night of October 25 yet no one, except the Chinese radio operators, remained on duty to monitor communications from the GLOMAR JAVA SEA or the NANHAI 205. No radio operator was on duty from 2300 to midnight and from 0600 to 0700, and no plan was in place for the radio operators to alert the ARCO operations manager or superintendent at their hotel had a distress message been received. Fortunately, the NHWOC office was manned as usual that night and received the message that the crew of the drillship had donned lifejackets and requesting that the ARCO operations manager be alerted. If the drillship had been able to make contact with ARCO headquarters in Zhanjiang at 2300, ARCO may have learned specific details of any problems aboard the vessel. Instead, the drillship was able to leave only a "call back" message with the Chinese radio operator in Sanya. Since ARCO is continuing its drilling operations in the South China Sea, there is a need for ARCO to develop a detailed contingency plan for its contracted MODU's and offshore supply vessels in case of an emergency. CNOOC should require ARCO and all companies conducting drilling operations to prepare and submit for review detailed contingency plans for emergencies.

Examination of the wreckage of the GLOMAR JAVA SEA and the distress message on 500 kHz on October 27 at 1307 indicates that the starboard lifeboat may have been successfully boarded and launched but not the port lifeboat. The cable laying in the starboard drums on the wreck of the GLOMAR JAVA SEA is the same amount observed by Safety Board investigators on the GLOMAR CORAL SEA when the GLOMAR CORAL SEA's lifeboats were lowered to the boat deck level. With the drillship listed 15°, embarkation and launching probably occurred near the boat deck level. Also, there was no evidence of damage to the GLOMAR JAVA SEA's starboard davit arm. In contrast, the port falls were in disarray on the drums and the port gripe pelican hooks were broken and distorted as though the port lifeboat may have been torn away from the GLOMAR JAVA SEA by the forces of the typhoon while the drillship was still on the surface or may have broken loose after the drillship capsized. The transmission of the GLOMAR JAVA SEA's call sign and a position at 1307 on October 27, 1983, could only have been sent on 500 kHz on a lifeboat radio by a person in one of the drillship's lifeboats. The GLOMAR JAVA SEA had sunk more than 36 hours before the message. Those who may have safely abandoned the drillship in the starboard lifeboat probably perished in the 20-knot winds and 7-foot seas which prevailed on October 27 and 28, 1983. Although the covered lifeboat was probably selfrighting with its hatches closed, the lifeboat probably would not right itself if it capsized with its hatches open. To rig the lifeboat radio antenna, it probably would have been necessary to open a hatch. FCC regulations required that by June 1, 1980, the

GLOMAR JAVA SEA's lifeboat radio be replaced by a lifeboat radio with an antenna that did not require the opening of a hatch. The survivors also may have opened the hatches for other reasons, not realizing the danger of capsizing if the boat took on significant amounts of water. On October 28, the accident area was searched intensely by helicopters and at 0950 an overturned lifeboat was spotted by air in a position near the position reported in the distress message. The Board believes that the overturned lifeboat probably was the GLOMAR JAVA SEA's starboard lifeboat. The port lifeboat has never been seen or recovered. Kadena RCC determined that the probability of the air search detecting a lifeboat was over 90 percent. Therefore, although there were no survivors from this accident, there probably were some survivors in the drillship's starboard lifeboat for 36 to 48 hours after the accident.

USCG lifeboat standards for drillships need to be improved. Federal regulations under which the GLOMAR JAVA SEA was certificated require sufficient lifeboat capacity on each side of the vessel for 100 percent of the persons onboard and liferafts of sufficient capacity for 50 percent of the persons on board. Similarly, SOLAS 74 requires cargo ships to have sufficient lifeboat capacity on each side of the vessel for 100 percent of the persons onboard and liferafts for 50 percent of the persons onboard. One reason for 100 percent capacity on each side is that lifeboats are designed to be launched at a maximum list of 15°. With the typhoon at its peak and the GLOMAR JAVA SEA listing 15° or more, it was probably impossible to launch the port lifeboat. Therefore, only part of the crew evacuated in the starboard lifeboat which had a maximum capacity of 64 persons. There was a crew of 81 persons aboard, and the USCG COI authorized up to 110 persons aboard while moored at the well location without any increase in lifeboat capacity above 64 per side. Since a drillship spends a large percentage of its time moored at the well location, the USCG regulations for MODU's should be amended to require 100 percent lifeboat capacity on each side at all times on drillships.

During its investigation of the sinking of the OCEAN RANGER, 34/ the Safety Board found that the large number of nonmarine persons on board MODU's when drilling makes the importance of the certificated lifeboatmen even greater than on other types of oceangoing vessels where most of the crewmembers are experienced mariners. The Safety Board found that, because the OCEAN RANGER was moored at the drilling site, there was no less of a need for certificated lifeboatmen for the liferafts. As shown by this accident and the OCEAN RANGER accident, the need for properly operated survival equipment is just as great when the MODU is moored as when it is underway. The Safety Board issued Safety Recommendation M-83-12 on February 28, 1983, recommending that the USCG:

> Provide guidance to officers-in-charge of marine inspection which relate the manning requirements for certificated lifeboatmen on a MODU to the size of the lifeboats and the number of nonmarine crew aboard a mobile offshore drilling unit and not to the mode of operation of the unit.

The USCG responded on July 20, 1983, that:

> The Coast Guard concurs with this recommendation. Policy guidance will be sent to all officers-in-charge of marine inspection directing them to require certificated lifeboatmen in accordance with 46 CFR 109.323.

34/ Op. cit., p. 51.

The Safety Board has classified Safety Recommendation M-83-12 as "Open—Acceptable Action" until such guidance has been issued.

On August 7, 1984, the USCG distributed a letter to Officer in Charge of Marine Inspection (OCMI) concerning the clarification of various USCG policies involving merchant vessel personnel. Item 23 of the letter addressed MODU lifeboatmen and reminded OCMI's that 46 CFR 109.323 is the applicable regulation to determine the number of lifeboatmen, able seamen, or licensed deck officers for lifeboats and liferafts on MODU's. Item 23 also stated that the USCG was reviewing the qualifications and examination requirements for establishing able seaman-special (MODU) and lifeboatmen (MODU) ratings and that a policy statement would follow in the near future. (As of the adoption date of this report, the policy has not been established.) The GLOMAR JAVA SEA again points to the need for adequate numbers of certificated lifeboatmen on MODU's where there is a large number of nonmarine personnel.

As a result of its investigation of the capsizing and sinking of the OCEAN RANGER with the loss of all 84 persons aboard, the Safety Board issued Safety Recommendation M-83-20 on February 28, 1983 recommending that the USCG:

> 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.

On July 20, 1983, the USCG replied:

> The Coast Guard partially concurs with this recommendation. The nature of oil exploration operations is such that offshore supply vessels routinely operate in the vicinity of mobile offshore drilling units. Offshore supply vessels typically have a low freeboard aft and can be readily used to recover persons from the water, provided that those persons are able to assist themselves. The vessels that tried to rescue the OCEAN RANGER victims were able to come close enough to toss lines to the victims but the persons in the water were unable to help themselves. If the persons in the water had been wearing exposure suits, they probably would have been capable of assisting themselves onto the rescue vessel.
>
> On February 3, 1983, the Coast Guard published a Notice of Proposed Rulemaking (48 FR 4837) which would require exposure suits for personnel on mobile offshore drilling units and other types of vessels. As pointed out in your report NTSB-MAR-83-2, the requirements would pertain to vessels operating in areas where the water temperature may fall below 60° F. There are no lifesaving appliances or survival equipment systems that can guarantee the survival of all personnel on board a vessel involved in a casualty, especially in wind and sea conditions such as those encountered by the OCEAN RANGER. However, had the proposed requirement for exposure suits been in effect at the time of the OCEAN RANGER casualty, the number of lives lost could have been significantly reduced. The standby vessel for the OCEAN RANGER, the SEAFORTH HIGHLANDER, was on scene within one hour. Therefore, the problem was not one of getting a standby

vessel on scene in a reasonable amount of time but rather one of rescuing victims who were rendered helpless by the effects of hypothermia.

We feel that the proposed regulations for exposure suits would effectively comply with the intent of this recommendation. In addition, the Coast Guard published an Advance Notice of Proposed Rulemaking for offshore supply vessels on 14 February 1983 (48 FR 6636). The proposed rules would require offshore supply vessels to be equipped with rescue boats that must be capable of taking an unconscious person on board from the sea. We believe that most of the rescue boats for offshore supply vessels will be of the inflatable or rigid-inflatable type, similar to boats now being utilized on Coast Guard cutters for rescue purpose. The only offshore supply vessels that would be exempt for the rescue boat requirement would be those that carry lifeboats or those offshore supply vessels that are designed or modified to be capable of recovering helpless persons directly from the sea.

The Safety Board has classified Safety Recommendation M-83-20 as "Open--Unacceptable Action" pending further consideration of this matter by the USCG.

Although no lives were saved by the GLOMAR JAVA SEA's standby boat, the NANHAI 205, the capsizing and sinking of the GLOMAR JAVA SEA again emphasizes the need for suitably equipped standby vessels. The USCG Advance Notice of Proposed Rulemaking of February 14, 1983, addresses U.S. offshore supply vessels but would not be applicable to the NANHAI 205 which was a PRC vessel. Canada, Norway, and the United Kingdom all require a standby boat for MODU's operating off their coasts. Since standby boats are already an integral part of drilling operations of a mobile MODU, both the USCG and the CNOOC should require that a suitable vessel, properly equipped for ocean rescue, be assigned to all MODU's when moored over a drill site.

Moreover, standby vessels should use their radar and all available radio equipment to keep in contact with the drillship and shoreside facilities during periods of severe weather or limited visibility. The NANHAI 205 was not using its radar and turned off its SSB radio around 2315 on October 25, 1983, leaving only its VHF radio for communication. Had the NANHAI 205 maintained a radio watch on its SSB radio, the NANHAI 205 might have been alerted earlier of the lack of radio communication between shoreside facilities and the GLOMAR JAVA SEA. If shoreside ARCO personnel had been able to contact the NANHAI 205 sooner, they may have realized that the drillship was in trouble. Without radio contact with either vessel, the shoreside radio station did not know whether the lack of communication was due to the weather conditions or some problem aboard the vessels. Although maintaining radar contact with the GLOMAR JAVA SEA under the severe weather conditions would have been difficult, the NANHAI 205 should have attempted to keep radar contact and might thereby have been alerted sooner of the drillship's disappearance. Both ARCO and the CNOOC should require that standby boats use their radar and maintain a radio watch on all available radio equipment at night and under adverse weather conditions. This would provide an additional safeguard in the operation of both the supply vessels and the mobile offshore drilling units.

Search and Rescue Efforts

The last communication from the drillship was a MARISAT call at 2341, October 25, 1983, to Global Marine's Houston office; however, the communication was cut off at 2346 before extensive information could be exchanged. During the next 2 hours, Global Marine

made repeated attempts to regain contact with the drillship. After receiving no response, Global Marine promptly called the USCG Rescue Coordinator Center (RCC) at San Francisco reaching it about 0220 and apprised them of the drillship's situation and loss of communication. At 0357, RCC Kadena, Okinawa, was notified by USCG San Francisco. However, at 0500, it was necessary for Kadena to contact Global Marine in Houston to obtain a detailed description of the drillship, its call sign, types of radios, and radio frequencies. Even though this information was available in Houston, it took some time for Global Marine to gather the specific data on the GLOMAR JAVA SEA.

Global Marine reacted quickly in notifying the USCG of the GLOMAR JAVA SEA's situation; however, time was lost because necessary vessel information was not available to the USAF RCC in the GLOMAR JAVA SEA's operating area. The Safety Board believes that Global Marine in the PRC and ARCO China should have had a contingency plan to notify the RCC in Kadena immediately of the vessel's moored position, description, number and types of lifeboats/liferafts, radio call sign, type of radios, and operating frequencies.

When informed of the loss of communications between GLOMAR JAVA SEA and Houston shoreside facilities, the RCC at Kadena Air Base immediately went into action and issued an urgent marine information broadcast (UMIB) and attempted radio contact with the drillship through a WC-130 (military aircraft) which was already in the area. When informed at 2140 on October 26 that a commercial airliner had picked up an EPIRB distress signal in the area, Kadena began an extensive air search that eventually covered 72,000 square miles and about 240 hours of flight time. The search lasted for 10 days with as many as six U.S. aircraft in the air on a single day. Aircraft pilots flew search sorties in extremely hazardous weather conditions, both day and night, and over waters that were very unfriendly. In spite of some initial communication and language problems and difficult weather conditions, the military aircraft were able to detect strobe lights, liferafts, dye markers, and other vessel debris. The Safety Board believes that the air search conducted and coordinated by Kadena was timely, thorough, and extensive.

Global Marine in Houston established a vital, 24-hour around-the-clock communications link between RCC Kadina and ARCO China in Hong Kong, which had a direct line to ARCO Zhanjiang. Global Marine also supported the search efforts by relaying such information as sightings of debris and possible survivors. Information from the U.S. search aircraft was forwarded by way of Kadena to Houston and then to ARCO China shoreside search operations and finally to the Chinese commercial and military vessels and aircraft involved in the search and vice versa. Despite language problems and differences in radio types and operating frequencies, this communication link was the primary means of communication and effectively contributed to the coordination of the search efforts.

Despite the fact that ARCO had no shoreside contingency plan for emergency situations, ARCO China and the NHWOC responded quickly, pooled their resources, and launched a competent search and rescue effort in China. The NHWOC, with the cooperation of the China National Emergency Committee, mobilized and coordinated the participation of 22 Chinese Navy surface vessels, 3 aircraft, and the Chinese fishing fleet at Hainan Island in the search and rescue efforts in weather conditions that were severe and at times life threatening.

The Hong Kong Marine Department contributed to the effort by dispatching a vessel to join in and assist in the search for survivors. In addition, the Hong Kong Marine Department was the communication center for commercial aircraft and merchant vessels.

Both EPIRB signals were reported first to Hong Kong which, in turn, relayed this information to Kadena and ARCO China. The distress message on 500 kHz at 1307, October 27, was also reported to Hong Kong.

The Safety Board believes that ARCO China, Inc., should develop a detailed contingency plan for its continued operations off the coast of the People's Republic of China which includes communication procedures, air and sea resources, and shoreside facilities for various emergencies, including severe storms. This contingency plan should include procedures for coordination with the People's Republic of China, Hong Kong, and Kadena Air Force Base, Japan.

ARCO's office in Zhanjiang was its base of operations in the PRC and was staffed by ARCO's operations manager, drilling superintendent, logistics manager, chief geophysicist, interpreter, three Chinese-speaking radio operators, and others. It was ARCO's usual daily working procedure to have no one in the office on duty from 1730 at night until 0700 in the morning except the radio operator, and according to the radio operator's working shift arrangement, there was no radio operator required on duty from 0600 to 0700 and from 2300 to midnight. The lack of a radio operator at ARCO's office from 2300 to 2330 on October 25 may have prevented vital information concerning the condition and the safety of the GLOMAR JAVA SEA from being transmitted ashore to key ARCO personnel.

ARCO's Zhanjiang office also was the hub of control and communications in the ARCO China operations network. ARCO Zhanjiang could communicate via SSB radio with the drillship, the supply vessels, the helicopters, and Tian Du Base at Sanya; by telephone to the local office of the NHWOC; and directly to ARCO's office in Hong Kong. The availability of communications for emergency situations is an essential element of a shoreside contingency plan. Inadequate communications procedures, such as the absence of a continuous radio watch in Zhanjiang and the lack of a shoreside contingency plan, allowed confusion as to whether the drillship had moved off location, had experienced a casualty, had sunk, or simply had lost radio contact for about 42 hours until the wreck of the GLOMAR JAVA SEA was located and identified by fathometer survey. Since radio contact had not been established between ARCO and the drillship at 2300, the assumption the next morning by ARCO was that the GLOMAR JAVA SEA had dropped its anchors and moved off location when the NANHAI 205 found the drillship's anchor buoys. To insure timely notification of shoreside ARCO management personnel in case of an emergency offshore, it is essential that ARCO maintain a 24-hour radio watch in its Zhanjiang office.

ARCO's SSB radio working frequency of 6521.8 kHz was assigned by the PRC. ARCO, in its everyday radio communications, did not monitor the high-frequency international calling and distress radio frequencies of either 2182 kHz or 8364 kHz of which their SSB units were capable. Even though the GLOMAR JAVA SEA and other vessels on the PRC's outer continental shelf carried equipment which would broadcast signals on the international calling and distress frequencies in the event of an emergency, neither ARCO nor the NHWOC maintained any radio listening watch on these frequencies. Therefore, had the GLOMAR JAVA SEA or one of its lifeboats sent out a distress radio signal on these frequencies, neither the ARCO radios nor the NHWOC radios would have received the transmissions. The frequency 500 kHz in the medium frequency band also is an international calling and distress radio frequency. Its use is for keyed, Morse Code radiotelegraphic communications only. The Safety Board believes that the CNOOC should establish emergency response centers at Tian Du, Zhanjiang, Guangzhou, and other centers of offshore oil operations which would maintain an around-the-clock listening watch on the international maritime distress frequencies of 2182 kHz and 8364 kHz inaddition to the designated operating frequencies and in time of emergencies would

coordinate the activities of air and sea rescue resources and shoreside rescue centers. In addition, ARCO China should consult with the PRC on maintaining a 24-hour listening watch on 2182 kHz and 8364 kHz.

The MARISAT communication system has a distress signal transmission capability. However, the rolling and starboard list of the drillship may have precluded the drillship's satellite antenna from maintaining a lock on the Pacific communication satellite. Once the lock was lost, it would have been difficult and taken some time to reestablish communications via MARISAT. Therefore, when the MARISAT communication to Houston was cut off at 2346, the crew aboard the GLOMAR JAVA SEA probably also lost the capability of transmitting a distress signal via MARISAT. The lack of any facilities to receive a distress message from the drillship, indicates a need for action to improve emergency radio procedures for vessel's operating in the South China Sea by both the drilling companies and the CNOOC.

A radiotelegraphic distress transmission on 500 kHz (apparently from the GLOMAR JAVA SEA's lifeboat) was received on a passing cargo vessel at 1307 on October 27. Current regulations require a portable emergency radio only on one lifeboat on each vessel; however, most seagoing vessels have more than one lifeboat installed. Since lifeboats can become separated when a vessel is abandoned in severe weather and since lifeboat radios are not designed for operation in inflatable liferafts, the Safety Board believes that each lifeboat and each inflatable liferaft should be equipped with a device, such as an EPIRB, to transmit distress signals automatically. An EPIRB would provide a means of detection by commercial aircraft or military aircraft which do not normally monitor the radio frequencies on which lifeboat radios transmit. Revisions to Chapters III and IV of SOLAS 74, which become effective July 1, 1986, include regulations requiring each survival craft to be provided with a manually activated survival craft EPIRB and a two-way radiotelephone unit and the general design requirements for each. The FCC already has begun the process of implementing the revisions to Chapter IV by proposing new FCC rules for the general design requirements for a manually activated EPIRB on survival craft and a two-way radiotelephone unit. However, the USCG has not yet issued any proposed rulemaking to implement Chapter III or to apply the EPIRB requirements to U.S. vessels in domestic trade. The USCG should require EPIRB's on all U.S. survival craft as soon as possible.

Drillship Manning and Crew Qualifications

Vessels engaged in offshore oil exploration, collectively designated MODU's, are divided into three major categories: self-elevating rigs--vessels which utilize bottom bearing legs to raise their hull above the surface of the sea; column stabilized rigs--vessels supported by columns on submerged buoyant lower hulls; and drillships, or drill barges--vessels with conventional hulls. Self-elevating rigs and drill barges have to be towed from location to location, drillships are self-propelled vessels, and column stabilized rigs can be either self-propelled or non-selfpropelled. All these vessels are considered vessels in navigation, except self-elevating rigs when fully elevated above the sea surface and, thus, are subject to the USCG manning and crew qualification laws and regulations. Since 1976, the Safety Board has investigated two other major marine accidents with a large loss of life involving vessels engaged in offshore oil exploration. On April 15, 1976, the self-elevating rig OCEAN EXPRESS 35/ capsized and sank with the loss of 13 lives, and on February 15, 1982, the column-stabilized OCEAN RANGER 36/ capsized and sank with the loss of 84 lives.

35/ Op. cit., p. 51.
36/ Op. cit., p. 51.

In 1978, the USCG published regulations for the inspection and certification of mobile offshore drilling units. However, it has not included personnel qualifications or manning standards for MODU's in the regulations, except to specify the number and qualifications of lifeboatmen required to man primary lifesaving equipment and to require that the owner must designate an individual to be the master or person-in-charge of a MODU. As a result of its investigation of the capsizing and sinking of the OCEAN EXPRESS, the Safety Board issued Safety Recommendation M-79-43 on April 17, 1979, recommending that the USCG:

> Expedite the promulgation of regulations for personnel qualifications and manning standards for self-elevating mobil offshore drilling units, and require that industrial personnel who perform seafaring duties obtain appropriate training and licenses.

On June 4, 1980, the USCG responded as follows:

> The Coast Guard partially concurs with the recommendation. Manning and crew qualification standards are being applied to MODU's of the "bottom bearing" non-self-propelled type (such as the OCEAN EXPRESS) as these units come under the inspection process under 46 CFR I-A in the next several years. Manning standards will apply only when such units are in navigation. At this point it is contemplated that the standard manning for marine personnel, while in navigation, will consist of:
>
> 1 - Designated Person in Charge
> 2 - Able Seaman
> 1 - Ordinary Seaman
> -- Lifeboatman (number appropriate for the installed lifesaving equipment necessary to accommodate the number of persons on board).
>
> Development of requirements for personnel on structures and MODU's not in navigation is being developed under the authority of the OCS [Outer Continental Shelf] Act. The Coast Guard believes that the OCS Act places limitations on the Coast Guard's ability to carry out the intent of this recommendation while the unit is in the bottom bearing mode. The OCS Act is applicable only to those activities on the United States Outer Continental Shelf. Accordingly, the application of a manning scale on units engaged in worldwide operations while in the bottom bearing mode is not possible under the provisions of the OCS Act.

On June 9, 1981, the USCG further replied:

> We have attached an IMCO [International Maritime Consultative Organization] document entitled "Training Qualifications of Crews Serving on Mobile Offshore Units" (STW XIV/WP.4) dated 21 January 1981 (Enclosure (2)). This document deals with a variety of considerations affecting units such as the OCEAN EXPRESS. Various duties/training qualifications of the person-in-charge and other persons are covered. The working group preparing the document did not stipulate whether the person-in-charge should be drawn from seafarer or regularly assigned special personnel with responsibility for others

(Appendix II, 3 and 4). This recognizes reality in that a mobile unit such as the OCEAN EXPRESS is a complex mixture of both industrial and marine considerations. The Coast Guard is of a similar opinion and believes a person qualified under either category could function in the position. Although this document is currently a working paper, it is scheduled to be formally reviewed at the 15th session of the Subcommittee on Standards of Training and Watchkeeping scheduled for February 1982. Due to the inherent limitations of the OCS Lands Act and the restrictions of the domestic statutes concerning vessel inspection and manning, the international agreement method appears the most viable initial approach. Although the resulting domestic regulations may be somewhat fragmented (due to the diverse statutory authority) and lacking when considering a bottom bearing unit on a foreign assignment, a foreign country which subscribes to the resolution could fill in this gap.

Insofar as the imposition of additional manning regulations specifically for MODU's, this appears to be generally unwarranted. Presently 46 CFR 157.20-15 addresses the Able Seaman/Ordinary Seaman question. The person-in-charge qualifications would be best delayed pending international action. As the STW working paper is almost a direct copy of a position paper presented at the 14th session of the STW in January 1981 by the International Association of Drilling Contractors (IADC), it can be reasonably assumed the industry will initiate compliance. Further, the MODU initial inspection program should be completed during the late summer or early fall of 1981, utilizing the manning scale noted in our letter of 4 June 1980.

The only statement in STW XIV/WP.4 concerning personnel qualifications and manning standards, other than emergency procedures and on board training for group survival states:

> 3. RESPONSIBILITIES OF PERSON IN CHARGE CONCERNING MARITIME SAFETY TRAINING
>
> 3.1 The person in charge should be well acquainted with the characteristics, capabilities and limitations of the unit. This person should be fully cognizant of his responsibilities for emergency organization and action, for conducting emergency drills and training, and for keeping records of such drills.
>
> 3.2 The person in charge, or persons delegated by him, should possess the capability to operate and maintain on board the unit all fire-fighting equipment and life-saving appliances and be able to train others in these activities.

As a result of its investigation of the capsizing and sinking of the OCEAN RANGER, the Safety Board on February 28, 1983, issued Safety Recommendation M-83-8 to supersede Safety Recommendation M-79-43 and to call for similar regulations covering all types of MODUs. Safety Recommendation M-83-8 recommended that the USCG:

> Expedite the promulgation of regulations regarding personnel qualifications and manning standards for mobile offshore drilling units.

In a letter dated July 20, 1983, the USCG stated that:

> The Coast Guard concurs with this recommendation. The licensing qualifications and examination requirements for masters, mates, chief engineers, and assistant engineers on mobile offshore units, which include mobile offshore drilling units, are part of a major regulatory revision project of 46 CFR Part 10. The Notice of Proposed Rulemaking is undergoing the final clearance process and is expected to be published shortly.

The Safety Board has classified Safety Recommendation M-83-8 as "Open--Unacceptable Action" pending further response from the USCG.

The Safety Board also issued Safety Recommendation M-83-9 on February 28, 1983:

> Require that the master and the person-in-charge of a mobile offshore drilling unit be licensed and that their licenses be endorsed as qualified in mobile offshore drilling operations, including knowledge of U.S. Coast Guard regulations, stability characteristics of mobile offshore drilling units, the operation of ballast systems on mobile offshore drilling units, and the use of lifesaving equipment peculiar to mobile offshore drilling units.

In response to Safety Recommendation M-83-9, the USCG stated that:

> The Coast Guard concurs with this recommendation. The Coast Guard is initiating a regulatory project to revise 46 CFR Subchapter I-A. As part of this project, 46 CFR 107.111 will be revised to indicate that the master of mobile offshore units (which includes mobile offshore drilling units) shall be the person-in-charge. All mobile offshore units will be required to have a licensed master, either as a master of mobile offshore units or a conventional master's license. Included in the 46 CFR Part 10 revision is a list of examination topics for a license as a master of mobile offshore units. This list includes all of the subjects mentioned in this recommendation. The need to endorse a conventional master's license has not been addressed in this regulatory proposal since the conventional master ocean licenses qualify a person to serve on mobile offshore units without further endorsement because of the similarity in examination topics and more extensive seagoing experience required for the conventional master's license. While we recognize that the industrial licensed masters must be familiar with unique equipment and operating conditions, it is our opinion and experience that the conventional masters will acquaint themselves with such equipment and conditions just as masters presently do with different types of cargo, freight or tank vessels. To emphasize this fact, a paragraph has been added to the revision of 46 CFR Part 10 which reads as follows: "With few exceptions, these regulations do not specify or restrict licenses to particular types of service such as tankships, freight vessels, or passenger vessels. However, it is incumbent on every licensed officer to become familiar with all unique characteristics of each vessel served upon as soon as possible after reporting aboard for duty. As appropriate for a deck or engineer license, this includes, but is not limited to: maneuvering characteristics of the vessel; proper operation of the

installed navigation equipment; firefighting and lifesaving equipment; stability and loading characteristics; and main propulsion and auxiliary machinery.

The Safety Board has classified Safety Recommendation M-83-9 as "Open--Acceptable Action."

On August 8, 1983, the USCG published an NPRM to amend the regulations dealing with the licensing of merchant marine officers. Although the NPRM addressed the Safety Board's recommendations regarding personnel qualification standards in Safety Recommendations M-83-8 and -9, the NPRM did not address manning standards other than that the master shall be in charge. Moreover, the USCG is planning to issue a revised NPRM sometime in 1985 which will delay the actual promulgation of MODU personnel qualification standards. The capsizing and sinking of the OCEAN EXPRESS, a self-elevating MODU, the OCEAN RANGER, a column-stabilized MODU, and the drillship GLOMAR JAVA SEA all involved matters putatively under the cognizance of mariners and not industrial personnel. The Safety Board believes that the USCG has delayed too long the promulgation of MODU personnel qualification and manning standards and reiterates recommendations M-83-8 and -9. The MODU license personnel qualification standards proposed in the August 1983 NPRM dealing with licensing generally are now scheduled to be revised at a date in the indefinite future. In view of the demonstrated problem and since the USCG has not yet addressed MODU manning standards, the Safety Board believes that the Secretary of Transportation should direct the USCG to promulgate MODU personnel qualification and manning standards as matter of urgent priority.

The USCG Certificate of Inspection for the GLOMAR JAVA SEA stated that while moored the marine crew required was: one master, two able seamen, one ordinary seaman, one chief engineer, and two oilers. When navigating 16 hours or less between drilling locations, the marine crew is to be augmented by one chief mate, one able seaman, one first assistant engineer, and one radio operator. The complement for more than 16 hours in navigation is one master, one chief mate, one second mate, one third mate, one radio officer, four able seamen, two ordinary seamen, one chief engineer, one first assistant engineer, one second assistant engineer, one third assistant engineer, and three oilers. The GLOMAR JAVA SEA's typhoon plan stated that when a severe storm is 1,200 miles away, the master will place personnel on board to comply with the USCG manning requirements for the drillship while underway. Although some of the skills may have been covered by Chinese crewmembers, the requirements for licensed officers in addition to the drillship's normal crew of one master, one chief engineer, two third assistant engineers, and one radio operator would be difficult since Global Marine did not have any licensed officers other than the GLOMAR JAVA SEA's crew stationed in the PRC. Appropriate USCG licensed personnel would have had to be sent from the continental United States and clear PRC immigration.

The Safety Board believes that it is an unrealistic expectation that drillships will augment their manning in remote areas where typhoons or other severe storms are frequent. Providing USCG licensed officers on short notice at frequent intervals to remote locations from the United States is a difficult task. Even if the appropriate officers had been sent from the United States when Typhoon LEX first entered the South China Sea, they probably would not have reached the drillship because of the severe local weather conditions. While in this case the master of the GLOMAR JAVA SEA had the option to seek shelter near Hainan Island, Global Marine should have an additional master or chief mate on board in remote locations during seasons of severe storms to provide the master with sufficient crew to safely navigate the drillship to a safe location. Global Marine should have a contingency plan for providing additional crewmembers.

The OCEAN EXPRESS, the OCEAN RANGER, and the GLOMAR JAVA SEA accidents all occurred when there was a division of authority and responsibility in time of an emergency.

- At the time of the capsizing and sinking of the OCEAN EXPRESS, the bargemover (master) who worked for the Ocean Drilling and Exploration Company (ODECO), the owner and operator of the rig, was technically in command, but the ODECO toolpusher 37/ was the person normally in charge of the rig. The bargemover decided that there was no need to abandon the rig, but the toolpusher and the Marathon Oil Company drilling superintendent ordered the rig abandoned.

- Although there was a USCG licensed master aboard the OCEAN RANGER, the person-in-charge (toolpusher), in accordance with USCG regulations, was an unlicensed, undocumented individual who was responsible for any decision to abandon the rig. Moreover, ODECO had designated another unlicensed, undocumented individual to conduct all drills, including fire and abandon ship drills. The Mobil Oil Company drilling foreman aboard the OCEAN RANGER, who had control of the helicopter and supply vessel and not the master, maintained contact with shoreside commands during the severe storm.

- On the GLOMAR JAVA SEA, although the operating manual recommended that the typhoon plan state that the master had absolute responsibility and authority for the safety of the crew and ship, the actual typhoon plan had no such statement. The "Critical Procedures" manual stated that the master had absolute responsibility and authority for the safety of the crew and ship but went on to say that the drilling superintendent was in charge until such time as the master was of the opinion that the ship and crew was or may become endangered. The ARCO drilling supervisor had exclusive control of the helicopters and supply vessels needed in case of an evacuation.

The Safety Board recognizes that MODU operations are different from conventional vessels where the master is the person-in-charge during all operations and has both the authority and responsibility to insure his crew and vessel is safe at all times. On MODUs, the master or bargemover works for the person-in-charge, the toolpusher, or the drilling superintendent. In addition, the oil company representative controls the helicopters and supply vessels which would be used to evacuate the crew if necessary. However, these three accidents clearly show that both the USCG and the offshore oil industry need to require that qualified marine personnel be in charge of the safety of the MODU and crew at all times. The master should have the authority to stop drilling operations, evacuate crewmembers, and abandon the well site without consulting the drilling supervisor and with full cooperation of the oil company representative. In time of emergency, decisions cannot be made by a triumvirate; one person needs to be in charge and that person should be the master.

Inspections

The drydock inspection by the USCG inspector and ABS surveyor during November 1982 and the USCG inspectors and ABS surveyor's inspections during October 1983 were thorough and comprehensive. However, the USCG and the ABS could improve

37/ The industrial supervisor of drilling operations was the toolpusher.

the thoroughness of their inspections and surveys of MODU's. The USCG overseas inspection program should emphasize the use of experienced personnel to conduct inspections of MODU's in remote areas, such as the South China Sea. The USCG inspector for the GLOMAR JAVA SEA had never inspected a MODU by himself or under the supervision of an experienced USCG inspector. The use of inexperienced personnel by the USCG in remote areas should not be permitted. The overseas inspection program is not temporary. There are a significant number of U.S. MODU's operating throughout the world, and the need for overseas inspectors will continue for a long time. The Safety Board believes the USCG should take the necessary steps to improve the experience level of the inspectors utilized in the overseas inspection program.

Although the metallurgical tests and examinations of the two fractures in starboard drillwater wing tank No. 6 indicate that they could not have been anticipated by a visual inspection before the fracture, the internal examination of tanks could be improved. The investigation showed that neither the USCG nor the ABS entered starboard drillwater wing tank No. 6 during either the November 1982 drydocking or the October 1983 inspections and survey. USCG policy does not require that USCG inspectors inspect a tank unless there is an outstanding ABS survey requirement or the USCG inspector suspects some problems. With the introduction of improved exterior hull coatings, an examination of the exterior hull of a vessel may no longer be an indication of the condition of the hull plating and internal framing. However, the internal structure of saltwater ballast tanks generally is not coated. Furthermore, an examination of the external hull plating does not indicate the condition of the internal plating. Recognizing the efficacy of improved hull coatings, the USCG is proposing to increase the drydock period for vessels in salt water from 24 to 30 months and USCG regulations already permit MODU's to have a special underwater survey in lieu of drydocking.

The USCG should conduct representative inspections of nonfuel oil tanks on a vessel during a drydocking inspection or biennial inspection at least once between ABS special surveys. The USCG also should conduct representative inspections of all tanks during ABS special surveys and the number of tanks should be increased as the vessel gets older. The cost of preparing nonfuel oil tanks for inspection is considerably less than preparing fuel oil tanks, and nonfuel oil tanks are more susceptible to corrosion than fuel oil tanks.

ABS survey rules require that specific tanks be examined internally at each special survey about every 4 to 5 years but not at any intermediate surveys. With the increase in time for required drydocking and the exemption from drydockings for MODU's, the ABS should put more emphasis on internal tank inspections. The ABS should require surveyors to inspect a representative sample of nonfuel oil tanks on a vessel during drydocking between special surveys. The number of tanks inspected should be increased as the vessels get older. Whether or not required by the USCG and the ABS, Global Marine should inspect a representative sample of nonfuel oil tanks on its drillships at least once every 30 months and fuel oil tanks at least once every 5 years.

Weather Forecasts

Adequate, regular, accurate, comprehensive, and timely weather reporting and forecasting information was provided to the GLOMAR JAVA SEA and ARCO China by the PRC Meteorological Service Company at Guangzhou and the Japan Meteorological Service at Tokyo. Typhoon LEX also was monitored and reported by the Royal Observatory of Hong Kong and the U.S. Joint Typhoon Warning Center at Guam. All four organizations were in agreement as to the speed, direction, development and severity of the tropical storm which became typhoon LEX.

Typhoon LEX maintained a relentless west and west-northwestward course with a predicted track to the north of the GLOMAR JAVA SEA's position. Typhoons and hurricanes are very erratic storms with the propensity and history of abruptly altering their course and speed as typhoon LEX did during October 23 and 24. Mariners should not make decisions concerning the safety of their vessel based on long range forecasts that a tropical storm will not affect their immediate location. Tropical storms should always be considered by mariners to be a potential threat when they develop in or enter the South China Sea. Actions to protect their vessels from the effects of tropical storms must take into consideration the uncertainties of the ultimate track and force of the storm.

CONCLUSIONS

Findings

1. The GLOMAR JAVA SEA capsized and sank about 2355 on October 25, 1983.

2. Deleted.

3. Deleted.

4. Deleted.

5. The fracturing of the hull plating in starboard wing tanks Nos. 6 and 7 was not the result of any deliberate or accidental explosion.

6. The fracturing of the hull plating in starboard wing tanks Nos. 6 and 7 was not the result of any deliberate ramming or accidental collision involving a vessel.

7. The transverse structural failure within starboard wing tanks Nos. 6 and 7 was not the result of corrosion, fatigue, or any preexisting fracture or defect.

8. The transverse structural failure within starboard wing tanks Nos. 6 and 7 probably was not the result of the material being overstressed due to longitudinal bending of the drillship under the wave conditions it experienced on October 25, 1983.

9. Deleted.

10. The damage caused by offshore supply vessels during January and August 1983 to the portside of the GLOMAR JAVA SEA did not contribute to this accident.

11. The GLOMAR JAVA SEA was not overloaded and had sufficient intact stability to withstand the effects of Typhoon LEX on October 25, 1983, provided no other overturning forces were acting on the drillship.

12. Deleted.

13. A remote gauging device in the engineroom of the GLOMAR JAVA SEA would have allowed the engineer on watch to detect flooding of wing tanks Nos. 6 and 7 immediately.

14. There is a need for the masters of mobile offshore drilling units to be informed of the degree of survivability to which their unit is designed so that the master can take appropriate action in case of an emergency.

15. Maintaining the stability of Global Marine drillships at a safe level would be better assured if the masters were in overall charge of loading and the distribution of weights.

16. The designation of nonessential personnel for evacuation during severe weather should appear in the individual drillship's heavy weather plan and not be left to the discretion of the master and the Global Marine drilling superintendent.

17. Both the Peoples Republic of China weather service and the Japanese weather service provided the GLOMAR JAVA SEA and ARCO China with complete and accurate forecasts of Typhoon LEX.

18. ARCO's lack of a shoreside contingency plan with specific radio procedures during severe weather allowed confusion as to whether the GLOMAR JAVA SEA had a casualty, had moved off location, or simply had lost radio contact for about 42 hours until the wreck was identified by a fathometer survey.

19. The lack of a radio operator at the Zhanjiang offices of ARCO from 2300 to 2330 on October 25 may have prevented vital information concerning the emergency aboard the GLOMAR JAVA SEA from being received ashore.

20. If the NANHAI 205 had maintained a radio watch on its single sideband radio between 2315 on October 25 and 0620 on October 26, there would have been less confusion over whether the GLOMAR JAVA SEA had sunk, moved off location, or lost radio communication.

21. If the NANHAI 205 had attempted to maintain radar contact with the GLOMAR JAVA SEA, the NANHAI 205 may have detected the sinking of the GLOMAR JAVA SEA.

22. If ARCO China and Global Marine in China had had a contingency plan to notify the Rescue Coordination Center in Kadena, Japan, of the GLOMAR JAVA SEA's position and other pertinent information, Kadena would not have had to obtain this information from Global Marine in Houston.

23. There is a need for standby vessels suitably equipped for ocean rescue to be assigned to all mobile offshore drilling units, especially for those units, such as the GLOMAR JAVA SEA, which operate in isolated areas.

24. Had the GLOMAR JAVA SEA been equipped with sufficient lifeboats on each side of the drillship to accommodate all persons on board, the persons who went down with the ship may have been able to abandon the drillship before it sank.

25. Since lifeboats and liferafts can become separated when a vessel is abandoned in severe weather, each survival craft should be equipped with a device to transmit a distress signal.

26. The inability of ARCO and NHWOC radio operators to receive on the international calling and distress radio frequencies any distress message from the GLOMAR JAVA SEA indicates a need for improved emergency radio procedures for vessels operating in the South China Sea.

27. Although there are no survivors from the accident, it is probable that some crewmembers successfully abandoned the GLOMAR JAVA SEA in its starboard lifeboat and survived for 36 to 48 hours after the accident.

28. The GLOMAR JAVA SEA's starboard lifeboat probably capsized during the afternoon or night of October 27 or early morning of October 28 and the persons aboard died before any of the rescue airplanes or vessels could locate them.

29. Although ARCO lacked a shoreside contingency plan, ARCO managed an effective search and rescue effort for the GLOMAR JAVA SEA and its crew.

30. Global Marine made a timely notification to the U.S. Coast Guard about 1 1/2 hours after the MARISAT call from the GLOMAR JAVA SEA. The U.S. Coast Guard timely passed the information to the U.S Air Force Kadena Rescue Coordination Center, which had begun taking action by first light on October 26.

31. Global Marine ably supported ARCO's search and rescue effort by providing a 24-hour communications link in Houston between ARCO China and Kadena Rescue Coordination Center in Japan and by sending personnel immediately to China to aid in the search and rescue effort.

32. The Nanhai West Oil Company fully participated in the search and rescue effort and coordinated the efforts of the Peoples Republic of China.

33. Kadena Rescue Coordination Center conducted a timely, thorough, and extensive air search.

34. Commercial and military vessels from the Peoples Republic of China conducted an extensive search for survivors under hazardous conditions.

35. The Hong Kong Marine Department contributed to the search effort by relaying information and sending a vessel to aid in the search.

36. Action to promulgate personnel qualification and manning standards for mobile offshore drilling units is long overdue.

37. Global Marine did not have sufficient licensed personnel aboard the GLOMAR JAVA SEA or stationed in China during the typhoon season to safely operate the drillship if the vessel had to move off location and seek shelter.

38. Decisions in time of an emergency must be made by a single source of authority and cannot be vested in a triumvirate (master, drilling company supervisor, and oil company representative) as is the present practice on many mobile offshore drillings units.

39. Although the USCG inspector in October 1983 conducted a comprehensive inspection, the USCG needs to improve the experience level of inspectors sent to conduct biennial inspections of mobile offshore drilling units in foreign waters.

40. With the improvement in exterior hull coatings for protection against corrosion, the exterior inspection by USCG inspectors and ABS surveyors during drydocking may not give a true indication of the condition of the vessel's interior structure and an internal examination of representative tanks is necessary.

41. The longitudinal fracture of the main deck plating above starboard wing tanks Nos. 6 and 7 at the forward starboard leg of the derrick substructure probably occurred when the derrick hit the bottom of the ocean as the vessel was sinking.

42. The transverse structural failure within starboard wing tanks Nos. 6 and 7 probably resulted from hydrostatic pressure after the vessel sank.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the sinking of the United States drillship GLOMAR JAVA SEA during Typhoon LEX was the decision by the master, the Atlantic Richfield Company drilling supervisor, and the Global Marine drilling superintendent to maintain the drillship at anchor at the well site with all nine anchors, which subjected the vessel to the full force of the storm and allowed it to capsize to starboard as a result of severe rolling while experiencing a 15° starboard list from an undetermined cause. Contributing to the large loss of life was the failure of the master, the Atlantic Richfield Company drilling supervisor, and the Global Marine drilling superintendent to evacuate nonessential personnel from the GLOMAR JAVA SEA before the weather conditions deteriorated sufficiently to make evacuation dangerous.

RECOMMENDATIONS

As a result of its investigation, the National Transportation Safety Board reiterated the following recommendations issued to the U.S. Coast Guard on February 28, 1983, as a result of its investigation of the capsizing and sinking of the mobile offshore drilling unit OCEAN RANGER on February 15, 1982:

> Expedite the promulgation of regulations regarding personnel qualifications and manning standards for mobile offshore drilling units. (M-83-8)
>
> Require that the master and the person-in-charge of a mobile offshore drilling unit be licensed and that their licenses be endorsed as qualified in mobile offshore drilling operations, including knowledge of U.S. Coast Guard regulations, stability characteristics of mobile offshore drilling units, the operation of ballast systems on mobile offshore drilling units, and the use of lifesaving equipment peculiar to mobile offshore drilling units. (M-83-9)
>
> 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. (M-83-20)

As a result of its investigation of the GLOMAR JAVA SEA, the National Transportation Safety Board made the following recommendations:

--to the Secretary of the U.S. Department of Transportation:

Direct the Commandant of the U. S. Coast Guard to address immediately the early promulgation of personnel qualification and manning regulations for mobile offshore drilling units. (Class II, Priority Action) (M-84-48)

--to the U.S. Coast Guard:

Revise the stability standards for drillships to include the capability of drillships to survive the flooding of any two adjacent compartments or tanks located within 5 feet of the hull. (Class II, Priority Action) (M-84-49)

Urge the International Maritime Organization to amend its 1979 Code for the Construction and Equipment of Mobile Offshore Drilling Units to include the capability of drillships to survive the flooding of any two adjacent compartments or tanks located within 5 feet of the hull. (Class II, Priority Action) (M-84-50)

Require that the operating manual for a drillship include guidance on the degree of survivability to which it is designed and the appropriate countermeasures to be taken in case of flooding. (Class II, Priority Action) (M-84-51)

(A recommendation made in the original report is no longer applicable.)

Amend the U.S. Coast Guard regulations for mobile offshore drilling units (46 CFR 108.503) to require each drillship to have sufficient lifeboats on each side to accommodate all persons onboard. (Class II, Priority Action) (M-84-53)

Require as soon as possible that all U.S. Coast Guard-approved survival craft be provided with a radio device capable of transmitting a distress signal. (Class II, Priority Action) (M-84-54)

Require every inspector (or the senior inspector if more than one) assigned to inspect U.S. mobile offshore drilling units in foreign waters to have had prior experience in the inspection of mobile offshore drilling units. (Class II, Priority Action) (M-84-55)

Require that a representative sample of nonfuel oil tanks on all U.S. vessels in saltwater service be inspected internally at least once every 30 months during drydock or biennial inspections and that the sample of tanks to be inspected be increased as the vessel gets older. (Class II, Priority Action) (M-84-56)

Require that a representative sample of fuel oil tanks on all U.S. vessels in saltwater service be inspected internally at least once every 5 years during drydock or biennial inspections and that the sample of tanks to be inspected be increased as the vessel gets older. (Class II, Priority Action) (M-84-57)

--to Global Marine Drilling Company:

Designate the master as the individual in overall charge of the ordering, loading, and safe stowage of all drilling equipment, drilling supplies, and ship consumables aboard Global Marine drillships. (Class II, Priority Action) (M-84-58)

Require that shorebased rig managers of drillships operating in remote areas contact the cognizant rescue coordination center to preplan procedures for an emergency. (Class II, Priority Action) (M-84-59)

Provide sufficient licensed personnel during severe weather seasons either aboard drillships or ashore nearby to man a drillship operating in a remote area to safely move off location and seek shelter if threatened by a severe storm. (Class II, Priority Action) (M-84-60)

Review and revise all heavy weather plans for Global Marine drillships to include a specific list, by position, of nonessential personnel to be evacuated on the approach of a tropical storm, a hurricane, or a typhoon. (Class II, Priority Action) (M-84-61)

Review and revise all heavy weather plans for Global Marine drillships to include realistic distance and time guidelines for the evacuation of nonessential personnel, the disconnecting of anchors, and the moving off location on the approach of a tropical storm, a hurricane, or a typhoon, and require that the master take these safety measures when the conditions arise. (Class II, Priority Action) (M-84-62)

Review and revise the operating manuals of each Global Marine drillship to include information on its survivability in case of flooding, actions that should be taken by the master to minimize the effects of flooding, and countermeasures that should be taken by the master in case flooding has occurred. (Class II, Priority Action) (M-84-63)

To improve the survivability of drillships, direct all masters, chief engineers, and drilling superintendents that adjacent wing tanks are not to be kept empty. (Class II, Priority Action) (M-84-64)

Require representative samples of nonfuel oil tanks on drillships be inspected internally at least once every 30 months and that representative samples of fuel tanks be inspected internally at least once every 5 years. (Class II, Priority Action) (M-84-65)

Install remote gauging systems in all drillships so the engineer on watch can immediately determine the liquid level in all tanks. (Class II, Priority Action) (M-84-66)

--to ARCO China, Inc:

Develop a detailed contingency plan for operations off the coast of the People's Republic of China which includes communications procedures; an inventory of air and sea rescue resources and shoreside facilities available for various emergencies, including severe storms; and a requirement to contact the cognizant rescue coordination center to establish procedures for an emergency. (Class II, Priority Action) (M-84-67)

Maintain a continuous 24-hour radio watch in the Zhanjiang, People's Republic of China, headquarters to listen for emergency radio transmissions. (Class II, Priority Action) (M-84-68)

Consult with the People's Republic of China on maintaining a listening watch in the Zhanjiang headquarters on the international distress frequencies 2182 kHz and 8364 kHz for emergency communications to improve the safety of continuing operations off the coast of the People's Republic of China. (Class II, Priority Action) (M-84-69)

--to the China National Offshore Oil Company:

Establish emergency response centers at Tian Du, Zhanjiang, Guangzhou, and other centers of offshore oil operations which would maintain a continuous listening watch on the international maritime distress frequencies of 2182 kHz and 8364 kHz, as well as the designated operating frequencies, and in time of emergencies would coordinate activities of air and sea rescue resources and shoreside rescue centers. (Class II, Priority Action) (M-84-70)

Require all oil companies operating off the coast of the People's Republic of China to develop and submit for your review detailed contingency plans which should include communications procedures and an inventory of air and sea rescue resources and shoreside facilities available for various emergencies, including severe storms. (Class II, Priority Action) (M-84-71)

Require that a suitable vessel, capable of retrieving persons from the water under adverse conditions, be assigned to all mobile offshore drilling units operating off the coast of the People's Republic of China at all times for the purposes of evacuating personnel from the unit in an emergency. (Class II, Priority Action) (M-84-72)

Require the standby vessels for a mobile offshore drilling unit off the coast of the People's Republic of China to maintain a 24-hour radio watch on radio distress and operating frequencies and to use their radar during periods of reduced visibility to maintain contact with the mobile offshore drilling unit. (Class II, Priority Action) (M-84-73)

--to the American Bureau of Shipping:

Revise the stability criteria contained in the Rules for Building and Classing Mobile Offshore Drilling Units to include the capability of drillships to survive the flooding of any two adjacent compartments or tanks within 5 feet of the hull. (Class II, Priority Action) (M-84-74)

(A recommendation made in the original report is no longer applicable.)

Require that a representative sample of nonfuel oil tanks be inspected internally at least once every 30 months for vessels in saltwater service and that the sample of tanks to be inspected be increased as the vessel gets older. (Class II, Priority Action) (M-84-76)

—to the International Association of Drilling Contractors:

Urge that member contractors review the chain of command aboard their mobile offshore drilling units to insure that the licensed master or bargemover can effectively exercise full authority over the unit during an emergency. (Class II, Priority Action) (M-84-77)

Urge that member contractors contact the cognizant rescue coordination center to preplan procedures for an emergency involving mobile offshore drilling units in remote locations. (Class II, Priority Action) (M-84-78)

REVISED REPORT ADOPTED
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

March 3, 1987

*/ This report was revised based on the Safety Board's reply to a Petition for Reconsideration of probable cause and findings. (See appendix H.) The original report was adopted on November 14, 1984, by the following members of the National Transportation Safety Board: Jim Burnett, Chairman; Patricia A. Goldman, Vice Chairman; and G.H. Patrick Bursley, Member.

APPENDIXES

APPENDIX A

DECEASED GLOMAR JAVA SEA CREWMEMBERS

	NAME	NATIONALITY	COMPANY	POSITION	HIRED FROM	BODY IDENTIFIED OR EXCLUDED	IF IDENTIFIED, LOCATION FOUND
1)	CLARENCE E. REED	U.S.A.	ARCO			Excluded	
2)	GEORGE G. SULLIVAN	CANADIAN	ARCO			Excluded	
3)	JERRY L. MANFREDA	U.S.A.	ARCO			Identified	Boat deck passageway, midships
4)	HERMAN G. AMMS, JR.	U.S.A.	GLOBAL	DERRICKMAN		Excluded	
5)	JERALD T. BATTISTE	U.S.A.	GLOBAL	ELECTRICIAN		Identified	Boat deck, Cabin
6)	SUBE M. BRACEY	U.S.A.	GLOBAL	TOOL PUSHER		Excluded	
7)	PATRICK B. CATES	U.S.A.	GLOBAL	SS ENGINEER		Excluded	
8)	DAVID P. CLIFTON	U.S.A.	GLOBAL	TOOL PUSHER		Identified	Superstructure deck, bathroom between Cabins
9)	JAMES F. CUSICK	U.S.A.	GLOBAL	CRANE OPERATOR		Excluded	
10)	JERALD J. FLANAGAN	U.S.A.	GLOBAL	RADIO OPERATOR		Excluded	
11)	LEONARD E. GANZINOTTI	U.S.A.	GLOBAL	FLOORMAN		Identified	Poop deck lounge
12)	LA JUAN A. GILMORE	U.S.A.	GLOBAL	MEDIC		Identified	Superstructure deck, Cabin
13)	HENRY M. GITTINGS	U.S.A.	GLOBAL	STEWARD		Identified	Boat deck, Cabin
14)	JAMES K. GITTINGS	U.S.A.	GLOBAL	AB SEAMAN		Excluded	
15)	DAVID HIGGINS, JR.	U.S.A.	GLOBAL	COOK		Identified	Superstructure deck, Cabin
16)	TYRONNE HIGGINS	U.S.A.	GLOBAL	OILER		Identified	Boat deck rail/AFT davit area
17)	THOMAS J. KOPAHL	U.S.A.	GLOBAL	ASST. ENGINEER		Excluded	
18)	JOHN W. JENNINGS, JR.	U.S.A.	GLOBAL	STOREKEEPER		Identified	Boat deck, Cabin
19)	JOHN W. LAWRENCE	U.S.A.	GLOBAL	SR. STAFF ENGR.		Excluded	
20)	ROBERT M. MCCURRY	U.S.A.	GLOBAL	ASST. DERRICKMAN		Identified	Superstructure deck, Cabin
21)	KENNETH W. MYERS	U.S.A.	GLOBAL	DERRICKMAN		Excluded	
22)	DONALD J. OUELLET	U.S.A.	GLOBAL	OILER		Identified	Poop deck lounge
23)	PETER POPIEL	U.S.A.	GLOBAL	CHIEF ENGINEER		Excluded	
24)	JOHN D. PIERCE	U.S.A.	GLOBAL	ASST. DERRICKMAN		Excluded	
25)	JEWELL J. REYNOLDS	U.S.A.	GLOBAL	DRILLER		Excluded	
26)	RUSSELL E.J. REYNOLDS	U.S.A.	GLOBAL	ASST. ENGINEER		Identified	Poop deck lounge
27)	WALTER T. ROBINSON	U.S.A.	GLOBAL	ELECTRONIC TECH.		Excluded	
28)	KENNETH B. ROGERS	U.S.A.	GLOBAL	BOSUN		Identified	Poop deck lounge
29)	LAWRENCE M. SALZWEDEL	U.S.A.	GLOBAL	DRILLER		Excluded	
30)	WILLIAM R. SCHUG	U.S.A.	GLOBAL	RIG MECHANIC		Excluded	
31)	DELMAR A. SPENCER	U.S.A.	GLOBAL	SUPERINTENDENT		Excluded	
32)	GUSTAF F. SWANSON	U.S.A.	GLOBAL	CAPTAIN		Excluded	

	NAME	NATIONALITY	COMPANY	POSITION	HIRED FROM	BODY IDENTIFIED OR EXCLUDED	IF IDENTIFIED, LOCATION FOUND
33)	KEVIN C. SWANSON	U.S.A.	GLOBAL	FLOORMAN		Identified	Boat deck, Cabin
34)	MICHAEL W. THOMAS	U.S.A.	GLOBAL	CRANE OPERATOR		Identified	Boat deck, Cabin
35)	EDGAR LIM	PHILIPPINE	HALLIBURTON			Identified	Boat deck, Cabin
36)	JACOB JOO KIM CHING	SINGAPOREAN	HALLIBURTON			Identified	Poop deck lounge
37)	GARY LOOKE	AUSTRALIAN	SCHLUMBERGER			Excluded	
38)	RAYMOND D. MILLER	U.S.A.	S.S.I.			Identified	Boat deck, Cabin
39)	TONG LONG LEE	SINGAPOREAN	S.S.I.			Excluded	
40)	RICHARD E. SHOFF	U.S.A.	S.S.I.			Excluded	
41)	THOMAS J. DIXON	U.S.A.	S.S.I.			Excluded	
42)	LARRY K. MYERS	U.S.A.	DRESSER MACCOBAR			Excluded	
43)	NIGEL FURNESS	BRITISH	ANALYSTS			Excluded	
44)	CHRISTOPHER J. SLEEMAN	BRITISH	ANALYSTS			Identified	Boat deck, Cabin
45)	TIMOTHY JARVIS	BRITISH	ANALYSTS			Identified	Boat deck, Cabin
46)	TERANCE C. GREEN	BRITISH	ANALYSTS			Identified	Poop deck, lounge
47)	XU HUI	CHINESE	GLOBAL	ROUGHNECK	NIOC	Identified	Poop deck lounge
48)	WU GUO RONG	CHINESE	GLOBAL	ROUGHNECK	NIOC	Neither I or E	
49)	HUANG HONG XI	CHINESE	GLOBAL	ROUGHNECK	NIOC	Neither I or E	
50)	ZHOU SHU RONG	CHINESE	GLOBAL	ROUGHNECK	NIOC	Identified	Poop deck lounge
51)	ZHOU YAO WU	CHINESE	GLOBAL	ROUSTABOUT	NIOC	Neither I or E	
52)	ZHOU JIE FANG	CHINESE	GLOBAL	ROUSTABOUT	NIOC	Identified	Poop deck lounge
53)	ZHEN FEI CHANG	CHINESE	GLOBAL	ROUSTABOUT	NIOC	Identified	
54)	SUN CONG JIAN	CHINESE	GLOBAL	ROUSTABOUT	NIOC	Identified	
55)	LI CHENG CHANG	CHINESE	GLOBAL	ROUSTABOUT	NIOC	Identified	BOAT DECK PASSAGEWAY
56)	FENG SHAO ZHEN	CHINESE	GLOBAL	ROUSTABOUT	NIOC	Identified	~~Poop deck lounge~~
57)	HUANG YONG LIANG	CHINESE	GLOBAL	ROUSTABOUT	NIOC	Neither I or E	
58)	LIU BING GUANG	CHINESE	GLOBAL	ROUSTABOUT	NIOC	Neither I or E	
59)	ZHANG XING ZHEN	CHINESE	GLOBAL	TRAINEE ASST.DRM	NIOC	Identified	Boat deck, Cabin
60)	RUAN HUA GUANG	CHINESE	GLOBAL	INTERPRETER	NIOC	Neither I or E	
61)	GUAN JAN TIAN	CHINESE	GLOBAL	INTERPRETER	NIOC	Identified	Boat deck, Cabin
62)	WANG YO FANG	CHINESE	GLOBAL	TR. OILER	NIOC	Neither I or E	
63)	XIA JING SHENG	CHINESE	GLOBAL	ORD.SEAMAN	NIOC	Identified	Boat deck, Cabin
64)	ZHANG YI HUA	CHINESE	GLOBAL	ORD.SEAMAN	NIOC	Neither I or E	

	NAME	NATIONALITY	COMPANY	POSITION	HIRED FROM	BODY IDENTIFIED OR EXCLUDED	IF IDENTIFIED, LOCATION FOUND
65)	CHEN WEI	CHINESE	GLOBAL	TR. WELDER	NHOC	Identified	Boat deck, Cabin
66)	TANG GUO DONG	CHINESE	GLOBAL	RADIO OPER.	CNOJS	Neither I or E	
67)	WANG ZIANG	CHINESE	GLOBAL	RADIO OPER.	CNOJS	Neither I or E	
68)	MO TIAN XIE	CHINESE	GLOBAL	COOK	CNOJS , GZBC	Identified	Boat deck, Cabin
69)	LI SUAN QIU	CHINESE	GLOBAL	COOK	CNOJS , GZBC	Identified	Main deck, Steward's Stores
70)	XING XING	CHINESE	GLOBAL	UTILITY	CNOJS , GZBC	Neither I or E	
71)	HUANG RUI WEN	CHINESE	GLOBAL	UTILITY	CNOJS , GZBC	Neither I or E	
72)	CHEN XIONG	CHINESE	GLOBAL	UTILITY	CNOJS , GZBC	Neither I or E	
73)	MO XUE YI	CHINESE	GLOBAL	UTILITY	CNOJS , GZBC	Neither I or E	
74)	CHENG SHU GUO	CHINESE	GLOBAL	UTILITY	CNOJS , GZBC	Neither I or E	
75)	LIANG ZHEN JUN	CHINESE	HALLIBURTON		NHOC	Neither I or E	
76)	XU MING RUI	CHINESE	SCHLUMBERGER		CPL/DA Coop	Neither I or E	
77)	ZHU DA HUAI	CHINESE	S.S.I.		CNOJS , GZBC	Neither I or E	
78)	HUANG DONG CAI	CHINESE	S.S.I.		CNOJS , GZBC	Neither I or E	
79)	KONG FAN XIANG	CHINESE	S.S.I.		CNOJS , GZBC	Neither I or E	
80)	LIA GUO ZHEN	CHINESE	ARCO			Neither I or E	
81)	LIN JIE FENG	CHINESE	ARCO			Neither I or E	

NHOC - NANHAI WEST OIL CORPORATION
CNOJSC - CHINA NANHAI OIL JOINT SERVICE CORP.
CNOJSC, GZBC - CHINA NANHAI OIL JOINT SERVICE CORP., GUANGZHOU BASE COMPANY

		Bodies
TOTAL EXPATRIATES.....	46	21
TOTAL CHINESE.....	35	10
TOTAL ON BOARD.....	81	31

APPENDIX B

GLOSSARY OF TERMS USED IN THE OFFSHORE OIL INDUSTRY AND METEOROLOGICAL TERMS

Offshore Oil Industry Terms

[1] **Bit.** The cutting tool at the lower end of the drill pipe.

[2] **Casing.** Tubular steel used to line the hole and provide space for the return flow of drilling fluids.

[3] **Drill string.** The drill pipe plus drill collars and other associated equipment.

[4] **Drill well.** A 20- by 22-foot opening from the main deck through the vessel's bottom.

[5] **Hanging off.** The process by which a joint connecting two lengths of drill pipe is brought up into the BOP stack and disconnected.
BOP stack. The equipment placed on the ocean floor to prevent a blow out or sudden pressure release from the well.

[6] **Jack-up drilling rig.** A type of drilling platform which utilizes bottom bearing legs while drilling and raises its legs and floats when making a move.

[7] **Marine riser.** The pipe enclosing the drill string between the drillship and the BOP on the ocean floor. The marine riser has a slip joint to compensate for about 20 feet of vertical motion by the drillship.

[8] **Trip.** The process of pulling all the drill pipe out of the well hole.

Meteorological Terms

[9] **Elemental forecast** - A marine climatic weather forecast divided into the following categories; air temperature, wind direction and speed, visibility, weather, maximum sea height, mean sea height, sea direction, swell height and direction.

[10] **Large scale.** An area having a diameter of 1500 to 2500 kilometers.

[11] **Tropical cyclone** - A warm core (center warmer than surrounding air) closed atmospheric circulation rotating counter clockwise in the northern hemisphere.

[12] **Tropical disturbance** - The weakest recognizable stage of a tropical cyclone in which rotary circulation is slight at the earth's surface but is better developed at higher levels in the atmosphere.

[13] **Tropical depression** - The weak state of a tropical cyclone with a definite closed circulation at the earth's surface with wind speeds less than 34 knots.

[14] **Tropical storm** - A warm core tropical cyclone with wind speeds of 34 to 63 knots, inclusive.

[15] **Typhoon** - A warm core tropical cyclone in the western North Pacific (west of the 180th meridan) with sustained winds of 64 knots or higher. Typhoons are usually larger than hurricanes, frequently more intense and occur more often.

APPENDIX C

PERSONNEL INFORMATION

John Lawrence, Assistant Rig Manager

Mr. Lawrence was Global Marine's senior person on board the GLOMAR JAVA SEA on October 25. He began his employment with Global Marine Drilling Company in Houston in July 1978, working as a maintenance analyst in the engineering department. While in the engineering department, he held positions of maintenance systems supervisor, senior staff engineer, and project manager in rig construction until August 1983 when he was assigned as a project manager in the operations department. During the week of August 15 to 19, 1983, Mr. Lawrence satisfactorily completed Global Marine's training school for basic well control. In September 1983, he was sent to China as assistant rig manager of the GLOMAR JAVA SEA. This was his first operational experience on offshore drilling vessels.

Delmar A. Spencer, Drilling Superintendent

Mr. Spencer, 42, began his employment with Global Marine Drilling Company on board the drillship GLOMAR NORTH SEA in October 1967. Between October 1967 and November 1974, he worked as derrickman, driller, and toolpusher. From November 1974 to September 1975, he was the assistant drilling superintendent on board the drillship GLOMAR II. He was next assigned to the drillship GLOMAR CORAL SEA, where he worked as toolpusher from September 1975 until June 1982. From June 1982 until the sinking of the GLOMAR JAVA SEA, he was the drilling superintendent on board the drillship. He held a USCG able seaman document with lifeboatman endorsement.

Gustav F. Swanson, Master (Alternate)

Mr. Swanson, 62, worked as alternate master of the GLOMAR JAVA SEA. He studied civil engineering at Washington State College and nautical science at Washington State Technical School. Captain Swanson obtained his third mate's license in 1951, his chief mate's license in 1956, and his master's license in 1958. From 1954 to 1959, he served as an officer on board a vessel operating in the South China Sea between North and South Vietnam. From June 1957 to January 1961 he worked as chief mate for Delta Steamship Company. From January 1961 to April 1963, he served as a master for Central Gulf Steamship Company. He then began service as a master of civilian ships for the U. S. Navy for 17 years (1963-1981). After retirement from the Navy in 1981, Captain Swanson accepted two jobs with Global Marine; he served one tour as master of the GLOMAR CORAL SEA in 1981 and one tour as master of the GLOMAR JAVA SEA in 1982. His familiarity with drillships included the piloting of such ships into Port Hueneme, California, during his Navy service.

Peter W. Popiel, Chief Engineer (Alternate)

Mr. Popiel, received his third assistant engineer's license in 1968, his second assistant engineer's license in 1977, his first assistant engineer's license in 1978, and his chief engineer's license on motor vessels of any horsepower in 1980. He joined Global Marine Drilling Company working as an engineer on the drillship GLOMAR II, in 1968, the GLOMAR CHALLENGER in 1970, the GLOMAR PACIFIC in 1977, the GLOMAR ATLANTIC in 1979, and the GLOMAR JAVA SEA in 1982.

Gerald Flanagan, Radio Officer (Alternate)

Mr. Flanagan was the alternate radio officer on board the GLOMAR JAVA SEA from 1975 until it sank. He was issued an FCC first class radiotelegraph operator's certificate in 1973 and a USCG first class radiotelegraphers license in 1974.

Clarence Reed, Senior Drilling Supervisor

Mr. Reed was ARCO's senior drilling supervisor and ARCO's senior person on board the drillship GLOMAR JAVA SEA. Mr. Reed received a U.S. Department of Commerce, Maritime Administration, Certificate of Training in Radar on August 8, 1975. On September 21, 1976, he was issued a USCG license to serve as Master of column-stabilized or self-elevating motor drilling vessels and radar observer. Reed's employment in off-shore drilling operations began as a rig mechanic on jack-up drilling rigs from 1966 to 1972. He then worked as a sub-sea engineer on semi-submersible drilling rigs from 1972 until 1974. From 1974 to 1975, he was the rig superintendent on a semi-submersible. He joined ARCO International in 1980 as Senior Drilling Supervisor.

Karl Kaufman, ABS Surveyor November 1982

Mr. Kaufman began his career in the USCG where he spent the last 8 years in vessel inspection. Following retirement from the USCG, he worked for a year and a half in the quality assurance branch of a major shipyard in San Francisco. He left the shipyard to accept employment as a surveyor for ABS where he had worked for 1 1/2 years before conducting the November 1982 survey of the GLOMAR JAVA SEA.

Lt. Thomas Falkenstein, USCG Inspector November 1982

Lt. Falkenstein had 2 1/2 years experience in vessel inspections. He stated that during that period he had inspected 10 or 12 vessels over 300 feet in length.

John Phillips, Global Marine Rig Inspector August 1983

Mr. Phillips graduated from the U.S. Merchant Marine Academy in 1975 as a USCG licensed marine engineer. He worked on a semi-submersible drill rig in the North Sea for 2 years, and then spent the next 3 years working as an engineer on tankships. He then spent 1 year working for the Military Sealift Command before joining Global Marine as a rig inspection supervisor in 1982.

Kong Hing Ho, ABS Surveyor October 1983

Mr. Ho began his career as a draftsman and then as an engineer, working for 6 years at shipyards in Hong Kong. He then traveled to Britain where he spent the next 4 years at Stratheclyde University, graduating as a naval architect. He returned to Hong Kong and worked for the next 2 years in shipyard management. In May 1981, he began employment with the ABS as a surveyor. ABS sent him to Kobe, Japan, for 3 months as an inspector of new construction of oil rigs. This was his first experience with oil rigs. He then returned to Hong Kong and was assigned as an inspector of oil rig construction for ABS at Euroasia Shipyard for 1 1/2 years.

Lt. John Lazaretti, USCG Inspector October 1983

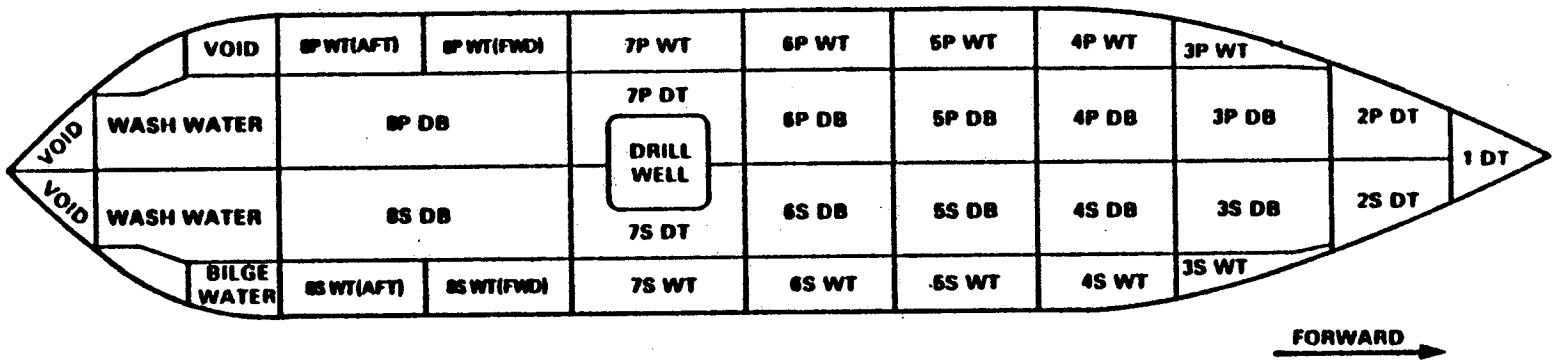
Lt. Lazaretti's marine experience began when he served as a USCG shipboard electrician for 5 1/2 years. He said during that time he sailed on vessels ranging in size from "255 feet to 450 feet" in length with propulsion systems of diesel, diesel electric, steam turbine, and gas turbines. After successful completion of USCG officers candidate school, he was stationed in Honolulu, Hawaii, where he worked onshore repair of Coast Guard cutters for 3 years. He transfered to the USCG New Orleans, Louisiana Marine Safety Office where he spent 2 years inspecting new construction and repair of offshore supply and miscellaneous vessels. He spent the next year performing small passenger vessel plan review for aluminum vessels under 120 feet in length. He then spent the next year in accident investigations. From New Orleans, he was transferred to Buffalo where he worked for 2 years in port operations prior to inspecting the GLOMAR JAVA SEA.

APPENDIX D

VESSEL DATA

Length Overall	400 feet
Length (Bow to Center Rudder Stock)	367 feet
Beam (Moulded)	65 feet
Depth (Moulded)	26.75 feet
Draft (Moulded)	20.96 feet
Draft (Keel)	21.02 feet
Lightship Displacement	6,122 long tons
Loaded Displacement	11,220 long tons
5-Inch Drill Pipe in Racker	23,580 feet
Casing Rack	400 long tons
Tubular Drill Pipe Storage	400 long tons
Liquid Mud Reserve Tanks	2,484 barrels
Active Mud Tanks	605 barrels
Bulk Cement	6,590 cubic feet
Bulk Mud	9,790 cubic feet
Sacked Materials	12,000 cubic feet

Class:	American Bureau of Shipping
Builder:	Levingston Shipbuilding Company, Orange, Texas
Designer:	Global Marine, Inc., Houston, Texas
Owner:	Global Marine Deepwater Drilling, Inc., Houston, Texas
Propulsion:	Diesel-Electric, 6-850 bhp - Catepiller D-399 diesels; 6-800 kw generators (a.c.); and 6-750 shp propulsion electric motors (d.c.), three for each shaft.



NOT TO SCALE

LEGEND:

1 DT – No. 1 Deep Tank, Forepeak – Ballast
2P DT – No. 2 Port Deep Tank – Ballast
2S DT – No. 2 Starboard Deep Tank – Ballast
3P DB – No. 3 Port Double Bottom Tank – Drill Water
3S DB – No. 3 Starboard Double Bottom Tank – Drill Water
3P WT – No. 3 Port Wing Tank – Ballast
3S WT – No. 3 Starboard Wing Tank – Ballast
4P DB – No. 4 Port Double Bottom Tank – Drill Water
4S DB – No. 4 Starboard Double Bottom Tank – Drill Water
4P WT – No. 4 Port Wing Tank – Fuel Oil
4S WT – No. 4 Starboard Wing Tank – Fuel Oil
5P DB – No. 5 Port Double Bottom Tank – Drill Water
5S DB – No. 5 Starboard Double Bottom Tank – Drill Water
5P WT – No. 5 Port Wing Tank – Drill Water
5S WT – No. 5 Starboard Wing Tank – Drill Water
6P DB – No. 6 Port Double Bottom Tank – BALLAST
6S DB – No. 6 Starboard Double Bottom Tank – BALLAST
6P WT – No. 6 Port Wing Tank – Drill Water
6S WT – No. 6 Starboard Wing Tank – Drill Water
7P DT – No. 7 Port Deep Tank – Ballast
7S DT – No. 7 Starboard Deep Tank – Ballast
7P WT – No. 7 Port Wing Tank – Fuel Oil
7S WT – No. 7 Starboard Wing Tank – Fuel Oil
8P DB – No. 8 Port Double Bottom Tank – Drill Water
8S DB – No. 8 Starboard Double Bottom Tank – Drill Water
8P WT(FWD) – No. 8 Port Wing Tank – Drill Water
8S WT(FWD) – No. 8 Starboard Wing Tank – Drill Water
8P WT(AFT) – No. 8 Port Wing Tank – Fuel Oil
8S WT(AFT) – No. 8 Starboard Wing Tank – Fuel Oil

Figure D1.—GLOMAR JAVA SEA tank arrangements.

APPENDIX E

U.S. COAST GUARD STABILITY CRITERIA MERCHANT MARINE TECHNICAL NOTE NO. 6-66

I. General

1. Stability information, furnished by the owner and approved by the Coast Guard is required to be provided to operating personnel of drilling vessels. This information shall include an indication of operating conditions which must be maintained to assure the safety of the vessel. Special emphasis should be given to requirements imposed by the drilling operation. The data as presented must be compatible with the background of the responsible operating personnel. A deadweight survey (with a conservative estimate of lightship v.c.g.) or a stability test is required unless the basic stability data are available from a sister vessel in which case it must be shown that reliable stability information for the exempted vessel can be obtained from such data. Normally a stability letter based upon an approved trim and stability booklet should be issued. An exception may be made where a stability analysis based upon a deadweight survey, or sistership data, indicates that no marginal stability condition exists (as will be the case for some non-self propelled drill barges). In cases of extremely broad beamed pontoon or column stabilized rigs, both a transverse and longitudinal stability analysis may be appropriate both as regards wind and righting moment and their relative curve characteristics. A load line is required if the vessel is 150 gross tons or over and operating outside of inland waters.

II. Intact Stability

1. The generally accepted criteria is that the vessel be able to withstand a 100-knot beam wind. Involved in the calculations are wind pressure, wind area, and wind lever. The resultant heeling moment is applied to determine the required G.

a. Wind pressure

(1) Basic equation. The basic equation for the wind pressure used by civil engineers in tower design is,

$$P = 1/2\ \rho\ V^2F^2CsCh \text{ (in psf)}$$

where

ρ = air density in slugs per cubic foot
V = gust factor which varies between 1.0 and 1.3
Cs = shape factor
Ch = height correction factor

Ch = height correction factor

If V is converted to knots and F is taken at 1.085, the equation reduces to:

$$P = .004\ Vk^2CsCh \text{ (psf for standard air density, i.e., } \rho = .00237)$$

This is our standard equation for wing pressure with the addition of the shape and height correction factors.

(2) Shape factor Cs. For flat surfaces Cs equals 1.0. For cylindrical shapes Cs varies with the L/D ratio between .6 for an L/D of 1 to 1.2 for an L/D of infinity. For an L/D about 40, it is close to one. For our purposes, Cs may be taken equal to 1.0 for all wind surfaces.

(3) Height correction factor Ch. This correction accounts for the decrease in frictional drag with resulting increase in wind velocity as the height above the water surface increases. For derrick towers it becomes significant and should be included.

$$Ch = \left(\frac{h}{30}\right)^{2/7}$$ where h is feet above water surface

Tabulated data for Ch versus h is given in Table C.1. The height of 30 feet has a Ch of 1.0 to standard wind velocities being measured at a height of 30 feet above the ground or wate level.

Table C.1
Height Correction factor

h (ft.)	30 or less	40	60	80	100	120	140	160	180	200
Ch	1.0	1.090	1.220	1.330	1.415	1.485	1.550	1.610	1.665	1.710

a. Wind Area

(1) Ship type (conventional hull) rigs

a. The wind area of the tower shall be taken as the projected area of all exposed surfaces on two opposite faces plus the area of the setback. In computing PAh the area should be broken down into suitable blocks and the proper height correction factor applied to each block. Augmentation is not considered necessary unless an unusual amount of closed in platform area becomes exposed to the wind with heel.

b. The PAh values for the remainder of the vessel may be calculated by standard methods.

c. PAh for the entire vessel can be assumed to vary as a cosine function with vessel heel.

(2) Column stabilized drill rigs. The exposed wind area and lever must be calculated on a rational basis. It must also be augmented by the increase in exposed area as the vessel heels. The height correction factor should be applied where it makes an appreciable difference.

c. Required GM

(1) Cross curves should be required. The required GM shall be based on the area under the righting moment curve being equal to 1.4 times the area under the wind heeling moment curve up to the lesser of the angle of second intercept of the curves, or downflooding.

(2) Eventually experience may indicate the required GM may be taken from 46 CFR 74.10-5 with PAh values computed as noted in Sections II.A and II.B above. This is thought to be a more severe requirement.

2. Results of wind tunnel tests may be accepted if conducted by a facility known to be competent in such testing. Acutal service data may also be significant.

III. Ballasting

1. Drill rigs for which a Trim and Stability Booklet is required (see section I) and which possess a significant ballasting capability should be required to include a recommended ballasting and deballasting schedule in the Trim and Stability Booklet. This is particularly important for rigs which undergo radical changes of waterplane area when transitioning from deep to mimimum drafts and vice versa.

IV. Subdivisions and Damaged Stability

1. There are no subdivision or damage stability requirements per se, however, there are two areas which should be given special attention.

a. A recent case of a gas blowout indicated forces involved were great enough that water was lifted in a "geyser" against the bottom of the drilling platform and cascaded onto weather decks. The resulting downflooding through open watertight doors and progressive flooding through open interior watertight doors was instrumental in capsizing the vessel. In the above instance, the hull was of the catamaran type however, all designs should be reviewed with an eye to possible downflooding due to the type of blowout described above. The use of quick acting watertight doors around the well head area and in whatever subdivision bulkheads are provided is appropriate. Standard operating procedures should call for these door to be kept closed during drilling operations.

b. Research on drilling platforms with large numbers of persons on board including scientists, students, and other special category persons, particularly on ocean going self propelled vessels capable of proceeding unassisted; should have some capability to withstand damage built into the vessel. In special cases of this nature, the design may be referred to the Commandant for policy guidance.

2. Pumps and valves which are essential for the safety of the rig (ballasting, dewatering, etc.,) should be accessible even though remote operation is provided. In those cases where pumps and valves may not be accessible at all times, it may be necessary to require a damage stability study.

APPENDIX F

1973 ABS STABILITY RULES FOR MOBILE OFFSHORE DRILLING UNITS

1.11 Operating Booklet

For each unit an operating booklet is to be prepared as a condition of Classification and to the satisfaction of the Bureau. The booklet is to contain the following information, as applicable to the particular unit, so as to provide suitable guidance to the operating personnel with regard to safe operation of the unit.

General description of the unit, inclining experiment results, light ship data, etc.

Pertinent data for each operating condition, including design loading, wave height, bottom condition, draft, etc.

General arrangement showing watertight compartments, closures, vents, permanent ballast, allowable deck loadings, etc.

Hydrostatic curves or equivalents

Capacity plan showing capacities of tanks, center of gravities, free surface corrections, etc.

Instructions for operation of the unit including adverse weather, changing mode of operation, any inherent limitations of operations, etc.

Stability information in the form of maximum KG versus draft curve or other suitable parameters based upon compliance with the required intact and damaged stability criteria

Representative examples of loading conditions for each mode of operation together with means for evaluation of other loading conditions

3.13 Stability

3.13.1 *General*

All units are to have positive stability in calm water equilibrium position, for the full range of drafts, whether as operating position for towing or drilling afloat, or as temporary positions when raising or lowering. In addition, all units are to meet the stability requirements set forth below for all applicable operating positions.

3.13.2 *Stability Afloat*

a ***Intact Stability*** All units are to have sufficient stability (righting ability) to withstand the overturning effect of the force produced by a steady wind from any horizontal direction in accordance with the stability criteria given in 3.15 for all operating conditions; afloat, transit and drilling. Realistic operating conditions are to be evaluated, with the capability to continue drilling operations with a steady wind velocity of not less than 36 meters per second (70 knots) for offshore service. The capability is to be provided to change the mode of operation of the unit to that corresponding to a severe storm condition, with steady wind velocity of not less than 51.5 meters per second (100 knots), in a reasonable period of time. In all cases, the limiting wind velocities are to be specified and instructions are to be included in the Operating Booklet for changing the mode of operation by redistribution of the variable load and equipment, by changing drafts, or both. Where the unit is to be limited in operation to sheltered locations consideration will be given to a reduced wind velocity of not less than 25.8 meters per second (50 knots) for normal operating conditions.

b ***Damage Stability*** All units are to have sufficient stability to withstand the flooding from the sea of any one main compartment which may reasonably be expected to be flooded for any operating condition which has been reviewed under **a** above. The unit is to possess sufficient reserve stability in the damaged condition to withstand the additional overturning moment of a 25.8 meters per second (50 knot) wind superimposed from any direction. In this condition, the final waterline is to be below the lower edge of any opening through which downflooding may take place. The ability to compensate for damage incurred, by pumping out or by ballasting other compartments, etc., or by mooring forces, is not to be considered as alleviating the above requirement, and it is also assumed that the unit is floating free of mooring restraints. The detailed requirements for damage stability are indicated in the applicable section of these Rules for the type of unit under consideration.

3.15.1 *Intact Condition*

Cross curves of stability and wind heeling moment curves with supporting calculations are to be prepared covering the full range of operating drafts including transit conditions. Where drilling equipment is of the nature that it can be lowered and stowed, additional wind heeling moment curves may be required and such data should clearly indicate the position of such equipment.

Curves of dynamic stability similar to Fig. 3.1 are to be prepared for a sufficient number of conditions covering the range of operating drafts. In all cases, except column stabilized units, the area under the righting moment curve to the second intercept or downflooding angle, whichever is less, is to be not less than 40% in excess of the area under the wind heeling moment curve to the same limiting angle.

For column stabilized units, the area under the righting moment curve to the angle of downflooding is not to be less than 30% in excess

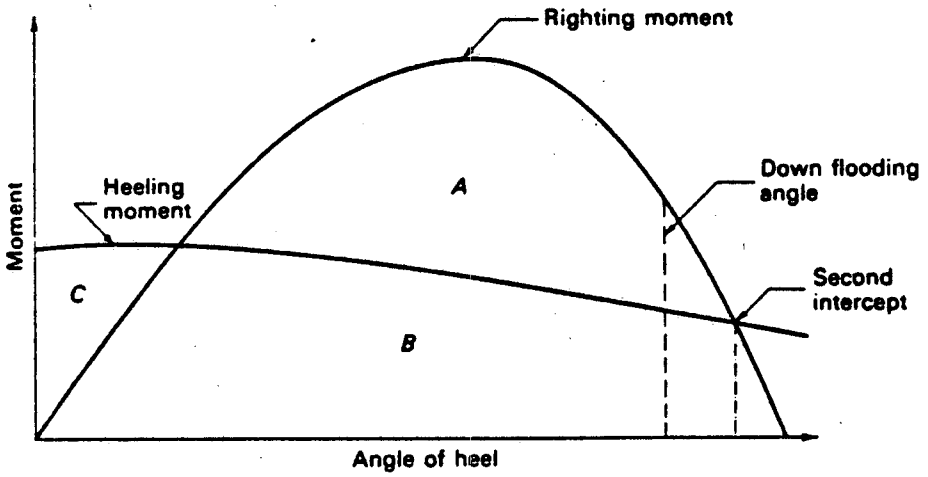


Fig. 3.1 Dynamic stability curve

of the area under the wind heeling moment curve to the same limiting angle. In all cases, the righting moment curve is to be positive over the entire range of angles from upright to the second intercept.

In calculating wind heeling moments for shipshape hulls the curve may be assumed to vary as the cosine function of vessel heel. For all other units, the curve is to be calculated for a sufficient number of heel angles to define the curve.

6.7 Damage Stability

6.7.1 *Extent of Damage*

In assessing the damage stability of surface type drilling units as required by Section 3.13.2, the following extent of damage is to be assumed to occur between effective watertight bulkheads.

a Depth of penetration will be assumed to be 1.5 m (5 ft)
b The vertical extent of penetration is to extend from the bottom shell to the upper deck

All piping, ventilating systems, trunks, etc. within this extent are to be assumed damaged. Positive means of closure are to be provided to preclude progressive flooding of other intact spaces. See 7.11. For specific requirements for watertight bulkheads, see Section 7. In addition to the above, the compartments inboard in way of the bottom shell and exposed decks are also to be capable of withstanding flooding individually.

APPENDIX G

METEOROLOGICAL INFORMATION
October 21 to October 30, 1983

The following weather conditions were in effect at the location of the GLOMAR JAVA SEA (17°18'N, 108°57'E) from 1600, October 21 through 0500, October 30. Conditions up to the approximate time of the accident are based primarily upon reports from the GLOMAR JAVA SEA which have been verified to fit the overall synoptic pattern. Conditions subsequent to the time of the accident are estimates based upon the synoptic pattern. The weather conditions described here would also apply generally to the Tonkin Gulf between Hainan Island and Viet Nam for the period from October 26 through October 30.

1600, October 21
Wind: 070°, 14-15 knots
Sea: 070°, 3 feet, 4 seconds
Swell: 050°, 5 feet, 4 seconds
Barometer: 29.79 inches
Weather: Visibility 10 miles

1600, October 22
Wind: 330°, 5 knots
Sea: 330°, 2 feet, 2 seconds
Swell: 050°, 4 feet, 4 seconds
Barometer: 29.79 inches
Weather: Clear

1600, October 23
Wind: 350°, 10-12 knots
Sea: 350°, 2 feet, 2 seconds
Swell: 050°, 8 feet, 7 seconds
Barometer: 29.72 inches
Weather: Intermittent cloudiness, occasional rain showers

0900: October 24
Wind: 000°, 10-11 knots
Sea: 000°, 2 feet, 4 seconds
Swell: 050°, 9-10 feet, 5 seconds
Barometer: 29.83 inches
Weather: Broken clouds, occasional rain showers

1600, October 24
Wind: 030°, 10 knots
Sea: 030°, 2 feet, 4 seconds
Swell: 050°, 16-18 feet, 7 seconds
Barometer: 29.77 inches
Weather: Occasional breaks in clouds, occasional rain showers.

0000, October 25
Wind: 000°, 20-25 knots
Sea: 000° 10-12 feet, 6 seconds
Swell: 050° 16-18 feet, 7 seconds
Barometer: 29.67
Weather: Cloudy, periods of heavy rain

0800, October 25
Wind: 000°, 25-30 knots
Sea: 000°, 20-24 feet, 8 seconds
Swell: 050°, 18-26 feet, 8 seconds
Barometer: 29.57
Weather: Cloudy, periods of very heavy rain

1600, October 25
Wind: 350°, 45-50 knots
Sea: 350°, 32-38 feet, 10 seconds
Swell: 050°, 30 feet, 12 seconds
Barometer: 29.51 inches
Weather: Cloudy, periods of very heavy rain

0000, October 26
Wind: 330°, 60 knots gusting to 75 knots
Sea: 330°, 34 to 38 feet, 11 seconds
Swell: 050°, 8 to 10 feet, 10 seconds
Barometer: 29.40 inches
Weather: Cloudy, rain ending

0500, October 26
Wind: 210°, 50 knots gusting to 60 knots
Sea: 210°, 18 to 22 feet, 9 seconds
Swell: 330°, 6 to 8 feet, 6 seconds
Barometer: 29.52 inches
Weather: Partly cloudy, widely scattered rain showers

1400, October 26
Wind: 140°, 30 knots
Sea: 140°, 11 feet, 7 seconds
Swell: 240°, 4-8 feet, 6 seconds
Barometer: 29.80
Weather: Partly cloudy

0200, October 27
Wind: 070°, 12 knots
Sea: 070°, 4 feet, 5 seconds
Swell: Coincident with sea
Barometer: 29.80 inches
Weather: Cloudy, rain showers

1400, October 27
Wind: 030°, 20 knots
Sea: 030°, 7 feet, 7 seconds
Swell: 060°, 2 feet, 7 seconds
Barometer: 29.91 inches
Weather: Considerable cloudiness intermittent rain showers

0200, October 28
Wind: 060°, 15 knots
Sea: 060°, 5 feet, 7 seconds
Swell: Coincident with sea.
Barometer: 29.42 inches
Weather: Mostly cloudy

1400, October 28
Wind: 060°, 20 knots
Sea: 060°, 7 feet, 8 seconds
Swell: Coincident with sea
Barometer: 29.86
Weather: Mostly cloudy, widely scattered rain showers

0200, October 29
Wind: 030°, 20 knots
Sea: 030°, 7 feet, 7 seconds
Swell: 060°, 3 feet, 7 seconds
Barometer: 29.41 inches
Weather: Mostly cloudy, widely scattered rain showers

1400, October 29
Wind: 040°, 15 knots
Sea: 040°, 5 feet, 6 seconds
Swell: Coincident with sea
Barometer: 29.87 inches
Weather: Mostly cloudy, widely scattered rain showers.

0200, October 30
Wind: 060°, 15 knots
Sea: 060°, 5 feet, 6 seconds
Swell: Coincident with sea
Barometer: 29.91 inches
Weather: Partly cloudy, scattered rain showers.

0500, October 30 (last data available)
Wind: 070°, 20 knots
Sea: 070°, 7 feet, 7 seconds
Swell: Coincident with sea
Barometer: 29.86 inches
Weather: Mostly cloudy, scattered thunderstorms

APPENDIX H

PETITION FOR RECONSIDERATION FROM GLOBAL MARINE, INC.,

NATIONAL TRANSPORTATION SAFETY BOARD

RE: 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

PETITION FOR REHEARING
OF GLOBAL MARINE INC. AND
GLOBAL MARINE DRILLING COMPANY

Submitted by Global Marine Inc. and
Global Marine Drilling Company

Joseph D. Cheavens
Randy J. McClanahan
Rolf G. Asphaug
James L. McCulloch

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RE: 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

PETITION FOR REHEARING
OF GLOBAL MARINE INC. AND
GLOBAL MARINE DRILLING COMPANY

On November 14, 1984, the National Transportation Safety Board (the "Board") adopted its Marine Accident Report (the "Report") in the captioned matter. Counsel for Global Marine Inc. and Global Marine Drilling Company ("Global Marine") advised the Board by letter of November 20, 1984, that Global Marine took issue with many of the Statements, Findings, Conclusions and Recommendations in the Report and that Global Marine would petition for rehearing pursuant to the Board's procedures. The following is Global Marine's Petition.

I.

PROBABLE CAUSE

A. The Board's theory: structural failure.

In the statements of Probable Cause (Report pp. 1, 76) the Board concludes:

> The National Transportation Safety Board determines that the probable cause of the capsizing and sinking of the United States drillship GLOMAR JAVA SEA during Typhoon LEX was the flooding of its starboard wing tanks Nos. 6 and 7 through a fracture in the hull resulting from a structural failure of undetermined origin near the bulkhead separating starboard wing tanks Nos. 6 and 7. Contributing to the structural failure was the decision that the drillship would remain anchored with all nine anchors, which subjected the vessel to the full force of the storm.

These statements are reiterated in Findings 2, 3 and 4 (which lead to Finding 9) in the Conclusions section of the Report. As demonstrated in this Part A, the conclusion of structural failure occurring on the surface is not supported by fact or reasoned analysis. Since it is based on pure speculation, it should be withdrawn. Global Marine offers in part B of this section an explanation for the sinking supported by fact.

That the Board would reach such a bold, positive conclusion is puzzling given the background of the investigation of this casualty. At the conclusion of all testimony a technical meeting was held attended by the parties

in interest, the United States Coast Guard and the NTSB investigating officers. The general consensus of that meeting was that without considerable additional studies the causes of the various fractures found in Global Marine's diving surveys could not be determined, nor could the relationship, if any, between those fractures and the sinking be determined. The Coast Guard and NTSB officials attending that meeting expressed reluctance for the federal authorities to pursue such studies, primarily due to time and budgetary constraints. The Board has confirmed to Global Marine since issuing its Report in November that no additional studies or calculations have been performed.

Moreover, the oral statements by the Board at its November 14, 1984 hearing are remarkably more equivocal than the language of the Report. See Official Transcript p. 135 (Member Bursley: "I think we really don't know"; p. 136 (Vice Chairman Goldman: "...[W]e would look forward to rewriting probable cause when the ABS study is done.") and responses of Mr. Johnson to questions of Chairman Burnett at pp. 137-138 ("We don't know" whether remaining anchored "maybe or probably" caused stresses that led to fracture). For the Board to reach the conclusions so positively set forth in the Statement of Probable Cause and in Findings 2, 3 and 4 without additional study, but based instead upon pure conjecture and speculation, is inappropriate.

The Board appears to have reached its conclusion by the following specious reasoning process: Because a 15° list was reported, and because flooding the No. 6 starboard drill water and No. 7 starboard fuel oil tanks could produce a list of about 15° (as determined by certain stillwater calculations performed by the Coast Guard), and because the transverse fracture at bulkhead 91 (or the longitudinal deck fracture at the substructure leg attachments[1/]) could flood such tanks; therefore: (1) the fractures occurred while the ship was on the surface and caused the list and (2) the list caused the ship to sink. This reasoning process is seriously flawed, and the facts upon which it relies are incorrect.[2/]

1. The transverse shell crack near Frame 91.

The key assumption in the Board's reasoning is that the transverse shell fracture near bulkhead 91 occurred

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1/ The Board avoids the question of whether the culprit was the transverse fracture near bulkhead 91 or the longitudinal fracture on the deck at the substructure attachments.

2/ The Board also speculates at p. 54 of the Report that the vents to tanks 6 and 7 may have fractured, causing the flooding of those tanks. The videotapes taken in the March diving expedition absolutely rule out such a theory. Moreover, the metallurgical studies show the crack in the deck at tank vent 7 originated over 10 feet away, below the sheer strake on the side of the ship. Tank vent 7 was near the terminus of the crack, not the origin.

prior to capsizing and caused tanks 6 and 7 to flood. That conclusion is unsupported by the record. In fact, at page 56 the Report candidly contradicts the Board's own conclusion by stating "the failure could have occurred while the vessel was afloat on the surface or when it hit the ocean floor." (Emphasis added.) The Report does not explain how the "could have occurred" statement is transformed into definite fact, yet it relies upon the assumed surface failure as a crucial reasoning step in its conclusion of probable cause. Nor does the Report purport to eliminate the alternative explanation suggested at p. 53 that the failure could have occurred when the ship "hit the ocean floor."

a. Engineering and metallurgical studies.

The conclusion that the fracture occurred on the surface is first contradicted by studies conducted by the ABS for the Board, the findings of which are summarized on p. 56 as follows:

> The shell plating had a yield strength about twice the load stress calculated by the ABS, and the motion and load calculations performed by the ABS showed moderate stress levels in the shell plating of the GLOMAR JAVA SEA under the assumed severe sea conditions. Thus while moored, the drillship should have been able to withstand the bending and twisting of its hull due to wind, waves and swells it experienced on October 25, 1983, based on its structural strength.

The "severe sea conditions" assumed by the ABS in its study actually led the ABS to overstate the likely stress levels actually experienced. At the Board's request a significant wave of 38 feet was assumed based upon the 1600 report from the vessel. The testimony and exhibits in the record, however, show that the conditions reported were maximum conditions, not significant conditions. Moreover, the fact that the calculated ship motions did not correlate with, but were greater than, the observed motions at 1600 demonstrate that the sea conditions assumed by the ABS were unreasonably severe. Nevertheless, even under the unreasonably severe environmental assumptions the ABS study as cited does not support the Board's conclusion.

At Global Marine's request, the ABS has repeated its computer analysis using more accurate environmental assumptions. These assumptions are based on detailed weather hindcast analysis performed by Dr. Charles L. Bretschneider, the world's foremost expert in this field. The results are contained in Exhibit 1. Significantly, the calculated ship motions at 1600 in this new study correlate well with the observed motions at that time. See Exhibit 1, pp. 8-9. The calculated extreme value of total vertical bending stress amidships was 6.77 L. tons/in^2 or 44.5% of the nominal yield stress of the material or about 36% of the actual yield stress of the material found by the metallurgical

studies of the coupons. This new ABS study underscores the lack of technical support for concluding that the fracture occurred on the surface due to stresses imposed by the storm conditions.

The points of maximum stresses as determined by both ABS studies were located on the deck and bottom. Metallurgical studies commissioned by the Board, however, show that the origin of the major portion of the transverse fracture was roughly one-third down the side of the ship, not on the ship's deck or bottom. The middle of the side of the ship would be near the neutral axis for such longitudinal bending stresses. The Board offers no explanation why the large crack at frame 91 would originate near the neutral axis of the bending forces exerted on the ship while afloat, rather than on the deck or on the ship's bottom where maximum stresses were occurring.

Another fracture, much shorter in length, originated on the bottom plating and extended outboard to just inboard of the bilge keel and inboard a few feet to a longitudinal girder. The ABS studies show that maximum stress levels due to the forces exerted on the ship by the storm when the ship was afloat on the ship's bottom were in compression. The crack on the bottom (like the crack on the side), however, originated and progated in tension, not compression. Thus the forces of the storm could not have caused the smaller

crack on the bottom. That crack was initiated when the ship hit the bottom.

Both ABS studies show the maximum stress levels amidships in the deck were in tension, although the calculated tension was a small fraction of the tension required to initiate or propogate the crack. Had the deck been in high enough tension to yield the material when the bulkhead 91 crack crossed the shear strake and into the deck from its mid-side origin point, the crack would have continued across the entire deck. Instead, however, the metallurgical studies show that the crack lost energy in the deck and ended a few feet inboard of the shear strake.

Thus the calculated stresses with the vessel floating in a seaway cannot explain the origins of the bulkhead 91 fractures. To the contrary, the metallurgical and engineering studies in the record presented to the Board are completely inconsistent with the hypothesis that the ship cracked while afloat. The Board ignores, however, these studies.

The evidence in the record is far more consistent with the conclusion that the massive indentation along the starboard side (as well as the indentation along the port side discussed infra) were caused by hydrostatic pressure after the ship sank, leading to the large fracture on the starboard side at frame 91. But before issuing its Report

the NTSB declined to pursue any further studies which it thought might be necessary to definitively support (or rule out) such a conclusion.[3/] Global Marine has pursued such studies on its own behalf. Exhibit 2 is a copy of a preliminary report prepared by Failure Analysis Associates ("FAA"). FAA concludes in the report that

> "[1] Hull plating in the starboard area adjacent to tanks No. 6 and No. 7 could experience yield when the ship sank to a depth of about 98 feet.
>
> [2] The calculated hydrostatic pressure stresses are very low under the ship's normal operating conditions."

Subsequent refinement and more elaborate study by FAA has confirmed these preliminary conclusions. These complete studies show that the side shell at tanks 6 and 7 begins to deform inward after the ship begins to sink. As the ship descends further bulkhead 91 ultimately collapses, lending to fracture of the side shell at a depth in excess of 100 feet. Attached hereto as Exhibit 3 are pertinent

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3/ Global Marine has been advised by the Coast Guard that, pursuant to recommendation of the Report, the ABS is pursuing additional studies at the request of the Coast Guard. Those studies should be completed by December, 1985. In view of the pendency of those studies and the compelling evidence discussed in this Petition against the Board's conclusion of Probable Cause, the Board (Footnote Continued)

excerpts from the deposition testimony of Dr. Bernard Ross in which he explains these studies and conclusions.[4/] The detailed finite element analysis conducted by FAA shows that the maximum calculated stresses in the side shell at tanks 6 and 7 due to hydrostatic pressure are at bulkhead 91 at precisely the point of origin of the crack. Dr. Ross' testimony and the FAA studies demonstrate definitively that the fracture at frame 91 occurred after the ship sank due to hydrostatic pressure.

b. Diving survey findings.

The conclusion that the transverse fracture near bulkhead 91 occurred while the ship was on the surface is not only inconsistent with engineering calculations and metallurgical findings but it also ignores significant physical evidence, inconsistent with the Board's conclusion, found in the March 1984 diving survey. The Report fails to discuss that evidence. The March diving survey found that

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(Footnote Continued)
should in the very least withdraw at this time its statement of Probable Cause pending conclusion of the ABS studies.

4/ The complete study is quite lengthy and does not consist of a narrative report. If the Board wishes to review the study, however, Global Marine will make copies and provide them to the Board. At the end of Exhibit 3 are copies of the color coded computer output showing stress levels and locations referred to by Dr. Ross.

the starboard side indent, which is deepest at bulkhead 91, is not localized but actually started near the bow and extended aft along the wing tanks at least to frame 110 if not to the aft house. There was a corresponding indent along the port side wing tanks. While the port indent was as deep as 8 feet at frame 91 and 6 feet at frame 59, the side shell plating was not fractured. The only logical interpretation of the physical evidence and calculations is that whatever caused the starboard indent also caused the port indent. The fracture near bulkhead 91 on the starboard side is merely the place where the indentation was most severe since tanks 6 and 7 starboard were completely empty, producing massive collapse of bulkhead 91. On the port side tank 6 was full. Hydrostatic pressure exerted on the side shell after the ship capsized and was sinking would explain all these indents. A mysterious, unexplained structural failure occurring only at bulkhead 91 on the starboard side while the ship was on the surface would not.

These facts were ignored in the Report. The Board was given the impression by Mr. Johnson at the November 1984 hearing that there was no significant damage to the port side. Official Transcript p. 97. Thus the "Wreckage" descriptions at p. 14 (paragraph 1) and pp. 35-36 (paragraph 1) and the summary of the March Diving Survey at p. 41

(paragraph 1) omit any reference to the long, longitudinal indentation between transverse bulkheads found on both the port and starboard sides of the ship.

c. Operating history.

The finding that the crack occurred on the surface due to some postulated but unexplained structural failure is also questionable if the operating history of the GLOMAR JAVA SEA and her sister vessels is considered. Taking such vessels as a group, this hull design has experienced over seventy-five years of exposure to the forces of the oceans, weathering safely far worse storms without fracture or deformation of the kind seen on the video tapes. See Global Marine Proposed Findings at p. 4. The oldest ship of the class, the GLOMAR GRAND ISLE, not only has experienced the most severe weather, but also at the time that weather was experienced had not been structurally strengthened with various members which were incorporated in the GLOMAR JAVA SEA. No reason is proffered why the GLOMAR JAVA SEA, the newest and strongest vessel of the class, should suddenly experience structural failure under conditions far less severe than those safely weathered by older sister vessels.

d. Mooring stresses.

Finally, the Probable Cause statement that remaining anchored contributed to the structural failure, and the

corresponding (although more equivocal) statement at p. 59 of the Report that "if the vessel had been free to maneuver to minimize its motion, it would have experienced less dynamic stresses and a structural failure may not have occurred," are equally speculative and unsupported by any calculations or studies. The only study considered by the Board contradicts the Board's conclusion to the extent that that study is applicable. The ABS study states:

> The midship vertical bending moment transfer functions in Figures V-10 and V-9, indicate that the mooring effects on vertical bending moment are insignificant.

MBI Exhibit 73, p. 15 (emphasis added). Further, completely ignored in the Report are facts which showed the captain slacked certain moorings, which would tend to relieve mooring stresses.

* * *

Given these considerations, concluding that the fractures at bulkhead 91 occurred on the surface is clearly not justified. Findings 2, 3, 4 and 9 should be deleted. This unsupported conclusion has led to Board Finding 9 and related recommendations to Global Marine and the ABS which are also totally unwarranted.

2. The longitudinal crack in way of substructure attachments.

The Board's Report also suggests at one point (see p. 56) that "massive flooding" of tanks could have occurred

through the longitudinal fracture "near frame 91 at the connection of the derrick [actually substructure] with the main deck plating." The Report says this crack "could" have been caused by "dynamic stresses in the deck caused by the motion of the derrick." These "could have" statements are then transformed by the Board into a positive finding that the flooding was due to the longitudinal crack (Finding 3).

No studies or calculations analyzing the dynamic effects of the derrick moving from port to starboard as the drillship rolled have been considered by the Board. Global Marine has conducted such studies which absolutely rule out the Board's conclusion as to the cause. The FAA report (Exhibit 2) treats this subject conclusively, finding that these effects "could not have resulted in fracture-level stresses in the deck plating." The uncontradicted testimony in the record is that the damage in the area of the attachment of the forward legs of the substructure to the deck was probably caused by the vessel striking bottom. The FAA report agrees.

Moreover, if the bending moments produced by the ship rolling in the sea did produce any damage at the attachments of the substructure to the hull, that damage would likely be symmetrical to both the forward and aft attachments on either the port side, or the starboard side,

or both. Such bending moments would not produce the damage noted only around the forward substructure legs.

Finally, the unsupported theory offered by the Board is refuted by Global Marine's successful record with this substructure design. The substructures of all Global Marine drillships since the GLOMAR II (a total of sixteen ships) have incorporated the basic design features employed on the GLOMAR JAVA SEA. These sixteen ships have collectively experienced hundreds of years of exposure to the elements, including sea conditions far more severe than experienced by the GLOMAR JAVA SEA. The stresses imparted by the derrick and associated equipment as these vessels rolled in those hundreds of years have never led to the kind of fracture hypothesized by the Board.

3. The 15° list.

The final step of the Board's reasoning process -- that the reported 15° list caused the ship to sink -- is also unsupported. No study has shown that a 15° list alone would have caused the GLOMAR JAVA SEA to sink, even under the wind and sea conditions that existed. On the contrary, the only study before the Board on this subject (MBI Exhibit 51) indicates that the ship should have survived the storm with such a list.

Moreover, the assumption that there was in fact a 15° list is open to serious doubt. Without in any way

impugning the veracity of Mr. Lawrence in reporting a 15° list, certain circumstances do raise legitimate questions concerning how literally or precisely one should take the report. A 15° list under stillwater conditions, although severe, is not inconceivable. But a 15° list with the ship rolling at least 15° (her roll at 1600 before the storm reached its peak) would technically mean that in each roll the ship would move from an even keel (0°) to 30° to starboard. Is it credible to believe that such conditions were actually being experienced? The lack of apparent discomfort and alarm among the crew raises serious question as to the existence of such a list.

It is reasonable to infer that there may have been some abnormal trim or roll condition -- a condition serious enough to prompt the call to Houston and to cause the captain to order all aboard to don life jackets. Nevertheless, that condition was not sufficiently alarming to cause those aboard to muster at abandon ship stations. Indeed, many bodies were found in staterooms and other places inconsistent with the degree of alarm and discomfort that would be experienced in a 30° roll. For instance, the bosun and an assistant engineer were found in the crew lounge. Toolpusher David Clifton (who was a certificated lifeboatman) was apparently taking a shower since his body was found unclothed in the bathroom adjoining his cabin.

Likewise, both Riddle and McGeough testified that Lawrence did not seem to be alarmed but was quite matter of fact. Were the ship truly rolling 30° to starboard, considerably more alarm would have been manifested by Lawrence and the crew.

This conclusion is supported by the testimony of two experienced Global Marine captains who have testified in the civil litigation. Captain Ludwig served as an officer on Global Marine ships beginning in 1972 and was permanent alternating master of the GLOMAR JAVA SEA from June 1978 to May 1983. He testified as follows:

> Q. You have heard, I take it, and it's been alluded to in questions here, that John Lawrence reported to Bill Riddle in a radio or Marisat call that the ship was experiencing a 15° list. Do you recall those references?
>
> A. Yes, sir.
>
> Q. There was reported, as of that afternoon report submitted by the Arco people, that the ship at 1600 hours was rolling approximately 14°.
>
> A. (Indicating)
>
> Q. What is your personal belief as to the accuracy of the report of a 15° list?
>
> * * *
>
> A. Personally when I heard that, I don't believe the ship had a 15° list.
>
> * * *
>
> Q. What is the basis for your doubting of the accuracy of that report, Captain?

* * *

A. I just -- Knowing that ship, I can't conceive it going over 15° and staying there, on there; and the reason that I'm doing that is the position of those bodies and where they were at.

For instance, Russell Reynolds and the boatswain in the crew's lounge, I just can't conceive those people, and David Clifton, in those rooms with that ship having a 15° list.

Deposition of Captain Russell Ludwig, at pp. 395-397.

Captain Eugene Spencer served as master or mate on Global Marine ships beginning in 1973. He served two "hitches" as master of the GLOMAR JAVA SEA, and served as chief mate on the voyage to China. He testified:

Q. Were you aware, Captain, that Mr. Lawrence reportedly was telling Houston that the vessel was experiencing a 15° list and that various members of the crew had put on their life jackets?

A. Well, knowing that drilling superintendent as well as I do, we had worked together before on the CORAL SEA -- Spencer, I'm speaking of -- and that chief engineer, Pete Popiel, whom I've known for 10 or 12 years, I can't believe that the vessel had a 15° list. It might have had a 15° roll, but I find it hard in my mind to see that that vessel had a 15° list because that chief engineer would have been down there bailing it out with a bucket if he had to.

There's no doubt that when you get a 15° list on that vessel, you've got an awful lopsided load somewhere.

Now, it might have been semantics. I don't know what Lawrence's background is. I don't know if he's a marine man. I don't know the man, if, in fact, that's his name.

In the process of a 15° roll, if he's sitting in the radio room--I assume he's in the

> radio room, on the phone--he could have meant a 15° roll, a 15 degree pitch. He could have meant anything. It could have possibly been a matter of semantics.

Deposition testimony of Captain Eugene Spencer, pp. 71-72.

Captain Spencer's question about Mr. Lawrence's background can be answered from the record. He had no seagoing experience or marine training.

The conclusions of Captains Ludwig and Spencer are underscored by the testimony of Gurbachan Virk, Global Marine's chief naval architect, who both knew John Lawrence and is most familiar with the motion characteristics of that class of vessel. Mr. Virk testified:

> Q. You're aware, I presume, of the conversation on Marisat from the ship to Mr. Riddle apparently sometime near the time that the vessel sank where it was reported that the weather was coming over the bow and that there was a 15 degree list to starboard? I presume you're aware of that conversation?
>
> A. Yes.
>
> Q. In your opinion and in thinking out the scenario that we have been discussing, how, if at all, do you fit that report into the scenario?
>
> A. I have thought about the report of 15 degree heel. And I have really never believed that there was a 15 degree heel -- list. From my experience dealing with the ships, I have had occasion to observe and hear from the captains and others that when the vessel is moored, it can, under the constraint, it can roll and pitch. And sometimes under heavy weather situation it can heel to one side and kind of appear to be kind of staying there and slowly move back with the mooring system and heavy weather coming off the bow.

So in my judgment, Mr. Lawrence, who was a very good friend of mine -- we worked together in the same group -- who had no marine background, that he was clearly mistaken. He may have confused a very slow roll movement, which can appear to kind of stay there -- it is actually for a few seconds generally -- which can appear very long, especially to the person who is sitting away. So I think a big wave may have landed on the deck, water; and maybe temporarily the vessel may have temporarily looked like it is stopped there and seemed to be heeled to one side. But I can't conceive a 15 degree list. And what has been reported to me, that his lack of alarm and people being in various places and not about to jump on the boats, it just doesn't make much sense.

* * *

Q. Now let's digress to the side for a moment and discuss your theory of the slow roll, or whatever, over 15 degrees for me that you discussed that might last for a few seconds and, in your opinion, confuse somebody as between a roll situation and a list. From a naval architecture point of view, what could produce a motion of the vessel where it went over and appeared to stay for at least an appreciable period, however long it may have been, as opposed to normal roll motion? What would be the technical explanation for this?

A. The technical explanation, in severe weather the mooring system sometimes can go to resonance, or the dynamic motions, hydrodynamic forces acting in a way that the coupling of the mooring system and the vessel can produce some situation where the vessel is swaying, going from side to side, surging -- it's heaving, it's rolling, it's pitching -- that a situation may arise where all these forces come to act together in a way. And the vessel may appear to be kind of heeled over to one side.

Now, you mentioned the word "appreciable time." Now, that, for me, if it's there for 30 seconds, it may not bother me. But for somebody else, even five seconds may look like five minutes. It all is a reaction of an individual to what he's

seeing. I've been on the ships where I observed this sort of thing and it hasn't bothered me. And so to complete my answer to your question, it's that it is a hydrodynamic phenomena which, depending on one's reaction, people react differently.

* * *

Q. Could water coming on deck, in your opinion, Mr. Virk, contribute to a situation which might be mistaken for a static list or heel by personnel on board the ship?

A. It could contribute towards that. It all depends how much water. We are making here assumptions. And how much water, how long it stays, how does it drain, does the -- successive waves, one after another, sometimes can come in quick succession. Before the water drains out, another big wave lands on it. So it's likely it could contribute. But it all depends on the circumstances.

Virk deposition p. 119-124.

In sum, although there may have been some abnormal trim or roll condition such as described by Mr. Virk, it is unlikely that it was of the magnitude of a 15° list. The hindcast of Dr. Bretschneider shows that at 2400 the wind was coming from 286°. (See Ex. 1, Appendix B, Table 2.) If the ship's heading was due north or a few degrees to the east of north (which is probable as shown at p. 23 below), a port beam wind was being experienced, which would cause some wind heel to starboard. That wind heel plus the water on deck as described by Mr. Virk could explain the reported "list." If one eliminates the cracks found at bulkhead 91 starboard as having occurred on the surface -- a conclusion

compelled by the facts and studies discussed above -- no explanation can be suggested for the cause of such a large list.

* * *

We recognize that the Board is charged by statute to determine probable cause. But that mandate should not serve as an excuse for the Board to "stretch" to find causes unsupported by fact or sound analytical study. The Board's Findings and Conclusion of Probable Cause relating to structural failure are based upon pure conjecture, not sound analysis or fact. Those Findings and Conclusions should be withdrawn.

B. Global Marine explanation: breaking of anchor chain.

The most likely key to the sinking of the GLOMAR JAVA SEA was the premature and unforseeable failure of the starboard forward bow moorings. The evidence and analysis supporting that conclusion is summarized in this part. Figures 1 and 2 which follow the text illustrate the scenario.

A careful study of the March diving and sonar surveys conducted from the Tender Carrier in March 1984 reveals pattern in the debris immediately to the southwest of the well. There are three features to the debris pattern: (1) the debris is concentrated in a relatively small area south-southwest of the well rather than around the well itself; (2) the configuration of the boundaries of the

debris pattern is longer in its east west axis than in its north south axis; and (3) much of the debris appears to be long slender objects of fairly uniform size, the longitudinal axis of which generally run east and west. Measurements of the approximate length of the sonar "returns" of these objects conform closely to the length of drill pipe and casing which would have been in the casing rack and pipe racks. A diving expedition by Global Marine in April 1985 over the easterly portion of the debris has confirmed that the objects in that area are casing, drill pipe singles and riser, all of which were stowed in the casing rack. These tubulars would have been "dumped" in a concentrated place on the sea floor below the point on the surface where the ship capsized.

The location and orientation of the debris compels the conclusion that the vessel did not capsize over the wellhead at her last reported heading of 340°[5/] but instead capsized some 300-500 feet to the southwest at a heading of

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5/ The heading at 2400 is not known with absolute certainty. The fact that anchor chains 4 and 5 had been slacked indicates that the vessel probably was turned (or permitted to weather-vane) as much as 20° to 25° to the east. Lawrence reported in the last communication that the ship was taking weather over the bow, and that report is more consistent with a heading of about 0° to 10° than 340°. Changing the vessel's heading to take weather over the bow is an accepted technique discussed at some length in Global Marine's Procedures Manual 5 "Marine Operations."

about 270°. Once the ship turned on her side, she would not have remained there but would have turned completely upside down in one continuous process. Thus the substantial quantity of tubular goods in the casing rack and pipe racker would have been "dumped" at the point at which the ship overturned. That point appears to be not immediately above the well head but at its closest point is about 300 feet to the south and southwest of the well. Moreover, the striking east-west orientation of the individual objects and of the overall debris pattern establishes that when the ship turned over it was not heading 340° to 010° but rather about 270°. The ship ended up on the bottom at a heading of about 285°, and the debris pattern suggests that the ship also capsized at a generally westerly heading.

For the ship to capsize where she did, anchor chains 2 and 3 had to break first. In the chain retrieval operation conducted by the SMIT LLOYD 50 in November 1983 anchors 2 and 3 were retrieved with broken anchor chains attached. In the M/V YU YO retrieval operation in April 1985 the ship ends of those chains were recovered. Only if these moorings parted could the vessel capsize at the position she did as shown by the debris pattern.

When the debris location and orientation findings are combined with findings concerning broken anchor chains, a logical hypothesis emerges which represents the most likely explanation for the sinking of the ship. With the

ship heading probably about 005° and anchored, heavy seas and swells were coming over the starboard bow. See Appendix B to Exhibit 1, ABS March 1985 study. The ABS calculations of anchor tensions show that even at 340° heading as the weather changed from 1600 to 2400 tensions on chain 3 declined but tensions on chain 2 remained relatively constant. Moreover, metallurgical investigations of the recovered remnants of chains 2 and 3 show that chain 3 failed at a higher stress level than chain 3. It is thus likely that under the stresses imposed by the seas anchor chain 2 broke first. A sudden shock load was then imparted to anchor chain 3, which failed at the kenter link. See Shankman report, MBI Exhibit 83. The starboard bow of the ship would now be unrestrained, and under the seas and swells being experienced the vessel would tend to broach with the bow swinging to the west. The ship would then experience broadside seas well before the bow began to fetch up on mooring 10. With the ship suddenly broadside in the seas, she would then be much more vulnerable to capsizing than if moored bow into the seas.

In this process (and immediately thereafter) considerable tension would be placed on anchor chain 4. That mooring would not prevent the bow from swinging to the west but instead the vessel would pivot on that mooring. Under this strain chain 4 would stretch and ultimately

break, the condition in which it was found after the casualty. The sonar mosaic (MBI Ex. 79) shows a "return" from the position of anchor 4 leading to the southwest about 2000 feet ending south of the debris pattern. After chain 4 parts, the ship would now be restrained primarily by anchors 10 and 5, which would act as tethers as the capsized ship moved to the south-southwest under the influence of the prevailing seas and current and ultimately sinks to the bottom. The number 5 and 10 moorings were found to be taut in the November dives and chain retrieval operation. This scenario is illustrated by Figures 1 and 2 (based on MBI Exhibit 19 and Figure 4 in the Report) on the following pages.

Calculations by the ABS of anchor tensions as the ship was moored (even assuming no slacking of moorings or change of heading) indicate that the anchor chains should not have failed under the weather conditions being experienced. Calculated tensions are well below the point at which failure could reasonably be expected. See Exhibit 1, Tables V-1a and V-2a. An initial program of metallurgical testing of the anchor chains by FAA has shown that a very high percentage of the samples tested do not meet API standards as to toughness. Global Marine has underway a much more extensive program of testing samples of the recovered chain to investigate further the likelihood that

the chain was below specification and more susceptible to premature failure at unreasonably low stress levels.

Although evidence gathering and studies are not complete, premature breaking of the starboard bow moorings, triggering a series of events culminating in capsizing and sinking, now appears to be a far more likely explanation for the casualty than the conclusion reached by the Board in its Report.

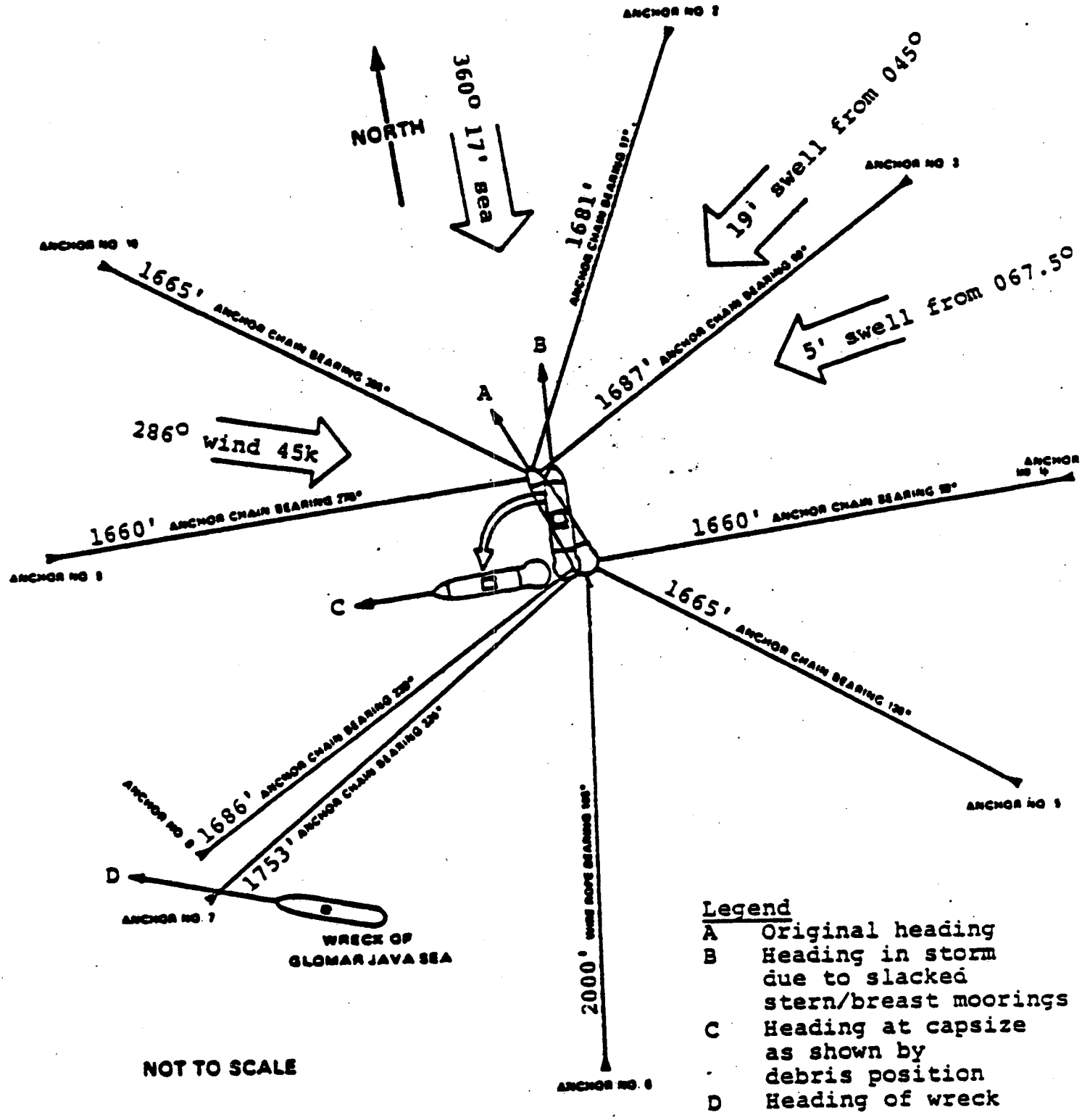
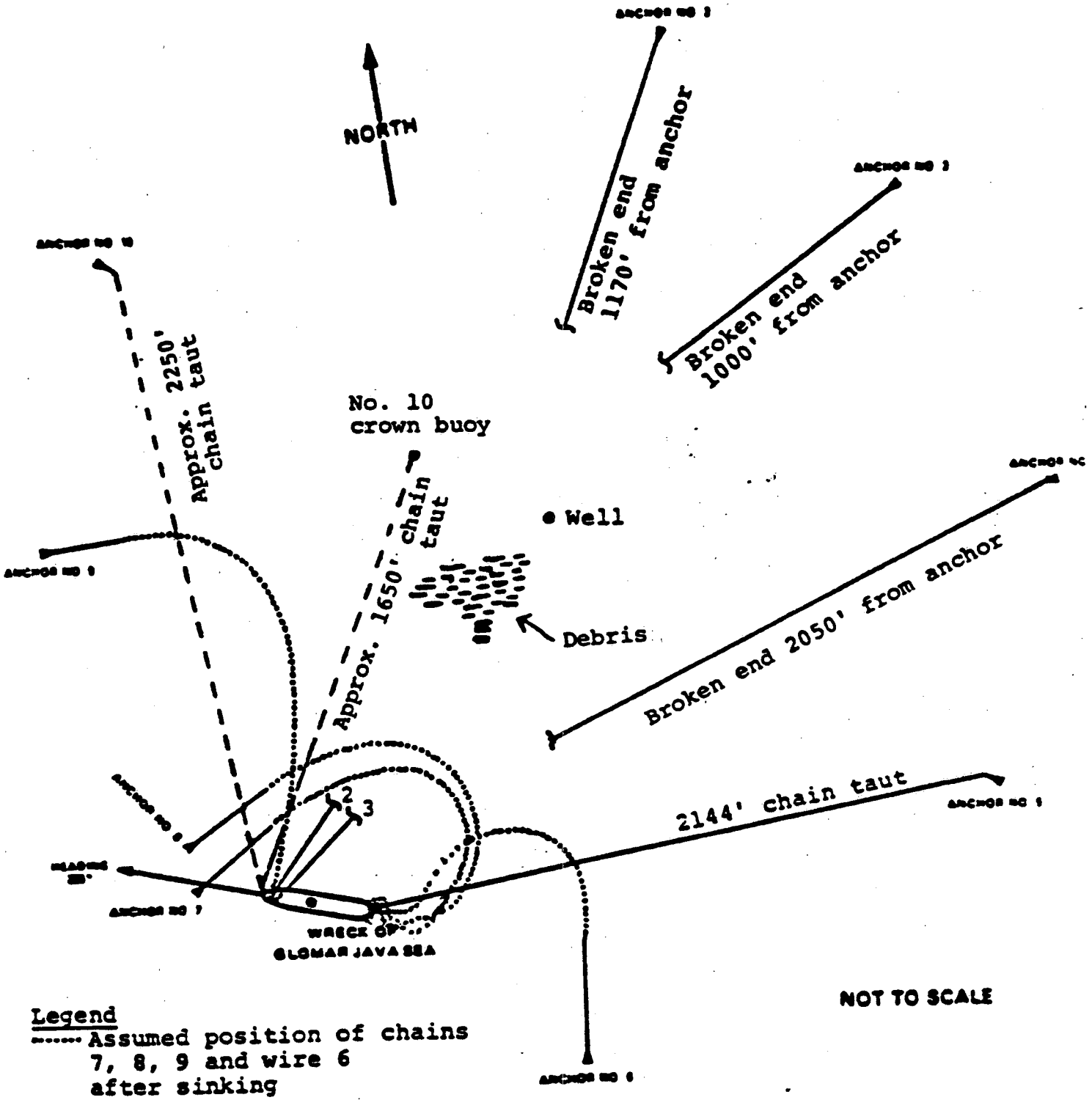


Figure 1. Headings before and during storm and at capsize



Legend

..... Assumed position of chains 7, 8, 9 and wire 6 after sinking

— — — Alternate positions of chain 10 after sinking (depending on whether or not anchor 10 dragged)

Figure 2. Position of wreck, anchor chains and debris of GLOMAR JAVA SEA (per chain recovery information and sonar studies)

II.

EVACUATION AND WEATHER

In the concluding sentence of the statements of Probable Cause (at pp. 1 and 76) the Board states:

> Contributing to the large loss of life was the failure of the master and of Atlantic Richfield Company and Global Marine management to remove nonessential personnel from the GLOMAR JAVA SEA.

This conclusion is unfair second-guessing of judgments made by knowledgeable, conscientious people with no demonstrated guiding motivation other than considerations of their own safety.[6/] To the extent that the Board seeks to substantiate its hindsight judgment, its conclusions are based upon inaccurate, misleading and incomplete statements in the Report concerning weather.

A. Exaggeration of Lex.

The Report starts (p. 1, paragraph 1) by calling tropical storm Lex "Typhoon Lex," an exaggeration which pervades the Report. The storm was never forecast to be a typhoon and never achieved typhoon strength. The Board's own Report in Appendix G shows that maximum sustained winds

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6/ The uncontradicted evidence is that evacuation decisions were not made by Global Marine or Arco "management" but aboard the ship. See Part III infra.

at the well site were 60 knots, although the Report at p. 35 states that the center of the storm passed as close as 15 nautical miles north of the vessel. Appendix B defines a typhoon as having sustained winds of 64 knots or higher. According to the storm advisories issued by Meteo, sustained winds were reported at their highest in the 1700 October 25 advisory of 60 knots. Other Meteo advisories reported lesser intensities. Thus the 2000 October 25 advisory reported 55 knots, as did the 2300 October 25 and 0430 October 26 advisories. None of the Meteo advisories gave a typhoon warning; all are either tropical depression or tropical storm warnings. The Royal Observatory of Hong Kong characterized Lex at its maximum as a severe tropical storm, with highest sustained winds of 60 knots. See Exhibit 4 attached. The Royal Observatory states that "Lex attained its highest intensity on 25 October when maximum sustained winds and minimum sea level pressure near the centre were estimated to be about 60 knots and 980 millibars respectively."

A glaring instance of this exaggerated treatment of the storm occurs in Figure 2, p. 4: the plot of the storm movement. The plot begins in the Pacific Ocean east of the Philippines on October 20 with the label "Path of Typhoon Lex." At that point what became Lex was a tropical depression (not a tropical storm); no warning of any kind

had been issued and the depression was unnamed. On October 21 the first Meteo tropical depression warning was issued when the low pressure area was over Luzon. Not until the 0430 advisory on October 23 was a tropical storm warning issued. At that point the storm was actually heading north toward Hong Kong, as Figure 2 shows.

The pattern of exaggerating the evident danger posed by the storm is again seen on page 2 of the Report. Contrary to the statements in paragraph 3, the 1800 Meteo forecast on October 22 did not predict maximum winds of 50 knots gusting to 60 knots for the area of the drillship's operation. That forecast was for predicted locations of the center of the storm, not the well site, at predicted positions at 1700 October 23 and 0500 October 24. Those predicted positions projected the storm center passing in excess of 55 nautical miles from the well location. The Meteo forecast referred to gives a prediction for maximum conditions at the well site (as opposed to the storm center) during the period 2000 October 23 to 0800 October 24 to be wind force of 8-9 (34-47 knots) with gusts to force 10 (55 knots), significantly milder conditions than the 60 knots erroneously stated in the Report, and well below typhoon strength.

The exaggerated characterization of the strength of Lex is compounded by the statement that the drilling location was "known locally as 'Typhoon Alley'" (p. 33

"Meteorological Information"). This colorful label was injected into these proceedings by lawyers for death claimants. Who is the "local" source for this phrase? This loaded language conjures a vision of the drilling site being in some narrow passageway of uniquely high incidence of typhoons. That simply is not the case. Areas to the east of the drilling location, and particularly to the north and east of the Philippines, may fit this description, but not the area just south of Hainan Island, where the frequency of the occurrence of typhoons is significantly lower. The vessel was in no more a "typhoon alley" at its drilling location than in the U.S. Gulf of Mexico.

Graphic verifications that the drill site was not uniquely susceptible to typhoons can be seen by examining the technical memorandum NWS NHC 23 published by the National Oceanic and Atmospheric Administration, Exhibit 5 hereto. That publication contains maps with contours showing the number of tropical cyclones that have occurred in 100 years. Viewing probabilities of the occurrence of a tropical cyclone over an entire year, the map on page A36 shows that the drilling site, along with almost the entire length of the southeastern coast of China and about half of the southern coastline of the principal islands of Japan, lie within the 80 to 100 curves, meaning those areas have experienced 0.8 to 1.0 tropical cyclones per year. Over

twice that frequency (ranging to a high of 2.4 per year) is found in the area north and east of the Philippines. The frequency curves shown on that page (as well as A28 for the month of October alone) hardly jibe with a description of the well site as being in "typhoon alley."

The exaggeration of the danger posed by Lex continues on p. 35 of the Report. The statement in the second full paragraph that there were 65 knot winds near the center at 0700 on October 24 is inaccurate. The Meteo advisory as of 0800 on October 24 lists maximum sustained winds of 45 knots with gusts to 55 knots near the center. If a typographical error is pleaded and the claim made that the referenced advisory should be for October 25 not 24, the 0800 advisory on that day gives maximum winds of 60 knots (not 65) with gusts to 75 knots near the center.

The third full paragraph contains a serious error in the statement that there was a "42% probability for the occurrence of a storm <u>of the strength of Typhoon Lex</u> at least once during the month of October in any given year." (Emphasis added.) The source of the information quoted shows a 42% probability for the occurrence of a <u>tropical cyclone</u> (i.e. any warm core closed atmospheric circulation storm having sustained wind speeds of greater than 34 knots) not a 42% probability for the occurrence of a storm <u>of the strength of Lex</u>. The probabilities decline sharply as the strength

of the storm is increased. Many storms qualifying as tropical cyclones have considerably less strength than Lex. This conclusion is borne out by a comparison of the frequency charts for the occurrence of severe typhoons and tropical storms in the referenced NOAA publication (Exhibit 5). The location of the GLOMAR JAVA SEA lies between the 5 and 10 contours with respect to typhoons of greater than 100 knots (see p. A66), in contrast to lying between the 80 and 100 contours for tropical cyclones in general (see p. A70).

B. The October 23 and 24 advisories.

After painting a misleadingly ominous picture of Lex being a threatening "typhoon," and the vessel lying in "typhoon alley," the report then glaringly omits any discussion of the storm advisories issued October 23 and 24. Yet it is those advisories which are most significant in evaluating the judgment of those aboard the ship not to evacuate nonessential personnel. Those advisories reported maximum winds near the center of the storm of 40-45 knots, with predicted maximum sustained winds never greater than 50 knots. Moreover, the Board's Report misleadingly omits any discussion of the predicted paths of the storm that were received during October 23 and 24. These predicted paths are plotted on Exhibits 2-2, 2-3, 2-4 and 2-5 to the Proposed Findings of Fact previously submitted by Global Marine. The report fails to note that on October 23 the forecast path of

the storm changed from crossing the southern end of Hainan Island (October 23 morning predictions) to crossing the northeast corner of Hainan Island (afternoon October 23 forecast). On October 24 the forecasts predicted the storm would head northwesterly toward Zhanjiang, a course some 200 miles to the northeast of the well location.

The startling omission of any discussion of these forecasts is perhaps responsible in part for the erroneous conclusion on page 59 that "by October 24,[7/] ARCO and Global Marine should have begun evacuating nonessential personnel." On that date the storm was predicted to pass approximately 200 miles northeast of the ship with maximum winds of 40-50 knots. Forecast conditions for the well site were maximum force 7-8 (28-40 knots). These forecasts would not dictate an evacuation, but the reader of the Report is not even told of those forecasts which are inconsistent with the Board's hindsight judgment.

Likewise, totally omitted in the discussion leading to the conclusion that there should have been evacuation of nonessential personnel on October 24 are facts concerning the dangers of an evacuation on that date. On

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7/ The Report concedes that evacuation on October 23 was not indicated. See p. 59.

October 24 the vessel was experiencing an 8-10° roll and heave of 12-24 feet so that a helicopter landing on the vessel or a transfer by personnel basket to the supply boat would have been extremely hazardous.

In addition to the glaring omission of any discussion of the October 23 and 24 advisories, the Report contains actual misstatements concerning weather conditions. The 1330 Meteo advisory on October 25 predicted that the storm would pass approximately 38 miles, not 20 miles (as stated at p. 6, paragraph 1), northwest of the ship location. Not until the 1630 advisory was the storm predicted to pass as close as 20 nautical miles. Omitted from the discussion of the last radio contact between the vessel and ARCO ashore at 1830 are a series of earlier radio conversations during the day, the substance of all of which was that no one was alarmed, no one was requesting or suggesting evacuation or moving the ship, the vessel was riding well, and although the seas were rough they were not significantly worse than any past storms experienced by the vessel.

The statement in the second paragraph at p. 58 ("Survival Factors") that evacuation of personnel would delay resumption of drilling operations and increase the cost to ARCO is not supported by any evidence in the record. In fact, an examination of the records in connection with

the July evacuation shows that there was absolutely no delay in resuming operations. More importantly, that evacuation shows that there was no reluctance to evacuate nonessential crew members, regardless of cost considerations, contrary to the statement in the first sentence of the third paragraph. In that connection, the prior evacuation was in July, not September as stated in the second sentence of that paragraph.

It is, of course, easy to second-guess after the fact. Subsequent events show that had personnel been safely evacuated on the 24th they would not have been aboard the ship on the evening of the 25th when it sank. Nevertheless, we submit that it is completely unfair to "Monday morning quarterback" in that fashion. We believe it is only fair to the captain and others advising him in any evacuation decision to take the situation as they knew it on October 24, namely the certainty of an extremely hazardous evacuation process weighed against predictions for a tropical storm (not a typhoon) to pass over 200 miles away with relatively mild forecast conditions for the well site. The sadly inappropriate conclusion by the Board is based not only upon improper second guessing but also ignoring facts of record. The uninformed reader of the Board's report is given no hint of what the truth is as to the situation confronting those aboard the vessel on October 24.

C. Who were "non-essential."

In addition to criticizing the decision not to evacuate, the Report also deals with the subject of who were the persons to be evacuated. The statement in the first paragraph on page 59 that the only essential personnel after the riser was secured "were those in the marine department and perhaps some Global Marine and ARCO supervisory personnel" is not supported by any testimony from any of the witnesses. The unanimous testimony was that the entire drilling crew would be essential. The Board is substituting its judgment on this point for that of many highly experienced witnesses, leading to a totally unjustified conclusion. There was no fundamental disagreement in the testimony concerning who were and who were not essential personnel. All agreed that service hands such as the employees of Schlumberger, Halliburton and The Analyst were nonessential personnel, and all agreed that the entire marine crew and the entire drilling crew were essential personnel. The only point of minor difference in the testimony concerns whether divers were or were not essential personnel. All of the witnesses agreed that the designation of who was essential and who was nonessential would depend upon circumstances then in existence.

Moreover, the actual experience of evacuation in July shows that it was the service hands and certain employees

of CNOOC who were evacuated. No members of the Global Marine drilling crew were evacuated. There is absolutely no evidence that there was any "confusion" in either July or October concerning which crew members should be considered nonessential. With respect to events in October the testimony concerning all of the conversations between ship and shore showed that no one gave serious consideration to evacuation of anyone when evacuation could have been safely accomplished (October 23) for the simple reason that evacuation was not indicated at that time, as the Board itself finds (p. 58).

Finding 16 (Conclusions, p. 74) should be deleted as creating more potential danger than the alternative rejected. The philosophical underpinning of this finding is that a rigid, mechanical evacuation plan is to be preferred to trusting the judgment of experienced, competent, trained personnel. As uniformly testified to in the Board proceedings, the determination of who is and who is not essential depends upon each situation. Here no personnel were evacuated, not because there was any difficulty in determining who was and who was not essential, but because everyone involved in the operation deemed that evacuation of no one was indicated. The Board does not cite any instance in the operation of this vessel where there was any problem, dispute or confusion concerning determination of who was

essential and who was not once the decision has been made to make a partial evacuation.

We submit that the matter of determining who is nonessential for purposes of evacuation is simply not appropriately subject to rigid, mechanical rules but is best left to the sound judgment of experienced, informed personnel. The alternative of a rigid rule may create more problems than it solves. We believe that the following guidelines as set forth in the Global Marine Procedures Manual No. 5 (at § 853.47, p. 5 of 6) are far preferable to the rigid rule proposed in the Board's report:

> V. EVACUATION
>
> It is recommended that if a tropical cyclone threatens the well site area, all nonessential personnel be evacuated:
>
> A. Judgment must be used. Evacuation could be a greater danger than keeping the personnel aboard the ship.

III.

SOLE AUTHORITY OF MASTER

The Board in its Finding 38 under Conclusions states:

> Decisions in time of an emergency must be made by a single source of authority and cannot be vested in a triumvirate (master, drilling supervisor, and oil company representative) as is the present practice on many offshore drilling units.

Global Marine agrees with this finding and believes that the single source of authority should be the master. Global Marine strenuously disputes, however, the implication in this finding, and explicit statements elsewhere in the Report, that the captain's authority on the GLOMAR JAVA SEA in an emergency, and in normal operations as to marine matters and vessel safety, was in any way diluted. To the contrary, the record before the Board without exception shows that the master of the GLOMAR JAVA SEA at all times had sole authority in an emergency and was vested with sole authority as to the safety of the vessel and crew. Testimony taken in depositions in the civil litigation that has continued after the hearings underscores the authority of the master.

A. The Board's inconsistent position.

Before discussing the authority of the master of the GLOMAR JAVA SEA as shown in the record before the Board

and in the testimony in the civil litigation, we think it appropriate to point out that in many respects certain statements in the Report and certain findings by the Board would undermine the authority of the master and thus be counterproductive to the Board's statement in Finding 38. For instance, Finding 16 by requiring a rigid, inflexible list of nonessential personnel would undermine the authority of the master. See discussion in Part II, supra. The criticisms relative to failure to evacuate on October 24 (see Report at pp. 58-59, last paragraph) and the final sentence in the statements of Probable Cause (at p. 1 and p. 76) are directed at ARCO and Global Marine management which, if accepted, imply that such management should have had the authority to override the decision of the master as to a question of marine safety. Thus, the final sentence of the statement of probable cause states:

> Contributing to the large loss of life was the failure of the Master and of Atlantic Richfield Company and Global Marine management personnel to remove nonessential personnel from the GLOMAR JAVA SEA. [emphasis added]

Implicit in this criticism is not only that ARCO and Global Marine management had the authority to order evacuation of personnel but that they should have exercised that authority to override the sound judgment of the master. That conclusion contradicts the standard suggested by the Board in

Finding 38. Global Marine believes that shore-based personnel should have the authority to suggest, to recommend and to raise questions but that ultimately the master must decide who is and who is not essential and whether an evacuation is or is not warranted by balancing potential dangers of evacuation against potential risks of remaining aboard.

B. Global Marine written policy manuals.

Finding 38 does not explicitly state (although in context it implies) that the master did not have sole authority in time of an emergency. The record in this hearing does not justify such criticism of Global Marine. Unlike some drilling contractors, Global Marine from the outset operated from floating vessels. It was the industry pioneer in drilling from floating vessels and developed much of the technology and operating expertise in floating operations. Unlike some drilling contractors who moved offshore from land based drilling operations, Global Marine has always been a marine oriented company. "Marine" was in its name from the beginning. It is apparent from reading the Report as a whole, particularly at pp. 66-70, that Global Marine is being criticized for deficiencies that may have been found in other casualty investigations in the operations of other companies.

Further, Global Marine has taken its marine responsibilities seriously and has sought to define carefully the uniquely marine aspects of its operations. Not resting upon its marine traditions, Global Marine management has defined these responsibilities in a series of written manuals which consistently demonstrate the sole authority of the captain in an emergency. Since these manuals were largely ignored by the Board in its Report, we believe it appropriate to cite their provisions.

1. Standard manning/job descriptions.

Global Marine Drilling Company's publication entitled "Standard Manning/Job Descriptions" (Exhibit 6 hereto) contains the master's job description. We quote pertinent parts:

OBJECTIVES:

> To operate in such a manner as to effect a safe, legal, and efficient performance by achieving the goals set forth under "Responsibilities."

RESPONSIBILITIES:

> * * *
>
> 9. Assume control and be responsible for the safety and welfare of the vessel and personnel during emergency periods and when the unit is underway. [Emphasis added.]

Statement 9 is clear and unequivocal. The other responsibilities of the master defined in his job description[8/]

8/ The others are as follows:

1. Operate vessels in accordance with safe marine practices such as those applicable portions contained in the GMDC Procedures Manual No. 5 (which now supersedes the former GMDC Marine Manual).

2. Assure vessel is in compliance with appliable government rules and regulations, government agencies, and regulatory bodies.

3. Recommend mooring headings and plan to Supervisor and supervise mooring/anchor moves.

4. Operate all anchor windlasses/winches and deck gear in a proper manner.

5. Monitor weather reports and weather progress. Make recommendations and consultations with the Drilling Department as to when to disconnect from the well head or take other necessary precautionary action.

6. Supervise safe and efficient conduct of supply boat and helicopter activity as applied to loading, offloading, coming along side, departing, landing, and take off from the drilling unit. . . .

7. Maintain seaworthiness and safety of the vessel at all times within prescribed marine law and operating criteria by:

   a. Proper maintenance procedures in accordance with GMDC preventative maintenance program.

(Footnote Continued)

lead up to that firm statement. For example, if after making recommendations and consulting with the drilling department as to when to disconnect from the wellhead as stated in Responsibility 5 (set forth in the footnote), the captain feels that operations must cease, he then is given the responsibility in Responsibility 9 to "assume control and be responsible for the safety and welfare of the vessel and personnel." Even during drilling operations, if the master deems the safety of the vessel or her crew to require it, he may order drilling operations to cease and the entire vessel placed under his direct command. There can be no doubt that after drilling operations had ceased and the vessel was waiting on weather, the master had sole command of the GLOMAR JAVA SEA.

2. Marine manual.

Procedure Manual 5 "Marine Operations" (MBI Exhibit 8) referred to in the master's job description

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(Footnote Continued)

b. Timely results.

c. Proper manning of vessel at all times.

8. Maintain vessel over hole and maintain trim of vessel. Be operationally knowledgeable of all ballast systems and their proper operation.

further underscores the unique responsibility of the master on a Global Marine drillship. The introduction to that book (§ 850.03, page 1 of 1) states:

> GMDC does not expect this manual to supersede the responsibilities legally required of its marine personnel. The Captain is responsible for the safety of the ship and crew. It is not the intention of any statement made in any Global Marine Manual to relieve the Captain of his responsibilities to the vessel or crew. [Emphasis added.]

The next page (§ 851.01, page 1 of 2) states:

> I. The Captain is responsible for the safety of the ship and everyone aboard. Whenever the safety of the ship or crew is in jeopardy, the Captain will declare a state of emergency and assume sole command. During any emergency the Captain will seek the advice of the Senior Drilling Personnel.

While the captain is wisely instructed to seek advice from other knowledgeable persons, it is clear that he alone has final authority. That he is counseled to seek advice in no way undermines that authority, any more than the authority of the President of the United States as Commander in Chief is undermined by the fact that he may deem it advisable to seek advice from the Secretary of Defense, the Joint Chiefs of Staff and others. Procedure Manual 5 proceeds in detail to give instructions and guidelines concerning many types of operations. Throughout the volume it is consistently emphasized that the captain has ultimate responsibility for the safety of the vessel and

crew and is given the typical responsibilities of a captain in any marine operation.[9/] In the discussion of heavy weather procedures (§ 853.47), which is relevant to the responsibilities of Captain Swanson aboard the GLOMAR JAVA SEA on October 22-25, the manual states:

> B. Area of Responsibility:
>
> 1. The Master has absolute responsibility and authority for the safety of the crew and ship.
>
> * * *
>
> XI. TO THE CAPTAIN
>
> A. It is your responsibility to offer the Superintendent the best possible advice, and to recommend appropriate action.
>
> B. Until such time that the Master is of the opinion that the ship or crew are or may become endangered the Superintendent is in charge and responsible for equipment.
>
> C. Prior to taking sole command consult with the Superintendent.
>
> D. Whenever it is apparent that the ship or crew are or may become endangered you must declare a state of emergency and assume SOLE command and responsibility.

9/ See for example paragraph § 853.01 "Over the Hole Operation", § 853.21 "Mooring/Unmooring Drilling Vessels", and § 853.37 "Guidelines for Workboat Operations" ("The responsibility rests fully on the Master to see that workboat operations are properly carried out." "The dispatching of supply vessels should be done with the knowledge and consent of Senior GMDC Drilling Personnel and client's representative aboard.
(Footnote Continued)

Again, the advice to the captain to consult with and advise the superintendent as contained in paragraphs A-C in no way undermines the ultimate authority of the captain as stated in paragraph D. That authority is emphasized by putting the word "SOLE" in all capital letters.

Procedure Manual 5 continues at § 855.03 "Basic Safety Practices for the Crew" to instruct (at p. 8 of 12 under the heading "Storm and Severe Weather Conditions") that "the Master will take appropriate measures to ride out the storm."

3. Critical Procedures Manual.

Another Global Marine manual covering the operation of all of its vessels is the Critical Procedures Manual (MBI Exhibit 7). It also unequivocally states the sole responsibility of the master in an emergency. One section of that manual deals with hurricane procedures and evacuation. The general notes to that section (at sheet 1 of 4) state:

> 2. The Master has absolute responsibility and authority for the safety of the crew and ship.
>
> 3. The Senior Drilling Department member aboard is responsible for the safety of the well and drilling equipment.

(Footnote Continued)
Consent is not required if the safety of the vessel is involved.") [Emphasis added.]

4. It is the Master's responsibility to offer the Superintendent the best possible advice, and to recommend appropriate action.

5. Until such time that the Master is of the opinion that the ship or the crew are or may become endangered, the Superintendent is in charge and responsible for drilling equipment.

6. Prior to taking sole command, consult with the Superintendent.

7. Whenever it is apparent that the ship or crew are or may become endangered, you must declare a state of emergency and assume SOLE responsibility.

4. Vessel Operating Manual.

Turning to the Coast Guard/ABS approved Operating Manual (MBI Exhibit 10) for the GLOMAR JAVA SEA, the captain's area of responsibility is stated in the heavy weather procedures as follows (at p. 21, part II):

1. The Master has absolute responsibility and authority for the safety of the crew and ship.

The instructions to the Captain contained in the Procedure Manual 5 at § 853.47, p. 6 of 6, quoted above, are set forth verbatim at p. 26 in the vessel Operating Manual. At pp. 29-30 an example is given as a guide for making a decision of whether to move off location when heavy weather threatens. Discussion of the example concludes with the following statement: "In this example the decision was made to move the vessel off location. This is left to the Captain's discretion." [Emphasis added.]

C. Global Marine policy in practice.

Testimony taken both by the Marine Board of Investigation and in the civil litigation, and documents produced in connection therewith, show that the Global Marine policies and manuals were followed in actual practice.

1. Records.

As the typhoon season approached in 1983 Captains Ludwig and Spencer prepared the first draft of the typhoon plan. Captain Lester was assigned to the operation in May 1983, and shortly after his arrival on board the vessel as master Marvin Brockman wrote him a memorandum (Exhibit 7 hereto) asking him to review the existing draft typhoon plan prepared by Captains Ludwig and Spencer and make any changes he thought appropriate. The attitude of Brockman, the shore based rig manager, toward the authority of Captain Lester is instructive:

> You and the crew are the people that will be out there during the storm and will have to make a spot decision. I value your opinion and will never second guess you on any split decision that has to be made.
>
> I think you will find Spencer and Anderson [the alternating Global Marine Superintendents at the time] very cooperative in any project you undertake.

It is evident that Brockman felt that Captain Lester had the sole and ultimate authority to make decisions concerning such matters as evacuation, handling of anchors,

discontinuing operations and leaving the well site. It is apparent that Brockman did not feel he had the authority to override the captain's decision in such matters, nor did Superintendents Spencer or Anderson.

The response to the tropical storms and typhoons in July also shows the authority of the captain. We attach hereto as Exhibit 8 a series of telexes from Captain Lester to Brockman concerning the approach of Typhoons Tip and Vera in July 1983. It is apparent from reading these telexes that Captain Lester was in command. It was Captain Lester, not the Global Marine Drilling Superintendent or the Arco Supervisor, who was notifying Brockman of decisions concerning evacuation and consideration that was being given to moving the vessel. Likewise, Captain Lester was telling what he was doing, not asking for Brockman's or Arco's instructions.

Interestingly, although at one point these typhoons were headed directly at the GLOMAR JAVA SEA, Captain Lester's tentative decision was not to move from the location. Thus, on the morning of July 11 he advised that with the storm expected on the afternoon of the following day he did "not anticipate move at this time." That afternoon he advised that Tropical Storm Tip

> has upgraded to typhoon 75 knots over location 7/12/13/83 followed by second storm within 80 hours. Am attaching buoys to all anchor

> chains except 10 plus 2 which I will retain should a decision be made to come off location.

Later that same afternoon he advised that the forward speed of the storm had slowed and that it had intensified to a strength of 80 knots near the center with arrival at the well site "p.m. tomorrow." Captain Lester said "Will most probably ride it out but will keep advised of the situation as it develops." It was that afternoon that 22 nonessential personnel were evacuated by helicopter and supply boat to Sanya.

The next morning Brockman issued his morning report to Houston updating the status of the approaching typhoon and concluding:

> Capt. Lester has assured me that the ship is secured for the storm. I have confidence in his judgment. [Emphasis supplied.]

Note that Brockman told Riddle that he had confidence in Lester's judgment. There was no reference to a judgment by any triumvirate consisting of Captain, Global Marine Superintendent and ARCO Superintendent. Nor was Brockman attempting to direct Captain Lester, nor did he seek directions from Riddle or anyone else in Global Marine management.

On July 13 Captain Lester telexed Brockman reporting that Typhoon Tip had passed to the northwest but that Typhoon Vera was "building over Philippines." He advised: "Will track and send you daily positions and guesstimates of

intentions." Again, it was Captain Lester telling Brockman what his (Captain Lester's) intentions were. He was not seeking orders from Brockman, Riddle, Arco or anyone else, nor was he advising of the intentions of any triumvirate aboard the ship.

These communications are unequivocal. Obviously, they were not made with a view toward this investigation or the civil litigation. These communications reflect that in actual practice the captain of the GLOMAR JAVA SEA was in command with respect to heavy weather emergencies. These communications show that the Global Marine policy manuals were not abstract edicts from management but were in fact implemented.

2. Testimony.

Turning to the sworn testimony given both in the Marine Board of Investigation and in the civil litigation, we see consistent support for the proposition that the Captain's authority was not diluted with respect to emergency decisions affecting the safety of the crew or vessel. The testimony is consistent from the head of Global Marine to the captains on the ship. Moreover, Arco personnel also testified that Arco deferred to the sole authority of the Master. We quote hereafter some of the pertinent passages from the testimony; Exhibit 9 hereto contains more lengthy quotes.

a. Mr. Russ Luigs, Chief Executive officer and Chairman of the Board of Global Marine Inc. testified on deposition as follows:

> Q. Suppose it came down to the question of evacuation of the vessel because of an impending typhoon. Who would have the decision to evacuate?
>
> A. The Captain.
>
> Q. And what about the drilling superintendent of Global?
>
> A. No.
>
> Q. What about the drilling superintendent of Arco?
>
> A. No.
>
> Q. Solely up to the Captain?
>
> A. Yes.

[P. 82, lines 2-13.]

b. Mr. Gary L. Kott, President of Global Marine Drilling Company testified on deposition as follows:

> Q. Now, with that weather coming in, and if it looked ominous, who was supposed to make the decision of whether it was such a situation that the vessel should be moved?
>
> A. The ultimate decision definitely was with the Captain.
>
> Q. Now, if Arco had said that we are fearful of this storm and we want the vessel moved at this point, whenever it might be, would you say that the Captain could refuse to go?
>
> A. Yes.
>
> Q. And he could completely disregard the directions of the Arco people?

A. Yes.

Q. And on what documents, if any, do you base that statement?

A. It's a general policy that we have, and have had, that the Captain is in charge of the ship, particularly in times of a concern for safety, marine safety.

[P. 48, lines 5-24.]

c. Mr. C. H. "Buddy" King, Executive Vice President Operations, testified on deposition as follows:

Q. Well, now, who in Global had authority to direct the JAVA SEA to leave the drill site in the event of dangerous weather?

A. There's only one person.

Q. And who is that?

A. That's the captain of the vessel.

[P. 73, line 21 - p. 74, line 3.]

Q. Are you suggesting that if someone in authority at Global directed the vessel to move off site at the time of this impending typhoon, that the captain had the choice of whether or not to obey that order?

A. Absolutely.

Q. Are you suggesting that if ARCO directed the vessel to move, that the captain could still override that order?

A. One hundred percent, yes.

Q. On what facts to you base that statement, Mr. King?

A. On the structure of our company, the structure of the way we operate.

[P. 75, line 20 - p. 76, line 8.]

d. Mr. Bill Riddle, Vice President Operations Drilling Group II (including the GLOMAR JAVA SEA) testified at the Marine Board as follows:

> Q. You didn't mention the fact that you also had a master on board. Would you give us your opinion as to the separation of responsibilities between these three individuals when a storm is approaching the drillship?
>
> A. Yes. The drilling superintendent and the master of the vessel coordinate the activities and the procedures that we're going to follow and discuss those with the ARCO supervisor and they come to a decision on how they are going to handle the present situation or the situation in the future.
>
> Q. If there was indecision or if there was not agreement amongst these three gentlemen that were on board, the three experts, who would you place in the highest position, the one that would make the final decision?
>
> A. The master.

[P. 1485, line 11 - p. 1486, line 3.]

> Q. What if the superintendent, though, on Mr. Cheavens' last hypothetical question, doesn't agree that it's a state of emergency? Assume that reference then has to be made to the operations manual to see who wins that battle. What must be done?
>
> A. The captain, if he decides to take sole command of that vessel and the superintendent declines, the captain can lock him up in irons.

[P. 107, lines 2-10.]

e. Mr. Marvin Brockman, rig manager GLOMAR JAVA SEA, testified at the Marine Board as follows:

> Q. (BY MR. VANDER LANS): Mr. Brockman, after the drilling operation is secured as it was

on board the JAVA SEA, am I correct that the decision-maker on the ship is then the captain?

A. Yes

[P. 279, lines 19-23.]

Mr. Brockman testified on oral deposition in the civil proceedings as follows:

Q. In connection with those storms, who would be in charge of the vessel --

Q. -- once the vessel was disconnected from the well?

A. The captain.

Q. Could you tell the captain to stay on location if he wanted to leave?

A. No.

Q. Could you tell him to leave if he had decided, in his judgment, that it was safer to stay?

A. No.

Q. Would the situation change any, Marvin, if you were out on the vessel?

A. No. The captain is the boss under them prescribed circumstances.

[P. 258, line 2 - p. 259, line 6.]

Q. Who, in the total chain of command with respect to the GLOMAR JAVA SEA, starting at the lowest rating on the vessel up through Houston management, who is it -- or is there a person in that range of people that has the responsibility for evaluating weather information and making decisions on the handling of the vessel in response to weather?

Q. Is there anybody?

A. The decisions are left up to the captain.

[P. 261, lines 14-25.]

f. Captain J. J. Lester, master of the GLOMAR JAVA SEA in May, July and September, 1983, and previously master of the GLOMAR GRAND ISLE, testified at the Marine Board:

Q. Hypothetically, if a typhoon was approaching the GLOMAR JAVA SEA when you were aboard, who would make the decision to drop the anchors and seek shelter?

A. I would.

Q. Would you have to consult with anyone?

A. Technically, no, sir. I would have in consideration my working relationship with my colleagues. But if I decided to release the anchors, that was it.

[P. 546, lines 4-13.]

Q. You were asked questions by the Board about some of the manuals and procedures. Is there any way that somebody sitting back in an office can write you directions which are in any way a substitute for your sound judgment as a master?

A. No, sir, I don't believe so. The guidelines, there are good guidelines. But I think the final decision had to be made by the master.

[P. 580, lines 9-18.]

Q. Captain, is my understanding correct that as master of the JAVA SEA you were the ultimate authority as to whether the vessel went out of the drilling mode and it would raise all or some of its anchors?

A. Yes, sir, I was.

Q. Without consultation being required by anyone?

A. I would consult or I would make the decision.

Q. And the same is true, Captain, is it not, if there were a determination as to whether the vessel would get under way, that would be your decision?

A. I that would be my decision. But I would have, as a courtesy, advised both superintendents of my decision.

[P. 588, lines 5-22.]

Q. As a master on board the JAVA SEA, you were responsible for the vessel's stability, were you not?

A. I am.

[P. 606, lines 3-6.]

Captain Lester testified at oral deposition as follows:

Q. Let me restate the question.

To your knowledge or understanding, was there some point pursuant to the company's policies and procedures when a ship was threatened with bad weather that you were permitted to supercede the authority of the drilling superintendent, even though the ship was still moored, and take complete command of the vessel?

A. Yes.

Q. And what was that point, sir? How was that defined?

A. I would determine that point.

Q. Did you have to consult with anyone in order to make that determination?

A. I wouldn't have to consult. I would discuss the matter with him, as a matter of principle, and then advise them that I'm obtaining command.

[Vol. I, p. 100, lines 1-18.]

g. Captain J. W. Leadbetter, master of the GLOMAR JAVA SEA in June and August 1983, testified at the Marine Board as follows:

Q. If a time ever came that you would have to evacuate personnel from the GLOMAR JAVA SEA, who would make that decision?

A. By that, do you mean reducing non-essential personnel?

Q. That is correct.

A. That would be a decision that would be developed by myself, by the drilling superintendent of ARCO and by the chief engineer.

Q. Would you as the master have the ultimate responsibility?

A. I would.

[P. 765, line 16 - p. 766, line 2.]

Q. Captain, I'm trying to get at the pecking order, if you will, or the authority on board the vessel of who makes the, who had the authority or who actually did make such decisions to evacuate personnel in the event of heavy weather. Let me ask the specific question: Did you as master have the sole authority to evacuate, make the decision to evacuate personnel?

A. I had the sole authority for the final decision of the safety of the ship and the people on board. In the process of removing non-essential personnel, as I testified before, that would be a collective type of thing that would develop as situations developed. And I don't know any other way to answer that question.

[P. 810, line 13 - p. 811, line 2.]

Captain Leadbetter testified at oral deposition as follows:

> Q. Do you know of any facts which would cause you to doubt that, if you were master, you would have had the absolute responsibility and authority referred to?
>
> A. Nothing came to my mind that I would have a conflict of taking control of that ship when I needed to.

[P. 240, line 16 - p. 241, line 2.]

h. Captain Russell Ludwig, permanent captain of the GLOMAR JAVA SEA for 5 years, stated on his deposition:

> Q. Well, did you have a general feeling that it was in your best interest as master of the vessel to stay on location as long as possible in the event of heavy weather coming through?
>
> A. No, sir. You mean my personal feelings?
>
> Q. Yes, sir.
>
> A. No, sir.
>
> Q. What did you perceive as your lines of authority, from you, up, once you arrived in China?
>
> A. You want to know my personal feelings? I considered myself master at all times.

[P. 39, lines 11-25.]

> Q. Throughout the day, Captain, there has been a lot of discussion about your position on board the GLOMAR JAVA SEA and what authority you had as master of that vessel. I understood you to say that in your own mind you were the ultimate authority on board that vessel and that there was no one senior to you on board the GLOMAR JAVA SEA; is that correct?

A. That was in my mind, yes, sir.

Q. That was your understanding of your position?

A. In my mind, yes, sir.

[P. 307, lines 3-14.]

i. Mr. Lee Wilson, Vice President Arco China Inc. testified at the hearing as follows:

Q. . . . . Who had the authority to make the decision or give the order to stop drilling in an emergency situation? As an example, if there was heavy weather coming.

A. Heavy weather. Well, again, the captain, our man could do it. Global Marine's drilling superintendent could do it. And the captain could do it. The captain would be the final word as far as the safety of the ship was concerned. But the others, the drilling superintendent of Global Marine and ARCO's drilling supervisor might decide the hole was not safe to take a chance on the weather and start the procedure for suspending operations.

Q. With your experiences with the GLOMAR JAVA SEA and these three individuals, your drilling supervisor and Global Marine's drilling superintendent and the master, did you find that they acted independently in decisions such as this, or would they talk to each other and come up with a mutually agreed upon decision?

A. Well, they would certainly talk to each other. And if there was something primarily to do with the drilling aspect of it, probably our man and the drilling superintendent of Global Marine would prevail. If it was weather or safety of the vessel, then the captain would.

[Vol. I, p. 30, line 12 - p. 31, line 13.]

j. Mr. Ernie Dean, Arco's number two man in China, stated on his deposition:

Q. And whose decision should it be?

A. About the moving off location?

Q. Yes, sir.

A. That would be the captain's decision.

Q. Do you see any problem with having it appear that it's a joint decision with regard to moving off location?

A. Well, the -- Sure it's a problem with the joint decision for moving off the location because that is a captain's responsibility; however, under normal conditions, before he would move off location, the operator, with the superintendent, would perform duties, such as marking the well location, so he would be able to move off the location and be able to come back to it.

So, that was the reason this was in here -- so once the operator and superintendent had the marker buoy marking the well in position, then the captain would be able to move off. Of course, he could always move off earlier, if he felt it was necessary. But normally he would wait for it to be done because it would be easier for him to come back to location.

Q. Do you see any problem with having a joint decision to be made by the operator and the captain and perhaps the supervisor? What kind of problems would you see?

A. There has to be one man in charge. There will be a discussion about "Is this done," or "Do you think we need to do this," or so forth. But the decision of the safety of the vessel, moving of the vessel, and safety of the personnel is the captain's; and he has to take that responsibility.

[P. 272, line 9 - p. 273, line 19.]

k. Mr. Joe Fry, Arco China Drilling Superintendent, testified at the hearing as follows:

Q. Now, I wasn't quite sure who made the decision of what non-essential personnel were to be evacuated. Could you expand on that?

A. Well, as I said a little earlier, at the end at the time to start evacuation, it is up to the captain to evacuate the rig. In other words, he takes over once the riser is laid on the deck.

So, I'm not saying now the Global Marine superintendent and the ARCO drilling supervisor aren't working in conjunction with him. But he has the last say. In other words, you have to sit down and talk this out.

[Vol. III, p. 398, lines 5-16.]

On his oral deposition Mr. Fry stated:

Q. If, for whatever reason, Arco felt that it was in the best interest of the crew to be evacuated from the GLOMAR JAVA SEA, who with Arco could make that decision?

A. No one with Arco could make the decision. The evacuation plan has been organized. The people on the rig -- and the captain is in charge of the vessel -- well, he's always in charge of the vessel.

[Vol. I, p. 38, line 20 - p. 39, line 2.]

Q. And if you felt it was in the best interest of Arco to see that the vessel was moved, you could send that order as well; right, sir?

A. I can't tell a captain what to do on the rig.

Q. Wait a minute, Mr. Fry. Are you saying that if, as you sat in your office, you believed that the captain either was doing something or failing to do something that put that crew at risk, that you couldn't pick up the phone and tell him that?

A. I could tell him that, yes. I could tell him he'd better take another look at what he's doing.

> Q. If you felt like it was in the best interest of Arco and the men on the GLOMAR JAVA SEA that the vessel be moved to another location, that's something that you could communicate to the ship, isn't it, sir? ... If you, as you sat in your office, said, "You know, something needs to be done here."
>
> A. We're going back to what we said here over 30 minutes ago. I don't have permission to call the captain up out there and tell him what to do.

[Vol. I, p. 46, line 17 - p. 47, line 22.]

These quotations are extensively supplemented in Exhibit 9.

D. Conclusion

In the light of this consistent, overwhelming evidence some of the statements in the Board's report are puzzling. The statement at the bottom of page 52 that the Operating Manual merely "recommended" that the master have absolute responsibility and authority for the safety of the crew and ship is plainly incorrect. As the quoted Global Marine Manuals show, the captain was unequivocally charged with that duty. The fact that Captain Lester testified that he reported "initially to the Drilling Superintendent" as referred to at p. 49 of the Report and that he would "consult with both the Drilling Superintendent and the [ARCO] Drilling Supervisor in the event of heavy weather of upcoming storm" in no way undermines that authority. During normal operations he did report to the Superintendent. But as the

manuals and quoted testimony make clear, when considerations of safety required or in any emergency he had the authority and the responsibility to assume sole command.

Thus it is apparent from the record that Captain Lester did assume sole command in July. The fact that Captain Lester thought it wise to consult with the Drilling Superintendent and the customer's Drilling Supervisor in no way undermines that authority. The practice of consultation by the captain with two other experienced, knowledgeable people does not transform the three into a "triumvirate".

The practice of consulting with others relative to evacuation is particularly instructive. As the Board's Report concedes at p. 59, "The Master had final authority to order evacuation." But it is only natural and wise that he would consult with others, including the people who were considered candidates for evacuation. Given the fact that the evacuation process itself might well endanger personnel, and given the fact that Sanya was an exposed port subject to its own hazards during a typhoon (particularly if it as opposed to the ship were hit directly), it is also not surprising that the practice in China was to consider the views of the personnel who were being considered for evacuation. The fact that this practice was followed does not mean that the captain did not have the authority to order evacuation of a given person if he felt that was necessary

for that person's safety. Nothing in the record would undermine that authority. What the testimony shows is that in making the evacuation decision the captain would in practice take into account the wishes of the candidate for evacuation.

The misunderstanding by the Board of the authority vested in the master of a Global Marine drillship is reflected in the statements in the Report relative to the captain's authority over the loading of the vessel. Thus at p. 20, paragraph 1, it is stated that a former master (presumably Captain Leadbetter) testified that the drilling superintendent did not consult with him regarding how much drill pipe or liquids could be loaded. This statement is not supported by Captain Leadbetter's testimony or any other part of the record. Captain Leadbetter's testimony on this subject (Transcript pp. 768-773) shows that the captain was continuously aware of the loading of the ship, that he knew after a supply boat arrived alongside what cargos (dry or liquid) were scheduled to be transferred to the ship, and that he ultimately made the decision about whether or not proposed cargos were to be transferred to the ship.

The inaccurate and misleading summation of Captain Leadbetter's testimony led the Board to conclude (at p. 58, and in its Finding No. 15 at p. 74) that the master should be in overall charge of loading and distribution of weight.

The Report implies that on the GLOMAR JAVA SEA the Master did not have this authority. The testimony and the quoted Global Marine manuals, however, demonstrate that on the GLOMAR JAVA SEA the master was that one person with such authority. The fact that in carrying out their routine duties engineers shifted ballast to keep the vessel in trim in no way derogates from the ultimate authority of the master. In any complex operation the person in charge delegates responsibility to carry out detailed routine operations. Likewise, the fact that the drilling superintendent, tool pushers, Global Marine storekeeper and ARCO personnel were involved in ordering supplies to be sent by supply boat does not derogate from the unequivocal testimony of Captain Leadbetter (and others) that once the supply boat came along side it was the captain, and the captain alone, who decided whether cargo could be taken aboard the ship.

Thus Arco Operations Manager Ernest Dean testified at his deposition:

> Q. Both Arco and Global Marine, people on the rig would send in requests for supplies, equipment, parts, fuel, whatever they needed to be carried out to the rig?
>
> A. That is correct.
>
> Q. When the boat gets to the rig, you testified that normally most or all of the supplies would be off-loaded; is that right, sir?
>
> A. That's correct.

Q. If the captain of the ship says that I don't want those particular supplies to be put on at this time, if it's going to overload the ship or it's going to put me in a stability condition, does he have the authority to say, "No, we're not going to put those supplies on the ship at this time. We're going to have to wait"?

A. Yes, he has that authority.

Q. And in the normal course of events, when the boat comes he is given information about what supplies are proposed to be off-loaded from the work boat on to the ship so that he can then exercise that veto right if he chooses to do so?

* * * *

Q. Is that your understanding of how it works?

A. This is my understanding.

[P. 857, lines 2-25 - p. 858, line 2.]

Moreover, Captain Leadbetter testified before the Marine Board that on occasion the supply boat was told to stand off and not unload supplies; his testimony supports the conclusion that the master was in charge of supply loading and distribution:

Q. You said you didn't control the supply vessels. So the supply vessel comes alongside, delivers its cargo, and then before it leaves you go out and look at the load line marks or the drafts marks?

A. I know where it is to start with. And if there is, if he was going to put nine hundred tons of water aboard and was close, why, we would find out, calculate where our draft was so that we could see whether we could take it or not.

Q. When did you find out that it was nine hundred tons? When it comes along side, he tells you that?

A. When he gets back up there and he asks how much has he got, what has he got for us? If I'm concerned about it, then I would find out, run the calculations on it.

But to answer your question, when they came out was when I would find out what they had on there to give to us. Sometimes we would offload it all, and sometimes we would have to hold him off until we could take it.

Q. That was my question. There were times when you could not offload all the cargo?

A. Yes, correct. Or we couldn't offload all the water.

[P. 772, line 14 - p. 773, line 14.]

In light of the foregoing evidence, Global Marine submits Finding 38 should be supplemented by a statement that regardless of the practice on other offshore drilling units, the practice on the GLOMAR JAVA SEA was properly to vest full authority in the master.

IV.

MANNING

Finding 37 under "Conclusions" states:

> Global Marine did not have sufficient licensed personnel aboard the GLOMAR JAVA SEA or stationed in China during the typhoon season to safely operate the drillship if the vessel had to move off location and seek shelter.

This Finding is an echo of the following statement at p. 28 of the Report:

> While in this case the master of the GLOMAR JAVA SEA had the option to seek shelter near Nainan [sic] Island, Global Marine should have an additional master or chief mate on board in remote locations during seasons of severe storms to provide the master with sufficient crew to safely navigate the drillship to a safe location.

There is no evidence to suggest that Captain Swanson could not safely have navigated the vessel to the lee of Hainan Island had he thought that action was required. The implication in the Report is that an additional master/chief mate would have been required to make that voyage safely or to make that voyage without violating the certificate of inspection. That implication is simply untrue. In an emergency situation, Captain Swanson could take such action as he thought appropriate for the safety of the crew and vessel, including departing from the well location.

All of the former masters who have testified in depositions in the civil litigation related to this matter

have stated that they would have had no hesitation to leave the site if they thought that was required. They would have felt no constraint by reason of the Certificate of Inspection or otherwise in making that decision.

1. Captain Lester testified as follows:

> Q. Captain, tell us whether or not you would feel any constraint in getting under way by virtue of the certificate of inspection if you thought you had to do so in the interest of safety of the ship and men.
>
> A. The ultimate responsibility -- my ultimate responsibility is the safety of my crew and my ship. If I felt it will be safer for me to get under way despite the fact that I was undermanned, I would get under way.
>
> * * *
>
> Q. Captain, tell us whether or not under the law, as you conceive it as master, you felt like you could get under way in the face of an emergency without a mate.
>
> A. Yes, I do.

[P. 115, line 20 - p. 117, line 6.]

2. Captain Leadbetter testified as follows:

> Q. Captain, if faced with a storm that, in the judgment of the master, required the ship to leave location in the South China Sea -- Let's talk about the real situation, not a hypothetical situation. Let's talk about Lex approaching the GLOMAR JAVA SEA in late October, 1983.
>
> If Captain Swanson had decided in his judgment as master that the safety of the vessel and the crew required him to leave the location, could he have done so without violating the certificate of inspection even though he didn't get a mate on board?

A. In an emergency situation, I do not consider that it would be a violation. You do what is necessary for the safety of the vessel and the people on board.

Q. When you were aboard, putting yourself back to the summer of 1983, if you felt personally that the safety of the ship or crew required you to leave, would the fact that the certificate of inspection says "add a mate on rig moves of less than 16 hours, have three mates on an extended voyage," would those statements in the certificate of inspection have hampered your exercise or interfered with your exercise of sound judgment in whether to leave or whether to stay?

A. No.

[P. 242, line 18 - p. 243, line 19.]

3. Captain Ludwig testified:

Q. It [an extra mate] was required by the Coast Guard Manning Certificate, was it not, in the event you were going to steam off of location?

A. I don't know how you'd interpret that certificate. I didn't interpret it that way. The way I interpreted it was this: That if I was on location and I had to make a move over 16 hours and I didn't have anybody aboard and I considered that ship and those personnel in danger, I'd leave. Then I'd battle with the Coast Guard people later.

[P. 89, line 22 - p. 90, line 7.]

4. Captain Spencer testified:

Q. Under the circumstances, if a ship -- and you've served on these others -- is anchored on location and you have a captain present only, no mate, and you, as captain, determine that it is required in the interest of safety to drop your anchors and get underway, to leave the location, whether it's because of weather, because of a blowout, a fire, hostile action threatened, or whatever reason, do you believe that you can get underway, do so safely, and do so without

violation of your certificate of inspection under those circumstances?

A. Without the assistance of an additional licensed?

Q. Yes.

A. Yes, I think under good conditions and depending if you have a good boatswain and a couple of good sailors, yes, it could be done.

Q. Well, and you could do so without being illegal if the emergency requires?

A. Yes.

[P. 78, lines 14 - p. 79, line 8.]

Thus conclusion 37 is not only unsupportable from the record before the Board, it is refuted by the testimony of four highly experienced, qualified ship's masters. Thus, Conclusion 37 should be deleted entirely. Moreover, the Report should explicitly state the plain fact that the vessel's manning met or exceeded the requirements of the Certificate of Inspection. It was manned at the time of sinking the same way it was manned during the Coast Guard inspection a few days earlier (during part of which time operations were suspended because of a tropical storm warning). At that inspection the vessel was found in compliance with Coast Guard regulations.

V.

SURVIVAL FACTORS

Findings 18-35 of the Conclusions section of the Report contain conclusions about procedures, equipment and actions that may have affected survivability of personnel from the casualty. The Investigation and Analysis sections of the Report contain various statements concerning life saving equipment, procedures and the search effort. Global Marine takes issue with certain of these Findings and statements.

A. Unwarranted Findings.

Considering first the Findings in order, Global Marine notes the following:

1. Finding 18. It is difficult to believe that any kind of "contingency plan" would have significantly reduced the inevitable confusion and uncertainty concerning what happened. In any event, any confusion and uncertainty did not delay the institution of an immediate search effort so that it is not conceivable that even the most elaborate of "contingency plans" could have affected the loss of life. Indeed, at p. 64 the Board concludes that despite the lack of a contingency plan the various parties "pooled their resources, and launched a competent search and rescue effort in China." In light of that statement the appropriateness of Finding 18 must be seriously questioned.

2. Finding 19 (and related statements in the third full paragraph on p. 65). The conclusion that search and rescue efforts were somehow delayed by a 30-minute absence of a radio operator (from 2300 to 2330) in Zhanjiang on the evening of October 25 is unjustified. After the Zhanjiang radio operator went on duty at 2330 he was notified by Tiendu that contact with the ship and supply boat had been lost. When the radio operators were unable to raise the vessel, responsible personnel were roused from bed and reported to the office by 0100. Meanwhile, the fact that the Marisat call had been interrupted was promptly communicated from Global Marine to ARCO in Los Angeles and thence to ARCO in China. There was no doubt that in a few hours there was serious concern about the fate of the ship, although all did hope that perhaps the ship had simply left the location. There is no indication whatsoever that that optimism or the absence of the operator from 2300 to 2330 delayed any search and rescue efforts.

3. Finding 22 (and related statements under "Search and Rescue Efforts" at p. 64, first sentence of second paragraph). No "valuable time" was lost in obtaining any information from Global Marine. The facts are that Global Marine made a prompt, timely notification to the United States Coast Guard that it had lost contact with the vessel, as the Board finds elsewhere in the Report. It was then the

responsibility of the Coast Guard, as knowledgeable experts in search and rescue efforts worldwide, to evaluate the situation and, if appropriate, notify the relevant SAR agency. This the Coast Guard did by calling the WESTPAC search and rescue center at Kadena, Okinawa, 1 hour and 37 minutes after Global Marine's call. WESTPAC then apparently evaluated the situation and decided it needed additional information from Global Marine, which it requested 1 hour and 3 minutes after receiving the telephone call from the Coast Guard in San Francisco. As shown in the attached affidavit from Bill Riddle (Exhibit 9 hereto), it then took Global Marine 10 minutes or less to gather and provide to WESTPAC all of the information requested.

Statements by the Board of "undue delay" by Global Marine in securing the information constitute a completely unfair "cheap shot" at Global Marine not supported by a shred of evidence in the record. In fact, all parties concerned -- Global Marine, Arco, the Coast Guard and WESTPAC -- acted promptly and appropriately under the circumstances. WESTPAC had the information it needed in hand well before first light in China on October 26 so that it was able to launch aircraft at the earliest opportunity.

No "contingency plan" in China could have achieved any faster results. In fact, greater delay would have been encountered had an effort been made to obtain the information

WESTPAC desired from the Global Marine office in Zhanjiang rather than Houston. As subsequent events during the search effort showed, it was much easier for WESTPAC to communicate directly by telephone with Houston than to attempt to establish contact with Zhanjiang. For WESTPAC to have attempted to obtain this information from the Global Marine office in Zhanjiang in the very early morning of October 26 would have presented a nightmare of communications and logistical difficulties and incredible delays, rather than the brief 10 minute period experienced by contacting Houston. Finding 22 and the referenced statements at page 65 are totally unsupportable and unjustifiable and should be stricken from the Report.

4. Finding 23. This conclusion raises questions not appropriately or fully developed in the record before the Board and could well lead to more problems than it solves. The question becomes, what vessel is more likely to survive a severe storm, a large drillship or a significantly smaller standby vessel. Major casualties involving large vessels may be prominent in our minds, but before this finding should be imposed upon the industry as a standard, a study should be done to determine which type of vessel is more likely to survive. We doubt that the Board is aware of or has made any systematic study of the much more numerous sinkings of smaller vessels.

5. Findings 24, 27 and 28. These conclusions are based upon pure speculation and conjecture and should be deleted. Whatever may have happened to the starboard lifeboat, there is no basis for concluding that had there been two boats on the starboard side any of the tragic events would have been changed. To conclude that it is "probable" that crew members successfully launched the starboard lifeboat and survived 36 to 48 hours, at which point the boat capsized and the persons aboard died, has no evidentiary support and is most inappropriate and unfortunate speculation. We believe that the Board should stick strictly to the facts and not reach such totally far-fetched conclusions.

The plain facts are that no lifeboat was ever found, and that one of the helicopters (not any of the U.S. military search aircraft or any surface vessel) spotted an object the description of which is consistent with a lifeboat. But by no means was that object positively identified as a lifeboat, much less a lifeboat from the GLOMAR JAVA SEA. Recall that hundreds of Vietnamese vessels sank in Lex, many of which could well have matched the description of what was seen from the helicopter. The statement on p. 12, paragraph 3, as a matter of absolute fact that an ARCO helicopter "spotted an overturned white lifeboat with its propeller showing but no survivors visible at 0950 on October 28" is misleadingly positive. It would be more appropriate for the Report to

state that a Chinese speaking observer aboard one of the helicopters spotted an object which the Chinese observer is reported (by third-hand hearsay) to have described as an object which could have been a lifeboat. Even if the object was a GLOMAR JAVA SEA lifeboat, there is no evidence that it was the starboard lifeboat or that it then or ever had any survivors in it.

The only basis on which anyone could conclude that any person boarded a lifeboat was the reported receipt by a merchant vessel of a distress call on the same frequency as the vessel's lifeboat radio, identifying the GLOMAR JAVA SEA's call sign and giving a latitude and longitude roughly in the debris pattern. Militating against any positive conclusions from that evidence however, is that the merchant vessel was far beyond the reasonably anticipated range of the lifeboat radio. The fact that a large number of crew members were found in their state rooms and that the body of the bosun (the most likely person to command a lifeboat with the captain on the bridge) was found in the crew lounge, point to the conclusion that no persons boarded a lifeboat. Although persons involved in this great tragedy may indulge in considerable private speculation, we believe it inappropriate for the Board to make the rank conclusions asserted as positive fact, contained in Findings 27 and 28.

5. Finding 26. The nonreceipt of a distress message may have been due to the vessel sinking so suddenly that no one had an opportunity to send a message. It is hard to conceive what additional radio equipment would have permitted sending a signal if the equipment aboard was not sufficient. This equipment far exceeded regulatory requirements by virtue of the presence of the SSB radios and the Marisat. The implication that there was something unique about the South China Sea location is puzzling. In fact, the area of the operation is just west of one of the most heavily trafficked sea lanes in the entire world. Again, the nonreceipt of conventional distress signals raises the much more likely inference that none was sent rather than any deficiency in the equipment or the procedures.

B. Erroneous fact statements.

In addition to the unwarranted Findings discussed above, the Report contains certain erroneous information concerning the search efforts which should be corrected. These errors are as follows (listed in the order in which they appear in the Report):

1. Page 12, paragraph 1. There were reports from two flights (Cathay Pacific Flight 712 and Lufthansa Flight 665), not one, of intermittent signals monitored on 121.5 mHz. Those reports were monitored on October 26 at 2039 and at 2330. The statement that these signals were "later

determined not to have come from the GLOMAR JAVA SEA's" EPIRB is puzzling. We are not aware of anything in the record which would exclude these signals as being from the EPIRB, and they were broadcast on the EPIRB frequency. Significantly, the EPIRB from the vessel was later recovered.

2. At the end of the same paragraph there is a reference to the vessel SUI JUI 201 as being hired by Global Marine to participate in the search. Although that vessel did participate in the search, it was not hired by Global Marine. Global Marine hired the vessel SALVANQUISH on October 26. The accounts of the search and rescue efforts strangely make no mention of the SALVANQUISH, although it spent in fact more hours searching the debris pattern than any other vessel. Those aboard the SALVANQUISH ventured into Vietnamese waters and were exposed to extreme dangers of adverse weather. The references in paragraph 3 on p. 12 to the SUI JUI 201 should be to the SALVANQUISH. The same mistake occurs in the first and third paragraphs on p. 14. Failure to mention the diligent efforts of the SALVANQUISH and her crew, and Global Marine's prompt action on October 26 in hiring a specialized salvage vessel, is a curious omission.

3. Although the regulatory requirements are described in some detail, the report omits the most significant conclusion to be drawn: the survival systems aboard the

GLOMAR JAVA SEA fully complied with and in fact significantly exceeded all existing regulations.

4. Page 27, second full paragraph: This paragraph neglects to state that at the required 90-day intervals the lifeboats on the GLOMAR JAVA SEA were lowered to the water. For instance, in May (as testified to by Captain Lester and as shown in the logs) one boat was lowered, released from the falls and exercised. In August (as testified to by Captain Leadbetter and as shown in the logs) one boat was lowered into the water but was not released because even in the moderate sea way then existing it would have been dangerous to the crew members to attempt to reattach the released boat to the falls. Again, the report neglects to note that the practice of Global Marine in conducting fire, emergency and boat drills was in full compliance with all regulatory requirements.

VI.

MISCELLANEOUS FACTUAL ERRORS

The following is a listing of miscellaneous additional factual errors contained in the report in the order in which such errors appear. While some of these errors may appear to be fairly insignificant when taken in isolation, when considered with the errors previously discussed there appears to be a consistent pattern of slanting of facts in a manner adverse to Global Marine. The pervasiveness of these factual errors, as well as their consistent bias against Global Marine, undermines the overall credibility of the Report. These errors are noted as follows:

1. Page 2, "The Accident," Paragraph 1. The GLOMAR JAVA SEA was not owned and operated by Global Marine Inc. As exhibits before the Board show, the registered owner is Global Marine Deepwater Drilling Inc. and the vessel was operated by Global Marine Drilling Company. Global Marine Deepwater Drilling Inc. and Global Marine Drilling Company are wholly owned subsidiaries of Global Marine Inc. Global Marine Inc. was the original owner of the vessel and operated the vessel until late 1977.

2. Page 5, second full paragraph. This paragraph contains a misleading account of the conversations between Mr. Joe Fry and Mr. Li Shian. There are two sources in the

record concerning these conversations: (1) the sworn testimony, subject to cross-examination by not only the Board but all parties in interest, of Fry, the ARCO drilling superintendent involved; and (2) a taped unsworn interview with Mr. Guo Shui Sheng, taken by two members of the Board and not subject to cross-examination by other members of the Board or by any parties in interest.10/ Unlike the testimony of Fry, the statement of Guo did not discuss matters within his personal knowledge but instead reported upon his second-hand understanding of conversations between Li and Fry on October 25. Li, as reported by Guo, supposedly had received information from an unnamed person described by Guo as the "director, Nanhai West Weather Station, Zhanjiang base," but described by the Board as a "Chinese meteorologist." The substance of this third-hand hearsay was that the tropical storm would pass near the GLOMAR JAVA SEA rather than turning to the northwest as predicted by Meteo. Fry denied under oath receiving the message in the morning of October 25 (TR 1809) although he did have a discussion with Li that afternoon (TR 1810). Both Guo and Fry agree that Li suggested

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10/ Counsel for Global Marine requested permission to cross- examine Mr. Guo but were denied that right.

that the vessel leave the drillsite. The report states that "the drilling superintendent [Fry] replied that ARCO would not move the drillship because the Meteo forecast predicted the storm to turn to the northwest and besides there was nowhere for the drillship to seek shelter. . . ." Unlike Guo who was not present at the conversation, Fry testified that when the suggestion was made he replied that he "had no authority to have the drillship moved, that this authority was strictly up to the captain on the vessel." (TR 1810). In what Fry described as "strictly a layman's discussion" he did observe that there were really no alternate places to which the vessel could safely run.

3. "Vessel Information," p. 15, paragraph 1. It is erroneous to say that these drillships were designed by Global Marine Drilling Company; they were designed by Global Marine Inc.

4. "Loading," p. 19, paragraph 2. The first sentence is erroneous. The watch engineer would shift liquids as required to maintain the vessel in trim. To state that such shifting occurred "once an hour" is inaccurate.

5. "Stability," p. 21. The first sentence on the page is inaccurate. The letter quoted on the preceding page was placed in the operating manual in satisfaction of the requirement.

6. "Mooring System," p. 23, paragraph 1. The statement that the prevailing wind was from 050° true is misleading. As shown by the OSI hindcast referred to elsewhere in the Report, there are two typical windflow patterns that were to be expected during the period the vessel was drilling the well in question. Figure 21 shows a north-northwest windflow pattern which would put the bow of the vessel directly into the wind at a heading of 340°. Figure 21 shows a northeasterly windflow pattern, which would put the wind off the starboard bow. The heading selection was made to account for both windflow patterns, as well as the anticipated swell from the northeast, so as both to give a lee for the work boats on the port side of the vessel and to have weather coming off the starboard bow so as to minimize vessel motions to permit maximum possible drilling time and minimum discomfort and working difficulty. The facts that no significant heading change was found to be necessary after the vessel moored, that no significant downtime due to excessive motions was experienced in September and October, and that even as the unusual weather contained in Lex approached the winds and waves were coming generally off the bow of the vessel (see page 5 of Report), demonstrates the wisdom of the heading selected by Captain Leadbetter.

7. "History," p. 28, 5th full paragraph. The Report neglects to note the significant fact that the ship did not

merely "safely weather" the storm on the voyage to China, but Captain Ludwig reported by telex on December 9 that the vessel "rode it like a thoroughbred." (Exhibit 7 hereto.)

8. Page 29, final paragraph. The implication at the end of the paragraph is that Brockman had neglected his duties in not submitting a follow-up report concerning correction of discrepancies found in the annual Preventative Maintenance inspection audit. The report should state that John Lawrence remained aboard the vessel on October 20 for the express purpose of determining that necessary items had been corrected and preparing the required report in a timely fashion.

9. Page 31. A complete account of the history of the vessel should have included a reference to the visit and inspection of the vessel carried out on October 19-20 when Bill Riddle, Carl Pascuzzo, John Lawrence and Ernie Dean were aboard. See paragraph 11 at pp. 64-65 of Global Marine's Proposed Findings of Fact.

10. Page 59. The "second guessing" by the Board in the second paragraph on p. 59 concerning the handling of anchors is likewise unsupported by the testimony, and the Board has little expertise that would justify its making these conclusions. On October 23, when anchor handling by the supply boats was feasible as shown by the weather reports, the predicted strength and direction of the storm

clearly did not warrant picking up the anchors any more than it dictated evacuation. On October 24, however, sea conditions would not have permitted anchor handling by the supply boat. As pointed out in other portions of the Report, if the master felt that the vessel was unduly restrained by the anchoring system, he could have slacked anchors or released them entirely even without employing the supply boats at any time he wished. In an emergency, he could let the chains run free from the wildcats and the vessel could be freed of some or all anchors in literally a few minutes.

The implication in the third paragraph is that before the vessel could get underway it needed to pick up seven of its nine anchors. To the contrary, the vessel could have gotten underway by releasing either all of its anchors in a few minutes in an emergency, or in even a fairly short amount of time could have released seven breast and stern anchors and picked up the two bow anchors, without the aid of a supply boat.

What the third paragraph completely ignores is that the predicted path and severity of the storm never warranted a decision to depart the drill site. See Part II of this submission. Even if Captain Swanson, the experienced master of the ship, were to agree with the conclusion of the Board that the 1330 forecast on October 25 warranted movement, he could have easily done so in the manner previously

described. He did not choose to do so, undoubtedly based upon his judgment and experience (which was superior to that of this Board) that it was better to remain on location than to attempt to run from the storm. For instance, the suggestion by the Board that he should have sailed to the southeast away from the storm is unwarranted. That course would have exposed the vessel to beam winds and seas while running a gauntlet between treacherous reefs and shoals of the Paracel Islands and the unfriendly windward shore of Vietnam. Captain Swanson had sailed for many, many years, including extensive sailing experience in these very waters of Vietnam. The second guessing of his judgment by the Board, which lacks Captain Swanson's years of experience at sea, is totally unwarranted.

11. Page 60. The criticisms of the typhoon plan contained in the first paragraph on p. 60 evidence a failure to understand the plan. The fact that the plan called for securing the well when a typhoon was 1200 miles away, and evacuation and releasing of anchors with typhoon center at a distance of 1000 miles, did not preclude taking those actions when a storm (whether of typhoon strength or less) was closer than the stated distances. Indeed, on this particular occasion the well was secured when the storm was less than 500 miles away. The well was secured in a timely fashion that would have easily permitted evacuation on

October 23 had that action been indicated, or departing the drill site for the lee of Hainan Island on October 23 or 24 (or even early on October 25) had such action been indicated.

VII.

CONCLUSION

For the reasons given above, Global Marine respectfully petitions the Board for rehearing in this matter pursuant to the Board's procedures.

Exhibits referenced in this petition are not reprinted herein but may be obtained from the National Transportation Safety Board, Public Inquiries Section, Washington, D.C. 20594 upon payment of established fees.

APPENDIX I

COMMENTS IN OPPOSITION TO PETITION FOR RECONSIDERATION

TO: Mr. James Burnett, Chairman
National Transportation Safety Board
800 Independence Avenue, S.W.
Washington, D.C. 20594

DATE: January 30, 1986

RE: CAPSIZING AND SINKING OF THE UNITED STATES DRILLSHIP GLOMAR JAVA SEA IN THE SOUTH CHINA SEA 65 NAUTICAL MILES SOUTHWEST OF HAINAN ISLAND, PEOPLE'S REPUBLIC OF CHINA, OCTOBER 25, 1983.

SUBJECT: LETTER MEMORANDUM BY PARTY-IN-INTEREST CLARENCE REED IN OPPOSITION TO THE PETITION FOR REHEARING FILED BY GLOBAL MARINE, INC. AND GLOBAL MARINE DRILLING COMPANY

Dear Mr. Burnett:

We have been associated by Mr. Michael E. Shelton of the law firm of Shelton & Goller of Houston, Texas, to respond on behalf of Clarence Reed ["Respondent"], a party-in-interest to these proceedings, in opposition to the Petition for Rehearing recently filed by Global Marine, Inc. and Global Marine Drilling Company. It is Mr. Reed's position that the report previously issued by the National Transportation Safety Board ["the Board"] was a thorough, incisive, and accurate assessment of the sinking of the Glomar Java Sea. Thus a rehearing is unjustified given the thoroughness and accuracy of the Board's report and the factual record which supports it.

The only reconsideration that may be appropriate is whether or not the Board should make specific comment on the

heedless disregard for safety and conscious indifference to the risk of human life exhibited by the Atlantic Richfield Company ["ARCO"], Arco China, Inc. ["ARCO"], and their Global Marine agents in their deliberate decisions not to evacuate the crew and to leave the Glomar Java Sea in the path of a typhoon to minimize the potential loss of time and money for their drilling operation. Unfortunately, it still appears that this industry, as it is made up of operators such as ARCO who ultimately control all phases of these operations, is coldly indifferent to the plight of men endangered by environmental hazards when it comes to choosing between safety and the protection of their financial interests in exploring for oil and gas.

The purpose of this letter memorandum is to address certain allegations raised by Global Marine in its Petition for Rehearing ["Petition"] on the basis of evidence allegedly gathered during the litigation of a separate action concerning the ship that has been pending in the Federal District Court for the Southern District of Texas, Houston Division, for the past two years. This case is generally known as the "Global Marine Limitation Proceeding." The parties to that litigation have included ARCO, Global Marine, the survivor of Clarence Reed as well as the families of other crewmembers lost as a result of the

sinking. Global Marine's Petition infers that the evidence adduced in the limitation proceeding supports its petition for rehearing. Clarence Reed strongly disagrees. The plain fact is that the evidence is entirely consistent with the Board's original report. If anything, discovery in the limitation case has palpably demonstrated that ARCO and Global Marine ran their China operation with an absolute conscious disregard for human life and safety. This was particularly true of ARCO. Hence, upon consideration of this evidence, the Board may wish to make further comment on this aspect of ARCO's and Global Marine's misconduct.

The purpose of this memorandum is to briefly summarize pertinent points in response to Global Marine's Petition and direct the Board to the actual limitation proceeding testimony and exhibits supporting each response so that it can study the materials for itself. Thus this text is really a key to a number of depositions, deposition excerpts, and documents that are incorporated herein by reference and included with the memorandum. They will, therefore, find amongst the materials the testimony of several key experts concerning the fact that Typhoon Lex was a typhoon and the testimony of Mr. Li Shian, Mr. Guo Shuisheng, Mr. Wang Wenmao, and Mr. Lu Boqin, who were agents or employees of ARCO or its Chinese joint venture, China National Offshore Oil Corporation, during the time in question.

Respondent Reed would further say as follows in specific response to Global Marine's Petition:

I.

THERE IS A FACTUAL BASIS AND REASONED ANALYSIS SUPPORTING A CONCLUSION THAT THE GLOMAR JAVA SEA MIGHT HAVE SUFFERED A FRACTURE OF ITS SIDE SHELL AT FRAME 91 WHILE THE SHIP WAS STILL ON THE SURFACE.

Global Marine initially contends there are no facts or reasoned analyses to support a conclusion that the Glomar Java Sea was broken open at Frame 91 while on the surface. See Global Marine' Petition at 2. This is not true. During discovery in the limitation proceeding Dr. Jerome H. Milgram, Professor of the the Department of Ocean Engineering at the Massachusetts Institute of Technology, and a recognized expert in the field of naval architecture and marine engineering, testified that it was indeed quite possible the Glomar Java Sea sustained a sideshell fracture on the surface through the combined effect of the ship's restrictive spread moorings and a thirty foot breaking wave that would have hit the ship at frame 91 and cracked her open thereby causing her to flood, list, and ultimately capsize. Professor Milgram's conclusions as to the statistical probability for the occurrence of such a breaking wave were supported by the independent work of Dr. Donald Resio, an oceanographer who had previously done work on both the Ella Fitzgerald disaster (for the NTSB) and the loss of

Ocean Ranger (for the Canadian government), who told Global Marine lawyers during his deposition that there was as much as a 20% likelihood for the occurrence of such a wave from an appropriate direction at or around 2300 hours on October 25th, 1983. The depositions of Drs. Milgram and Resio are included for The Board's review. See, Milgram Deposition and Resio Deposition, Volume I, at 140-147.

Dr. Milgram also stated the loss of the Glomar Java Sea was foreseeable in this regard because seamen have known since time immemorial that the mooring of a vessel bow and stern effectively turns the ship into a breakwater thereby exposing it to the increased likelihood that it will sustain damage when being pounded by waves. Another naval expert, Admiral Elmo Zumwalt, Jr., former Chief of Naval Operations for the United States Navy, concurred in this assessment by noting that sailors from the time of the Phoenicians have known that ships trapped in restrictive moorings will be damaged by the certain though occasionally not understood fury of the sea which includes the predictably powerful force and effects of waves crashing against seaborn structures. The Deposition of Admiral Zumwalt has not been included because of its length but is available to the Board upon request.

II.

THE BOARD'S REPORT DID NOT OVERSTATE THE LIKELY STRESS LEVELS ACTUALLY EXPERIENCED BY THE SHIP.

At page 6 of its Petition, Global Marine argues that the Board overstated the likely stress levels actually experienced by the ship. It bases its critique on its own assessment that the significant waves reported at 1600 hours, October 25th, by the vessel were really "maximum" waves not "significant" waves. In support of its position, Global Marine cites The Board to a hindcast performed by Dr. Charles L. Bretschneider, whom it contends is "the world's foremost expert in this field."

As a preliminary note, Global Marine's other oceanographic and meteorological expert, Dr. John Freeman of the Institute for Storm Research in Houston, disagreed with Global Marine's interpretation of the reported conditions as maximum wave conditions. Strangely enough, Dr. Freeman's work has not been cited by Global Marine anywhere in its petition for rehearing. Dr. Freeman's sworn opinion was that the ship was observing significant wave heights and that it reported the highest significant wave height readings taken over a period of time as "maximum" readings. He concluded that the combined significant wave at that point would have been 48.4 ft. with a maximum wave of 72 feet! See Freeman Deposition at 112, 119, 155-157.

Dr. Freeman's analysis was consistent with the opinions of two other experts. First is that of Dr. Don Resio who discussed

this issue at length with Mr. Cheavens, Global Marine's intrepid chief attorney. See Resio Deposition, Volume I, at 71, 186-188. The second expert who stated an opinion in this regard was Dr. Colin S. Ramage. See Ramage Deposition, Volume II at 251. Dr. Ramage was recommended as an expert for the limitation proceeding by members of the United States Air Force Weather Command Center in Nebraska who consider him to be one of the foremost experts in the area of tropical meteorology. Dr. Ramage was formerly with the Royal Observatory in Hong Kong, and is currently the Chairman of the Department of Meteorology at the University of Hawaii, the same institution which formerly employed Dr. Bretschneider before his quiet resignation from the university's department of ocean engineering awhile back.

III.

THE FALSITY OF THE BRETSCHNEIDER ANALYSIS

Much of Global Marine's Petition is predicated either on the Bretschneider analysis or on work done by American Bureau of Shipping ["ABS"] and others that is based on the Bretschneider analysis. Hence, any error in the Bretschneider analysis also affects the validity of calculations by ABS and others who have relied on Bretschneider's conclusions. The specific scientific shortcomings of Bretschneider's analysis were discussed in great detail by both Dr. Ramage and Dr. Resio. See Ramage Deposition,

Volume I, at 84-141 and Resio Deposition, Volume I, at 88, 156-189, and Volume II, 13-41.

There are several problems with the Bretschneider analysis that should be of particular concern to the Board. First, Dr. Bretschneider did not do a complete hindcast of the typhoon. Instead, he focused on a short series of moments and data selected by Global Marine and did not model the whole storm muchless the critical maximum sea states of 2300-2400 hours on October 25th. Thus, for example, Bretschneider did include a calculation of swell in his final report, Technical Report #12. For discussion, see Resio Deposition, Volume II at 13-41. The actual swell given to ABS by Global Marine was done by its own employee Gurbachan Virk who also made editorial revisions on drafts of the ABS report ostensibily prepared by Dr. Liu.

Secondly, Dr. Bretschneider did not consider pertinent reported data, specifically the weather data from John Lawrence in his telephone conversation at 2300 hours or the weather data from Nanhai 205 shortly thereafter, in his analysis. In fact, he rejected it, choosing instead to rely on the artificial numbers of his wave model and discount as false any actual data that contradicted it. The critical data on windspeeds that Dr. Bretschneider did use originally came from data collected by the Joint Typhoon Warning Center

at Guam which the good doctor altered by incorrectly assuming that Guam's one minute mean windspeed data could be validly watered down in strength and reported as a lower ten minute mean windspeed data to justify a disregard of Guam's classification of Lex as a typhoon.

Dr. Bretschneider's questionable ethics and scientific methodology soundly criticized by Dr. Ramage and Dr. Resio. Dr. Ramage in fact felt so strongly about Dr. Bretschneider's deviation from accepted scientific method that he stated Dr. Bretschneider was intellectually dishonest and an embarrassment to the University of Hawaii. See Ramage Deposition, Volume I at 130-133,141. For a similar critique by Dr. Resio, see Resio Deposition, Volume I, at 189.

IV.

MOORING FAILURES WERE FORESEEABLE GIVEN THE EXCESSIVE CHAIN TENSIONS THE SHIP EXPERIENCED DURING THE PASSAGE OF LEX.

Contrary to what Global Marine would have the Board believe, the Glomar Java Sea had experienced chain failures on numerous occasions prior to its visit to China. Thus, for example, it experienced failures of chains 2 and 3 on October 27 and 29 respectively in 1976. Number 2 broke during a surge to a tension of 253 kips. Number 3 broke two days later with a surge to 390 kips. Similar episodes occurred in 1979 and 1980. See chain failure documents

accompanying this memorandum. In short, it was foreseeable before October 25th of 1983 that this ship could experience mooring chain failures at less than 400 kips, a number far below the chains' stated breaking strength of 885 kips.

It is more than evident that the conditions experienced by the ship on October 25, 1983, subjected its chains to tension definitely in excess of 400 kips. Global Marine's own expert, Dr. Randy Paulling, of the University of California at Berkley, calculated that chains 2 and 3 could have seen as much as 650 to 674 kips of strain as early as 1600 hours on October 25th. See Paulling Deposition Exhibit 7. Again, using Dr. Bretschneider's figures, Dr. Paulling also found that these two chains might still be experiencing cycling tensions as high as 640 kips eight hours later at 2400 hours local time. In fact, when Dr. Paulling used his non-linear formula, which he refused to claim was accurate, he got readings as high as 1,000 kips for maximal tensions. Dr. Paulling did not do maximum tension analyses with Dr. Resio's wave measurements which, as discussed earlier, were significantly higher than those of Dr. Bretschneider. Nevertheless, Dr. Paulling did look at base line tensions with the Resio weather scenario and found that they in effect doubled the numbers he had derived using Bretschneider's weather.

Dr. Milgram also did breaking strength calculations using the Bretschneider weather. According to his analysis, it would only take a 30 foot wave to displace the ship far enough to cause chain tensions to exceed 885 kips. See Milgram Deposition, Volume II, at 69-72. If the significant wave calculations of Doctors Resio, Ramage and Freeman are correct, the Glomar Java Sea could foreseeably have experienced tensions in excess of 885 kips from as early as 1600 hours local time until the time it is alleged to have sunk at around 2400 hours local time because significant wave readings for this period of time were in excess of 30 feet. This consideration excludes for the moment the possibility of the ship experiencing waves in excess of 30, 40, 50, or 60 feet which would have also had the same effect vis-a-vis causing the foreseeable failure of the ship's chains the way it was moored. Given the ship's history of chain failures in environmental analyses performed by Global Marine's expert John Freeman as well as the experts offered by Respondent and other claimants against Global Marine, it is simply bogus for Global Marine to argue the only factual explanation for the mooring failures experienced by the ship were "defective" anchor chains. Obviously, this is not so.

V.

THERE IS NO QUESTION THAT TYPHOON LEX WAS A TYPHOON.

The cornerstone of Global Marine's Petition for Rehearing is a conclusion that "calling Tropical Storm Lex 'Typhoon Lex' is an exaggeration" because, according to Global Marine, the storm never achieved typhoon strength. See Global Marine's Petition at 30. Dr. Freeman, Global Marine's expert, disagrees. He stated unequivocally that Typhoon Lex was a typhoon; that its westward tract toward the operation site was predictable and consistent with the climatology of the region, and, lastly, that the typhoon directly affected the ship's location. See Freeman Deposition at 39-40, 60-61. His opinion is shared by the Chinese National Weather Service, which had classified the storm as a typhoon under the Chinese system as early as October 22nd, the Joint Typhoon Warning Center at Guam, which reclassified the cyclone as a typhoon on October 25th and Drs. Ramage and Resio. See Ramage Deposition, Volume I, at 149, and Resio Deposition, Volume I, at 55-79.

Global Marine makes a big deal of the fact that the Royal Observatory in Hong Kong never described Lex as a typhoon. According to Dr. Ramage, however, if the Royal Observatory, or for that matter, Meteo Services, had been given the benefit of the data actually reported by the ship

and the Nanhai 205 during October 25th, they would have classified the cyclone as a typhoon. See Ramage Deposition, Volume I, at 159. The reason the Royal Observatory, and Guam for that matter, did not have data concerning Lex was a direct result of a failure by Global Marine and ARCO to participate in the World Meteorological Organization's ["WMO"] weather reporting network which collects storm information from ships at sea which is then transmitted to Guam and the Royal Observatory.

Global Marine's Petition also argues that the 24-hour forecast from Meteo Services for October 23rd and 24th gave it no cause for concern that the typhoon would hit the operations area. Global Marine's argument in this regard simply underscores its apparent continuing ignorance of the operational margin of error in 24-hour forecasts. Actually, its own expert, Dr. John Freeman, spoke specifically about calculations and anticipation of operational error in forecasts during his deposition. He stated, for example, that the potential path of a typhoon is determined by drawing a line from the actual position to the 24-hour forecast position and then adding 30 degree vectors to the right and to the left of that line. See Freeman Deposition at 30. In short, Dr. Freeman would give a 60 degree field of possibility as to where a storm might actually end up in

24 hours. Dr. Ramage elaborated on this point as well. He noted, for example, that the acceptable error for locating storms in the 24-hour forecast from the Joint Typhoon Warning Center at Guam for 1983 was plus or minus 117 nautical miles from the forecast position. See Ramage Deposition, Volume I at 179. This would translate into a range of almost plus or minus three degrees of longitude or latitude in the South China Sea region.

Dr. Ramage also noted that the actual position fixes for tropical storms and typhoons are subject to an appreciable margin of error as well. The range of error goes from an absolute best of plus or minus 10 nautical miles with the use of radar to plus or minus 60 nautical miles when the fix is done largely by satellite. See Ramage Deposition, Volume II, at 246. The conclusion to be drawn is that the if Meteo Service data were given to an experienced shoreside coordinator, the job Joe Fry was allegedly trying to do, the coordinator would have had significant reason to believe that Typhoon Lex might approach the ship's operation area as early as the late afternoon of October 23 when the storm resumed its westward tract. As Dr. Freeman stated, if he were onboard the ship at the time, the advice he would have given to the captain would have been to "get out of there." See Freeman

Deposition at 185. Dr. Ramage heartily concurred with Dr. Freeman on this point. See Ramage Deposition, Volume III, at 419.

VI.

CONTRARY TO GLOBAL MARINE'S REPRESENTATIONS, ARCO AND GLOBAL MARINE SHOULD HAVE EVACUATED THE SHIP BY OCTOBER 24TH.

The topics of contingency planning, evacuation planning, quantification of risk, and pre-planning for disasters were also the subject of extensive discovery in the limitation proceeding. See Ramage Deposition, Volume II, at 305, et seq.; Resio Deposition, Volume II, at 72-83; and Paulling Deposition, Volume II, generally. The Board is referred, in particular, to the testimony of Mr. Hamish McDonald of the Robert Gordon Institute of Technology, Offshore Survival Centre. It was Mr. McDonald's opinion that Global Marine, and more especially ARCO as the entity with overall control of the situation, should have known that evacuation of non-essential personnel could only occur within the operational margins of their helicopters and supply boats. Thus, ARCO in particular should have considered the likelihood of the typhoon's approach by October 24th, realized its helicopters and supply boats could not work in conditions approaching 34 knots of wind, and effected evacuation of non-essential personnel no later than

the end of that day. See McDonald Deposition generally. Mr. McDonald's point was simply this: a reasonably prudent operator should not let those under its control face potential weather hazards that will clearly exceed the capabilities of its rescue craft. As a corollary, he noted that once conditions did exceed those limits, the only alternative left for the ship was to get underway to avoid the storm as opposed to sitting in its projected path.

VII.

GLOBAL MARINE MASTERS CLEARLY DO NOT HAVE SOLE AUTHORITY TO COMMAND THEIR SHIPS.

Global Marine seems to shed alligator tears over The Board's finding No. 38 to the effect that the master was not in control of the ship. See Global Marine's Petition at 42. The Board's conclusions in this regard were, however, entirely correct. During discovery in the limitation proceeding, testimony was taken from a number of Global Marine masters. As one former Global Marine skipper, Frans Kupper, put it: "Global Marine Personnel were generally told to please the operator [here ARCO] regardless of any written policy to the contrary". See Deposition of Captain Frans Kupper, Volume I, at 186-190. A captain's failure to do so could have heavy consequences. While serving on another Global Marine drillship, Kupper took issue with an

Exxon drilling supervisor's request to bring a supply vessel along side. The captain said it was too dangerous. The operator disagreed, overruled the captain, and ordered the vessel to come along side, which it did. Kupper was summarily removed from his command as a result of this incident even though Global Marine agreed he was technically correct in trying to overrule the operator. See Kupper Deposition, Volume I, at 186-190. Obviously, when it came to choosing between safety and pleasing the operator on Global Marine's ships, safety took a second seat.

Captains on Global Marine drillships also had to take orders directly from Global Marine drilling superintendents. The case of Captain Ed Stevens, a former Glomar Java Sea skipper, is particularly on point. Captain Stevens had been removed from command of the Glomar Java Sea and rehired as a master for the Glomar Grand Isle in the Spring of 1983. He ran into trouble with the ship's superintendent Mr. Ken Boran almost immediately. Apparently, as far as Mr. Boran was concerned, Captain Stevens' presence on the ship was merely ornamental. Hence, during the course of a rig move, Captain Stevens observed that "Mr. Boran made a point of issuing orders to change the vessel's location by giving orders directly to the crew and work boats without consulting with me. In the interest of peace, I let him

proceed and observed to ensure that the vessel was not in trouble." See letter from Captain Ed Stevens, Global Marine Limitation Proceeding Document Discovery Nos. 053518-22, with specific reference to Document 053519.

The superintendent subsequently terminated Captain Stevens a couple of days later because the Captain refused to stow away dry stores. Boran then then told Captain Stevens he was going to send him ashore with eleven Philippino crew members. Stevens' reply was, "I told him that we had to have a licensed captain aboard. His reply was, he did not need one. My answer was to tell him that I would enter in the log that I was put off the vessel under his orders." Later that evening at 2100 hours, the captain recalled that the superintendent, "ordered the crew to pick up anchors and have the vessel towed to another location. At no time did he confer with me or ask my opinion or notify me that the move was being made." The captain concluded his letter as follows: "I am not a man of violence. My passive actions in this matter have been taken in the name of harmony aboard the vessel." Letter of Captain Stevens, Document 053521.

The same kinds of practices also prevailed in China with ARCO. Hence it was the ARCO supervisor with the assistance of the drilling superintendent who made the plans

for a partial evacuation of the ship in September, 1983. The captain on board at the time was none other than the highly praised Captain J. J. Lester. As Captain Lester reluctantly conceded, however, though he was consulted on the evacuation by the ARCO man and the drilling superintendent, he was not in command of either the evacuation, or, more significantly, the ship itself at the time. See deposition of Captain J. J. Lester, Volume II, at 76-79. The reality of the command situation onboard the Glomar Java Sea in China was such that if the operator or his agent, the drilling superintendent, told the ship's captain to jump, the only proper reply from the captain would have been: "how high?"

VIII.

LI SHIAN AND JOE FRY DID MEET TO DISCUSS MOVEMENT OF THE SHIP ON THE MORNING OF OCTOBER 25TH, 1983.

On page 86 of its Petition, Global Marine accuses the Board of publishing a misleading account of an alleged conversation between Joe Fry and Li Shian of the Nanhai West Oil Corporation ["NHWOC"] on the morning of October 25th, 1983. Global Marine asserts the conversation did not take place that morning but in the afternoon and that it was not of substance. Li Shian might strongly disagree.

At about 9:30 a.m. on the morning of October 25th, Li Shian, the senior designated manager for the China National

Offshore Oil Corporation ["CNOOC"] in its joint venture with ARCO, went to meet with his ARCO counterpart, Joe Fry, the senior onshore drilling supervisor, at the ARCO offices in Zhanjiang. Li Shian and his colleagues were concerned about the approach of Typhoon Lex. The Chinese had previously classified the storm as a typhoon ["Typhoon 8316"] by the evening of October 22nd. CNOOC had been observing the typhoon's progress every since then with increasing alarm. The typhoon that had started as a storm east of the Philippines and proceeded on a westward course into the South China Sea tracking a common traditional typhoon path that eventually would take it over the ship's location and on into Vietnam.

Though warned of the possibility that the typhoon might affect the ship's operation area as early as October 23rd, ARCO and Global Marine kept the ship on location. By the morning of October 24th, CNOOC decided to call ARCO because of its concern about the typhoon's steady approach. It told ARCO that the typhoon was tending to move in the direction of the Glomar Java Sea's operation area, and asked it to "observe closely the movement of the typhoon and take anti-typhoon measures [i.e. move the ship to avoid the typhoon]." See Deposition on written questions of Mr. Guo Shuisheng (Deputy Director of NHWOC and a CNOOC designee for

the ARCO-China Joint Venture) at Pages 9 and 17. ARCO, however, ignored the advice, choosing instead to keep the ship locked on its drilling location, gambling that she would not experience the worst of the typhoon and thus be able to resume the completion of the well in progress as soon as possible thereby minimizing the chance of damage or loss of the hole.

By the morning of the 25th, things had worsened, Li Shian received a call from his deputy manager of operations who informed him of the possibility that the typhoon would hit the ship directly and asked him to specifically "suggest to ARCO again that it take measures to protect the ship." See Deposition of Li Shian at 4. Such a "suggestion" was the strongest recommendation CNOOC could make to ARCO because its agreement with ARCO prevented it from overtly ordering ARCO to do anything with the ship. See Deposition of Guo Shuisheng at 15. Inferably, Li Shian, as a senior manager, chose to underscore the formality and importance of CNOOC's recommendation by appearing in person at the ARCO offices at 9:30 a.m. that morning.

At the meeting, Li Shian told Fry of the possibility that the typhoon would hit the ship directly. Though Fry showed Li Shian a weather telex received at 7:30 a.m. seeming to indicate that the eye of the typhoon would move

somewhat to the north of the ship as it passed, ARCO had actually received an emergency phone call at 8:30 a.m. that morning from the deputy manager of its weather service informing ARCO of precisely what Li Shian was saying; to-wit: that the typhoon would hit the operation area directly that evening. See Deposition on written questions of Mr. Lu Boqin at 6.

Li Shian specifically asked Fry what measures ARCO would take to protect the ship from this typhoon? He then pointedly suggested that Arco move the ship away from its drilling location to evade the typhoon. Fry disagreed. ARCO, he indicated, had determined the only way for the ship to weather the typhoon was to "remain anchored [i.e. over the hole, in its drilling mode moorings] and see how things developed." See Deposition of Li Shian at 4-6.

It is reasonable to assume that Li Shian was more than a little puzzled by Fry's response. Almost a year before, during a visit by ARCO and Global Marine to his company's headquarters, he and a number of other Chinese officials had been informed by Mr. Marvin Brockman, the Glomar Java Sea Rig Manager, "that if there was a typhoon which would threaten the ship, the ship would move to an area where the wind and waves were not strong, in order to evade the typhoon." See Deposition of Guo Shuisheng at 9. No mention

was ever made of any discretion vesting with the Captain in this regard. Thus, in October, 1983, a year later, when a typhoon actually threatened the ship, the Chinese came to ARCO's offices because it had the power and the mandate to move the ship and thus called all the shots. Why then, Li Shian might have wondered, was the ship not going to be moved when it was most definitely threatened by a typhoon? By way of excuse, Fry lamely offered that it was now too late to move the ship. The Chinese, of course, thought otherwise; hence Li Shian's visit. In point of fact, the ship could have been moved. Apparently, the truth was that ARCO had considered its priorities and simply decided not to move it. Global Marine's management obviously concurred.

Fry brought the meeting to a quick close by stating to Li Shian in glad-handed fashion that while the captain of the ship was responsible for safety, ARCO would nevertheless be sure to look after the safety of the ship and its crew and asked Li Shian not to worry about it. See Deposition of Li Shian at 6.

Shortly after Li Shian left ARCO's offices, the Chinese tried again to find out what ARCO would do to protect the crew by calling the ARCO logistics superintendent, Brad Bouchard. Now that moving the ship seemed out of the question, they asked whether or not ARCO was going to use

supply vessels to evacuate the crew? Bouchard said no, there would be no evacuation. See Bouchard Deposition at 148.

Thus, by the late morning of October 25th, ARCO had sealed the fate of the ship's crew by eliminating any possibility that the men would be taken out of the path of the approaching typhoon by evacuation or movement of the ship. Global Marine voiced no complaint to this plan. Some fourteen hours later, while Fry lay soundly asleep in his hotel room, the typhoon hit the ship's operation area as previously predicted, causing her to capsize and sink with the resultant loss of her crew of 81. The apparent gamble that the ship could be left in its drilling moorings, ready to go back into the hole in the face of the typhoon, had failed. ARCO would nevertheless subsequently determine that its gas finds in the region were commercially viable in time to sign a $500,000,000.00 contract with the Chinese for a pipeline project despite the incidental cost of eighty-one lives.

IX.

A WORD ABOUT THE "UNFRIENDLY VIETNAMESE SHORE".

Throughout the course of this proceeding, constant reference has been made by ARCO and Global Marine to the "unfriendly windward shore of Viet Nam." See Global

Marine's Petition at 92. The fact of the matter is there is no indication that the Vietnamese opposed or would have in any way hindered a transit by the Glomar Java Sea through their waters in time of emergency. To the contrary, it is more than reasonable to assume that Vietnam, as a participant in the International Conference on Safety of Life, at Sea would have let the Java Sea enter its waters in times of emergency and permitted search and rescue activities for possible survivors as well.

Global Marine's glib generalization that the Vietnamese were unfriendly is nothing more than a charade to hide the fact that it and ARCO completely ignored the issue of contingency planning for maritime disasters involving the Glomar Java Sea. Query: If Arco was able to use Henry Kissinger as a consultant to facilitate its entry into China for business purposes, why couldn't it have at least made a minimal effort along the same lines to contact the Vietnamese about the relatively non-controversial topic of preplanning for the safety of men at sea? It seems the issue was just not important enough to merit ARCO's concern.

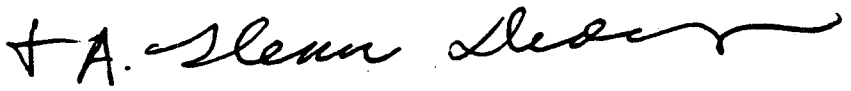
CONCLUSION

Perusal of the testimony and evidence adduced during the limitation proceeding leads to the inevitable conclusion that the Board's original report concerning the tragic loss

of the Glomar Java Sea was the result of a careful and accurate investigation to determine probable causes for the loss of the ship. Though operating under time constraints, the Board did a remarkable job. The collateral investigation of the catastrophe in the limitation proceeding has of course gone further in determining the details and causes of the sinking. It is, however, more than fair to say that the Board's initial conclusions are still more than adequately supported by the facts that have come to light. If there is more work to be done, it might be by way of a further critique of ARCO's and Global Marine's gross disregard and conscious indifference to issues of safety and the plight of the ship's crew whose misfortune it was to serve these companies. One would think that the lessons learned from Ocean Ranger and similar disasters would have been sufficient notice for any operator and contractor going into hazardous waters to adequately prepare for weather related disasters at sea. At least as far as the Glomar Java Sea was concerned, this was not the case, unfortunately. For the reasons stated, Clarence Reed submits that the Board's original report and its considered critiques of ARCO and Global Marine for their mishandling of the Glomar Java Sea was in all respects justified by the record. Upon

consideration, Global Marine's Petition for Rehearing is without merit and should be overruled.

Respectfully submitted,



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1GD/O

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of this letter memorandum has been forwarded to all parties in interest by certified mail, return receipt requested, on this the 30 day of January, 1986.

A. Glenn Diddel III

1GD/O

Documents referenced in this comment are not reprinted herein but may be obtained from the National Transportation Safety Board, Public Inquiries Section, Washington, D.C. 20594 upon payment of established fees.

APPENDIX J

NTSB RESPONSE TO PETITION FOR RECOMSIDERATION

National Transportation Safety Board

Washington, D.C. 20594

April 6, 1987

Global Marine, Inc. and
Global Marine Drilling Company
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)

RESPONSE TO PETITION FOR RECONSIDERATION

Based on its review, the National Transportation Safety Board hereby grants, in part, the Petition for Reconsideration. In accordance with its rules (49 CFR 845), the Safety Board has entertained a petition for reconsideration of its analysis, findings, and probable cause in the marine accident involving the 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, on October 25, 1983.

On November 14, 1984, the Safety Board issued its report, NTSB/MAR-84/08, of its investigation of the capsizing and sinking of the 400-foot-long GLOMAR JAVA SEA. Eighty-one persons were aboard; 35 bodies were located and the remaining 46 persons are missing and presumed dead. The vessel is resting inverted on the bottom of the sea in about 315 feet of water; its estimated value was $35 million.

As a result of its investigation, the Safety Board determined that:

> . . . the probable cause of the capsizing and sinking of the United States drillship GLOMAR JAVA SEA during Typhoon LEX was the flooding of its starboard wing tanks Nos. 6 and 7 through a fracture in the hull resulting from a structural failure of undetermined origin near the bulkhead separating starboard wing tanks Nos. 6 and 7. Contributing to the structural failure was the decision that the drillship would remain anchored with all nine anchors, which subjected the vessel to the full force of the storm. Contributing to the large loss of life was the failure of the master and Atlantic Richfield Company and Global Marine management personnel to remove nonessential personnel from the GLOMAR JAVA SEA.

The petition for reconsideration as submitted by Global Marine, Inc., and Global Marine Drilling Company is divided into numerous sections, each dealing with several related items in dispute. The comments on the petition for reconsideration as filed by the commenter, Clarence Reed, deal with some, but not all, of the issues raised in the petition. The Safety Board's response to the petition has been divided into sections that are similar to those of the petition. The sections in the Safety Board's response are presented in the same order as presented by the petitioner and contain discussions of the viewpoints of the petitioner, the commenter, and the Safety Board, as appropriate.

The Probable Cause: Structural Failure or Breaking of Anchor Chains

The petitioner claims that the "conclusion of structural failure occurring on the surface is not supported by fact or reasoned analysis" and should be withdrawn. At the conclusion of the testimony taken for the Federal investigation, a technical meeting was held and attended by the parties-in-interest, U.S. Coast Guard investigators, and Safety Board investigators. According to the petitioner, the consensus of that meeting was that, without considerable additional studies, the causes of the various fractures found in Global Marine's diving surveys could not be determined, nor could the relationship, if any, between those fractures and the sinking be determined. The petitioner states that the Coast Guard and Safety Board officials attending the meeting expressed reluctance for the Federal authorities to pursue such studies, primarily due to time and budgetary constraints. The meeting referenced by the petitioner was held at the World Trade Center Building in Houston, Texas, on June 14, 1984. No transcript or other record of the meeting was made. The Safety Board investigators who attended the meeting do not believe that the "general consensus" described by the petitioner is correct. The Safety Board investigators recall that they and the Coast Guard investigators agreed that no further tests or studies would be conducted as part of the Federal investigation, and that the tests and studies that had been conducted were inconclusive as to the cause of the vertical fracture. Nevertheless, regardless of any consensus of the meeting, which dealt specifically with technical tests and studies, the Safety Board analyzed independently all available evidence and presented the analysis in its report. 1/ Technical tests and studies were only a part of the evidence, and as such, they received appropriate weight in the Board's deliberations.

The petitioner states that "the oral statements by the Board at its November 14, 1984 hearing are remarkably more equivocal than the language of its Report." The petitioner offers several quotes from the official transcript, such as "I think we really don't know. . .," ". . . We would look forward to rewriting probable cause when the ABS study is done. . ." and "We don't know. . ." in an attempt to show that the probable cause determined by the Board was based upon conjecture and speculation. However, it is not surprising or unusual that all of the spoken deliberations at a Safety Board meeting do not support one statement of probable cause. The discussions often encompass differing points of view, but usually result in the adoption of a probable cause that is endorsed by all of the Members. Such discussions serve to ensure that all relevant viewpoints are considered and brought into the public forum. That some parts of the discussions do not support the adopted probable cause shows that the probable cause resulted from careful deliberation as opposed to conjecture and speculation.

The petitioner believes that the Safety Board's reasoning process was: because a 15° list was reported, because flooding of the No. 6 starboard drill water and the No. 7 starboard fuel oil tanks could produce a list of about 15°, and because the transverse fracture at bulkhead 91 or the longitudinal deck fracture at the substructure leg attachments could flood those tanks; therefore, the fractures occurred while the ship was on the surface and caused the list, and the list caused the ship to sink. The petitioner states that such a reasoning process is "seriously flawed, and the facts upon which it relies are incorrect." The commenter disagrees with the petitioner and refers to additional testimony which would support the probable cause adopted by the Safety Board.

1/ Unless otherwise stated, all references to page numbers and to the "report" refer to the Board's original report, NTSB/MAR-84/08.

The petitioner points out that the Safety Board "avoids the question" of which fracture caused the flooding. The petitioner is correct that the Board did not determine which fracture led to the flooding. The probable cause adopted by the Board and the discussions at the November 14, 1984, Board meeting indicated that the evidence was not sufficient to make such a determination. According to the petitioner, the Board also speculates on page 54 of the report that the vents to those tanks may have fractured and caused the flooding. The petitioner states, however, that the videotapes taken during the diving expedition "absolutely rule out such a theory." The Safety Board agrees. On page 54 of the report, the Board merely states the possibility of the vents fracturing. At the top of page 55, the Board clearly states that one vent was found undamaged and that the other was damaged by the large transverse fracture on the starboard side. Thus, the Board ruled out the possibility of flooding through fractured vents.

The Transverse Shell Crack Near Frame 91

The petitioner claims that "the key assumption in the Board's reasoning is that the transverse shell fracture near bulkhead 91 occurred prior to capsizing and caused tanks 6 and 7 to flood." According to the petitioner, "that conclusion is unsupported by the record," and the report contradicts it by stating, "the failure could have occurred while the vessel was afloat on the surface or when it hit the ocean floor."

A review of the report shows that the statement quoted by the petitioner was made in reference to the longitudinal crack in the main deck, not the crack in the side shell. The Board finds no contradiction in stating several possible alternatives and, through analysis, selecting the most probable alternative. In this case, only two of many possible specific alternatives were presented, and it would have been preferable to make the general statement that the fracture could have occurred before or after the vessel capsized. Consequently, page 55 of the report will be modified.

The petitioner contends that the studies conducted by the American Bureau of Shipping (ABS) contradict the conclusion that the transverse fracture near frame 91 occurred while the GLOMAR JAVA SEA was afloat on the surface. In support of this contention, the petitioner offers five general points:

1. The sea conditions assumed in the ABS study (American Bureau of Shipping Technical Report OED-84009, "Motions and Load Effects Analysis of the GLOMAR JAVA SEA for Marine Board of Investigation," June 13, 1984) were unreasonably severe and led the ABS to overstate the likely stress levels actually experienced. The ABS has repeated its study using more accurate environmental assumptions provided by the petitioner, and lower stress levels resulted.

2. The locations of maximum stress as determined by both ABS studies were in the deck and in the bottom of the vessel. However, the origin of fracture "A" was in the side near the neutral axis.

3. The ABS studies show that the maximum stresses in the vessel's bottom were compressive, but fracture "B" originated and propagated in tension.

4. The ABS studies show that the maximum stresses in the deck amidships were only a small fraction of the tensile stresses required to initiate or propagate a crack. If the deck had been in high enough tension to yield, the crack would have continued across the entire deck.

5. A finite element analysis conducted on behalf of the petitioner indicates that the maximum stresses in the side shell at tanks 6 and 7 due to hydrostatic pressure after the vessel sank are "at bulkhead 91 at precisely the point of origin of the crack."

The commenter believes that the fracture in the GLOMAR JAVA SEA's side shell could have occurred while the vessel was afloat on the surface. The commenter offers two general points to support this belief:

1. The sea conditions assumed in the ABS study were not unreasonably severe, and the likely stress levels were not overstated. The environmental conditions provided by the petitioner to the ABS for use in repeating the study were incorrect.

2. The GLOMAR JAVA SEA's side shell could have been cracked open by the impact of a 30-foot breaking wave while the vessel was restrained by its moorings.

According to the petitioner, the environmental conditions used to recalculate the stresses experienced by the GLOMAR JAVA SEA are based on a "detailed weather hindcast analysis" performed by an expert witness. The petitioner did not provide the analysis or testimony regarding the analysis for review, but states that the results of the analysis are contained in the ABS study prepared for the petitioner. On the other hand, the commenter provided the testimony of three expert witnesses (one of whom was hired by the petitioner) who believe that the weather conditions experienced by the GLOMAR JAVA SEA were more severe than indicated by the weather hindcast analysis prepared by the petitioner's expert. Also, the environmental conditions used in the ABS study prepared for the Safety Board were discussed during a meeting attended by all of the parties to the investigation, including the petitioner, and were considered to approximate a "worst case" scenario. A review of the testimony, both ABS studies, the available weather information, and the Board's report indicates that the environmental conditions experienced by the GLOMAR JAVA SEA might have been somewhat less severe than those assumed for the initial ABS study. However, the environmental conditions proposed by the petitioner are less severe than can reasonably be accepted and less severe than those presented on either page 46 or page 54 of the Board's report. Therefore, the Board cannot accept the petitioner's claim in the first point that the sea conditions assumed in the ABS study were unreasonably severe.

The Board acknowledges on page 47 of the report that the computed stress values are probably higher than the drillship actually experienced because the computed vessel motions are somewhat higher than the reported vessel motions. The Board's report states on page 56 that the ABS calculations showed moderate stress levels and that the drillship should have been able to withstand the bending and twisting of its hull due to the wind waves and swell. The report then goes on to discuss other possible causes of the fractures. The Board concluded in finding 8 that "The transverse structural failure within starboard wing tanks Nos. 6 and 7 probably was not the result of the material being overstressed due to longitudinal bending of the drillship under the wave conditions it experienced on October 25, 1983." Thus, the Board is in general agreement with the petitioner's reasoning in the second, third, and fourth points that fractures "A" and "B" did not result from seaway-induced longitudinal bending stresses. However, the ABS study deals only with those primary bending stresses, and it leads only to the conclusion that the transverse fractures near frame 91 did not occur as a result of primary longitudinal bending stresses while the vessel was afloat on the surface. The ABS study does not

negate the possibility that the fractures occurred from some other cause while the vessel was afloat. Therefore, the Board does not agree that the ABS study "contradicts the conclusion" that the fractures occurred while the vessel was afloat on the surface.

The petitioner has provided excerpts from the deposition testimony of an expert witness who believes that fracture "A" was caused by hydrostatic pressure after the GLOMAR JAVA SEA sank and that fracture "B" occurred when the vessel struck the bottom. According to the petitioner, an indentation in the starboard side of the GLOMAR JAVA SEA's hull that begins near the bow and extends at least to frame 110 and a corresponding indentation on the port side were found during the March 1984 diving survey. The petitioner claims that both indentations can be explained as the result of hydrostatic pressure exerted on the side shell as the vessel was sinking. The petitioner states that the Board was given the impression at the November 14, 1984, Board meeting that there was no significant damage to the port side and that the report omits "any reference to the long, longitudinal indentation between transverse bulkheads found on both the port and starboard sides of the ship." A review of the transcript of the Board meeting shows that the discussion regarding damage to the port side was very brief and related only to damage caused by supply vessels and to the influence, if any, of the damage to the course of events. A review of the record of this case does not disclose any indication of previously undiscovered damage that could be characterized as "long, longitudinal indentations between transverse bulkheads," and the petitioner has provided no new evidence suggesting such damage. During the March 1984 diving survey, the hull of the GLOMAR JAVA SEA was found to have numerous buckles, folds, dents, and cracks. No attempt was made in the Board's report to describe or to determine the cause of every item of damage. The major damages, including those on the port side, are given in the last paragraph on page 41 of the report. The Board believes that the petitioner and the Board have described the same major damages, but in a different manner. There is no question that the side shell at some tanks was bulged inward, and hydrostatic pressure could account for some of those damages. If the fracture at bulkhead 91 did not occur while the vessel was afloat, it could have occurred as a result of hydrostatic pressure while the vessel was sinking. However, hydrostatic pressure is not the only possible cause of the damage at bulkhead 91.

The commenter has provided the deposition testimony of an expert witness who believes that the side shell of the GLOMAR JAVA SEA could have been fractured by a 30-foot breaking wave as the vessel's motions were restrained by its anchors. This witness believes that the most likely scenario for the sinking of the GLOMAR JAVA SEA involves the breaking of anchor chains 2 and 3, the reorientation of the vessel with its starboard side more toward the sea and swell, the fracturing of the side shell near bulkhead 91 as a result of wave impact, the flooding of wing tanks 6 and 7, the listing of the vessel to starboard, and the capsizing of the vessel as a result of wave action. This witness acknowledges, however, that some of the damages seen on the vessel could be the result of hydrostatic pressure.

The testimony provided by the petitioner indicates that the finite element analysis shows an area of high stress, referred to by the expert witness as a stress hot spot, near the intersection of bulkhead 91 and a longitudinal stringer. This witness testified that fracture "A" occurred after the vessel sank past a depth of about 100 feet and bulkhead 91 collapsed as result of the hydrostatic pressure applied to the side shell of wing tanks 6 and 7. The origin of fracture "A" is near the stress hot spots shown on the various diagrams submitted by the petitioner. The stress hot spots are along the side shell at bulkhead 91, an area of the side shell that would be relatively stiff and less able to deform to accommodate impact loads than other areas, such as the side shell at the middle of a span between transverse bulkheads. Thus, the side shell at bulkhead 91 is also a likely area for

the origin of a brittle fracture due to wave impact, and the finite element analysis prepared for the petitioner does not rule out causes for fracture "A" other than hydrostatic pressure. The cause of fracture "A" and its effect on the sinking of the GLOMAR JAVA SEA will be discussed further in the section of this response dealing with the petitioner's theory regarding the breaking of anchor chains.

The petitioner states that the occurrence of the fracture at bulkhead 91 while the vessel was afloat "is also questionable if the operating history of the GLOMAR JAVA SEA and her sister vessels is considered." According to the petitioner, the hull design of these vessels has experienced over 75 years of exposure to the forces of the oceans and has weathered safely far worse storms than LEX. Although the successful operating history gives some indication of the performance of the vessels in storms, it does not prove that the GLOMAR JAVA SEA could not have been damaged by typhoon LEX. Although hindcasts can be developed to estimate the environmental conditions at the location of the GLOMAR JAVA SEA at the time that it sank, there is no way to be certain of the conditions that actually existed immediately before the sinking since there were no survivors. For example, it is possible that the vessel could have been subjected to the forces associated with several extremely large waves. Accordingly, the Board does not believe that the operating history of this class of vessel precludes damage to the GLOMAR JAVA SEA by typhoon LEX.

The petitioner contends that the statement "remaining anchored contributed to the structural failure" and the statement on page 59 of the report "If the vessel had been free to maneuver to minimize its motion, it would have experienced less dynamic stresses and a structural failure may not have occurred" are speculative and unsupported by calculations or studies. The petitioner concludes this section of the petition by stating that "concluding that the fractures at bulkhead 91 occurred on the surface is clearly not justified. Findings 2, 3, 4 and 9 should be deleted." The petitioner also indicates that the recommendations related to finding 9 are unwarranted. These claims will be discussed later in this response.

The Longitudinal Crack in Way of Substructure Attachments

The petitioner claims that the dynamic effects of the derrick moving from port to starboard as the drillship rolled "could not have resulted in fracture-level stresses in the deck plating." According to the petitioner, the Board did not consider any studies or calculations analyzing those dynamic effects, and the uncontradicted testimony in the record is that the damage in the area of the attachment of the forward legs of the substructure to the deck probably was caused by the vessel striking bottom. The petitioner has provided a report entitled "Preliminary Report on Stress Analysis of Hull Plating in the Vicinity of Wing Tanks 6 and 7 of GLOMAR JAVA SEA" which concludes that the maximum stresses in the derrick subbase were about 4.4 ksi and that the deck rupture undoubtedly resulted from impact of the derrick with the sea bottom. The calculations forming the basis for the report were not submitted. The expert witness hired by the commenter testified that the stresses imparted to the deck by the derrick were low and would not have caused the deck to fracture. A review of the record shows that no studies or calculations of the dynamic effects of the derrick on the deck plating were presented. Although the petitioner did not provide the calculations, the loading conditions described in the submitted report are reasonable, and considering the testimony of the expert witness hired by the commenter, the Board agrees that the 5-foot longitudinal fracture near frame 91 at the connection of the derrick substructure with the main deck plating probably was not the result of dynamic stresses caused by the motion of the derrick. Consequently, page 56 and finding 4 of the report will be appropriately modified.

The 15° List

The petitioner initially contends that "the Board's reasoning process —that the reported 15° list caused the ship to sink — is also unsupported." Nowhere in its report does the Board state that the 15° list caused the ship to sink. Therefore, the Board will take no action on this contention.

The petitioner states that "the assumption that there was in fact a 15° list is open to serious doubt." The petitioner has provided excerpts from the deposition testimony of two former masters of the GLOMAR JAVA SEA who do not believe that the vessel had a 15° list. One master bases his belief on the location of the bodies found in the wreck, stating, "For instance, [the assistant engineer and the boatswain] in the crew's lounge, I just can't conceive those people, and [the toolpusher] in those rooms with the ship having a 15° list." The other master said, ". . . and that chief engineer . . . whom I've known for 10 or 12 years, I can't believe that the vessel had a 15° list. It might have had a 15° roll, but I find it hard in my mind to see that that vessel had a 15° list because that chief engineer would have been down there bailing it out with a bucket if he had to." The petitioner also provided excerpts from the deposition testimony of Global Marine's Manager of Engineering. He testified, ". . . I have really never believed that there was a 15° heel -- list . . . sometimes under heavy weather situation it can heel to one side and kind of appear to be kind of staying there and slowly move back with the mooring system and heavy weather coming off the bow." The petitioner infers that the assistant rig manager may have used the term "list" incorrectly since he did not have a marine background, and states that, although there may have been some abnormal trim or roll condition, it is unlikely that it was of the magnitude of a 15° list. A review of the record shows that there is substantial evidence indicating that a 15° list did exist. During the MARISAT call from the assistant rig manager to the drilling group vice president in Houston, Texas, the assistant rig manager not only indicated that there was a 15° list, but he also said that the cause of the list had not been determined, that the engineering people were continuing to search for the cause of the list, and that the mud on the starboard side was being dumped. Apparently, the engineering personnel onboard the vessel agreed that there was a list since they continued to search for its cause. Further, it is doubtful that action would have been taken to dump the mud on the starboard side unless the list was real and significant. The Board does not believe that the location of the bodies in the wreck of the vessel leads to any particular conclusions since the actions taken or contemplated by those persons will never be known. The Board remains convinced that the GLOMAR JAVA SEA was experiencing a significant list when the assistant rig manager made the MARISAT call to his drilling group vice president. No changes will be made to the report in that regard.

Global Marine Explanation: Breaking of Anchor Chain

According to the petitioner, "premature breaking of the starboard bow moorings, triggering a series of events culminating in capsizing and sinking, now appears to be a far more likely explanation for the casualty. . . " The petitioner states that the debris pattern on the bottom of the ocean indicates that the vessel capsized about 300 to 500 feet southwest of the wellhead at a heading of about 270°, and that for the vessel to capsize in that location, anchor chains 2 and 3 had to break first. The bow of the vessel would then swing to the west, and the vessel would experience broadside seas and become more vulnerable to capsizing. As the bow was swinging to the west, anchor chain 4 would stretch and break. After anchor chain 4 broke, the vessel would be restrained primarily by anchors 5 and 10 and would move to the south-southwest under the influence of the prevailing seas and current "and ultimately sinks to the bottom." Although the petitioner has proposed that the "premature breaking of the starboard bow moorings" triggered "a

series of events culminating in capsizing and sinking," no further explanation for the capsizing is offered. The petitioner did not submit any proposals, studies, or calculations describing the mechanism which initiated the capsizing, e.g., severe rolling, synchronous rolling, or listing due to cargo shift or flooding.

The petitioner contends that the anchor chain tensions calculated by the ABS "are well below the point at which failure could reasonably be expected." The petitioner states that an initial program of metallurgical testing has shown that a very high percentage of the anchor chain links tested did not meet American Petroleum Institute (API) standards for toughness. No test results or testimony in this regard was submitted. The commenter argues, based on the testimony of an expert witness, that a 30-foot wave would displace the vessel sufficiently to cause the anchor chain tension to exceed the anchor chain's rated breaking strength. An expert witness hired by the petitioner believed that the anchor chain's rated breaking strength would be exceeded in the weather conditions proposed by the weather expert hired by the commenter.

During the diving surveys, anchor chains 2, 3, and 4 were found broken. Since there were no communications from the GLOMAR JAVA SEA regarding broken anchor chains, it is not possible to determine precisely when the chains broke. It is most likely that they broke while the vessel was on the surface, either upright or capsized, and was experiencing the forces of the severe weather. It is doubtful that the chains broke after the vessel had sunk significantly below the surface and was subjected only to the lesser forces associated with subsurface currents. Since the anchor chain tensions calculated by the ABS are based upon the weather hindcast prepared by the petitioner's expert, which the Board cannot accept as accurate, those anchor chain tensions are probably lower than actually experienced. The petitioner states, as a fact, that anchor chains 4 and 5 had been slacked. With regard to anchor chain 4, about 400 feet more chain was recovered than was initially set. While this chain might have been slacked before the vessel capsized, it is also possible that the additional chain payed out as the vessel drifted southwest after it capsized. Since the chain in the chain locker could easily become fouled in itself and knotted as the vessel capsized, and then would have payed out only until the knot was reached, breaking of the chain about 2,050 feet from the anchor does not prove that anchor chain 4 had been slacked before the vessel capsized. With regard to anchor chain 5, again, additional chain could have payed out after the vessel capsized. Thus, while it is possible that anchor chains 4 and 5 were slacked before the vessel capsized, the evidence is inconclusive.

The Board's initial determination of the probable cause of the capsizing and sinking of the GLOMAR JAVA SEA was based on careful consideration of the information available at that time. There was much information in the investigative record, and much additional information has been submitted by the petitioner and the commenter. The commenter is in general agreement with the probable cause initially determined by the Board, i.e., the flooding of starboard wing tanks Nos. 6 and 7 through a fracture in the hull. The petitioner believes that the fracture in the side shell was a result of hydrostatic pressure after the vessel sank, and that the breaking of the starboard bow moorings triggered a series of events culminating in capsizing and sinking. Available evidence supports both theories.

The location and orientation of the debris on the bottom leads to the conclusion that the starboard bow moorings broke before the vessel capsized, thus allowing it to turn broadside to the seas and drift southwest to a location above the debris before capsizing. The commenter believes that the starboard side shell at bulkhead 91 then fractured as a result of wave impact, allowing wing tanks 6 and 7 to flood and cause a 15° list. If the

side shell had fractured as a result of wave impact while the vessel was afloat, it is likely that the two fracture surfaces would have struck each other repeatedly as a result of the vessel working in the seas, at least in those areas where the surfaces were close together. Also, if a series of waves struck the GLOMAR JAVA SEA's side shell with sufficient force to cause the damage observed at bulkhead 91, it is likely that the bulwark would have shown extensive damage. The fracture surfaces did not show evidence of striking each other, and the bulwark at frame 91 did not show extensive damage, indicating that the fracture probably did not occur from wave impact while the vessel was afloat. Accordingly, the Board agrees with the petitioner that the damage at starboard wing tanks Nos. 6 and 7 probably resulted from hydrostatic pressure after the vessel sank. Findings 2, 3, and 9 will be replaced with one finding describing the damage as a result of hydrostatic pressure. Other references in the report to the occurrence of the fractures while afloat will be deleted. Since the review of the structural design of the other five Global Marine drillships is close to completion, Safety Recommendations M-84-52 and M-84-75 will remain "Open."

Since the 15° list did not result from the fracture at bulkhead 91 on the starboard side, its cause cannot be determined with certainty. The list might have been caused by a shift of drill pipe and/or casing, or intentional or unintentional flooding of other spaces. In either case, the crew should have been aware of the cause — a shift of drill pipe would have been accompanied by significant noise, and a gradual flooding of intact spaces should have led to the recognition of the list and the search for its cause long before the list reached the magnitude of 15°. Regardless of the cause of the list, the list would have made the vessel more vulnerable to capsizing to starboard as it rolled in the heavy seas. The Board believes that the vessel capsized to starboard as a result of severe rolling in the heavy seas and will rewrite the probable cause accordingly.

Exaggeration of LEX

The petitioner claims that LEX was never forecast to be a typhoon and never achieved typhoon strength. The petitioner did not provide any new evidence to support this claim. The commenter disagrees and has provided transcripts of depositions of three expert witnesses who believe that LEX was a typhoon. The record clearly shows that LEX was classified as a typhoon by the U.S. Joint Typhoon Warning Center (JTWC), Guam. LEX was classified as a severe tropical storm by the Royal Observatory of Hong Kong. The difference in classification results from a difference in methods of determining the mean wind speed. However, regardless of the different classification methods, the difference between LEX being classified as a typhoon or a severe tropical storm amounts to a sustained wind speed difference of 4 knots. Consequently, because the Board believes that it is appropriate to relate the JTWC's classification of the storm to a U.S. drillship, no changes will be made in the report to the classification of typhoon LEX.

The petitioner claims that figure 2 on page 4 of the report shows an exaggerated treatment of the storm. A review of the report shows that one could conclude that LEX was a typhoon throughout its entire path if the figure is not used in conjunction with the narrative of the report. A better presentation would have differentiated between the tropical depression, tropical storm, and typhoon phases of LEX, as is shown on figure 8, page 32. The Board agrees with the petitioner's claim and will amend figure 2 accordingly.

The petitioner claims that the first sentence of the last paragraph on page 2 is incorrect because the 1800 METEO forecast did not predict maximum winds of 50 knots gusting to 60 knots for the area of the drillship's operation. A review of the forecast

shows that the tropical storm was forecast to have winds of 50 knots gusting to 60 knots. The forecast also stated that the tropical storm "will influence this operation area. Pay attention to it." However, the forecast did not specifically state that the drillship's area of operation would experience 50 to 60 knot winds. The Board will amend its report accordingly.

The petitioner claims that the use of the phrase "typhoon alley" on page 33 "conjures a vision of the drilling site being in some narrow passageway of uniquely high incidence of typhoons." The petitioner claims, "That simply is not the case." The petitioner did not provide any new evidence to support this claim. National Oceanic and Atmospheric Administration Technical Memorandum NWS NHC 23 shows that the drillship was located near the axis of maximum values of annual typhoon frequency. Therefore, characterization of the location as "typhoon alley" is consistent with the data, and no change will be made in this regard.

The petitioner claims that the statement in the second full paragraph on page 35 that there were 65-knot winds near the center at 0700 on October 24 is inaccurate. Review of the appropriate METEO forecasts shows that the petitioner is correct. There is a typographical error in the first sentence of that paragraph in that the date should be October 25, not October 24. The second sentence of the second full paragraph on page 35 will be amended to reflect the data contained in the METEO Service Advisory issued at 1030 local time on October 25, namely maximum winds of 60 knots with gusts to 75 knots near the center.

The petitioner claims that the fourth full paragraph on page 35 contains a serious error in the statement that there was a 42 percent probability for the occurrence of a storm of the strength of Typhoon LEX at least once during the month of October in any given year. The petitioner states that the source quoted in the report shows a 42 percent probability for the occurrence of a tropical cyclone. A review of the referenced publication shows that the petitioner is correct, and pages 35 and 60 of the report will be amended accordingly.

The October 23 and 24 Advisories

The petitioner claims that the report "glaringly omits any discussion of the storm advisories issued October 23 and 24." The petitioner states that those advisories are "most significant in evaluating the judgment of those aboard the ship not to evacuate nonessential personnel." The Board's report at the top of page 5 shows the 1030, October 23 METEO forecast. The next METEO forecast referenced on page 5 was issued at 0730, October 25. Thus, the METEO forecasts issued on the afternoon of October 23 and on October 24 are not mentioned in the Board's report. In those forecasts and even after it had turned southwesterly, LEX was forecasted to move northwesterly and to pass near or over the northern part of Hainan Island with maximum sustained winds not greater than about 50 knots. The Board agrees that those forecasts may have played a part in the decisions made onboard the GLOMAR JAVA SEA with regard to evacuation of personnel and preparation for a storm, and pertinent references to the forecasts will be included in the revised report. However, the Board continues to believe that typhoons are very erratic storms with the propensity and history of abruptly altering their course and speed, and that mariners should consider the uncertainties of the ultimate track and force of a storm when making decisions about the actions to be taken to protect a vessel from the effects of a storm. Accordingly, the Board will not alter its analysis on page 73 of the actions to be taken in the face of the forecasts pertaining to Typhoon LEX.

The petitioner claims that "totally omitted in the discussion leading to the conclusion that there should have been evacuation of nonessential personnel on October 24 are facts concerning the dangers of an evacuation on that date." The petitioner states that on October 24, the vessel was experiencing an 8° to 10° roll and a heave of 12 to 24 feet, so that a helicopter landing on the vessel or a transfer by personnel basket to the supply boat would have been extremely hazardous. The data on vessel motions apparently have been extracted from the afternoon report sent to ARCO Zhanjiang on October 24 by the ARCO supervisor onboard the GLOMAR JAVA SEA. The ARCO drilling report indicates that the vessel at 0800 on October 24 was rolling 5° and heaving 12 feet. The drilling report indicates that the vessel motions increased during the day. The Board believes that the vessel motions were marginal for evacuation of nonessential personnel early in the day, and agrees that attempting evacuation late in the day would have been dangerous. However, the Board's basic premise that nonessential personnel should have been evacuated as indicated by the typhoon plan remains unchanged. The onscene evaluation of when to begin the evacuation should have included consideration of the existing weather conditions and vessel motions at the drilling site, as well as the forecasted positions of LEX, so that the evacuation could be completed before the conditions deteriorated sufficiently to make evacuation dangerous. There was no impediment to beginning to evacuate nonessential personnel at any time on October 23 after about 1015 when the marine riser was brought on deck. The 1030 METEO forecast indicated that LEX would pass within 100 nautical miles north of the GLOMAR JAVA SEA, and that forecast alone should have provided sufficient impetus to begin the evacuation. The paragraph that begins at the bottom of page 58 of the report will be modified appropriately.

The petitioner claims that the 1330 METEO forecast on October 25 predicted that the storm would pass "approximately 38 miles, not 20 miles" northwest of the ship location. Plotting the forecast positions of LEX for 2300, October 25 and 1100, October 26 given in the 1330, October 25 METEO forecast indicates that LEX was forecast to pass about 30 nautical miles to the northwest of the drillship. The report will be corrected.

The petitioner claims that "omitted from the discussion of the last radio contact between the vessel and ARCO ashore at 1830 are a series of earlier radio conversations during the day, the substance of all of which was that no one was alarmed, that no one was requesting or suggesting evacuation or moving the ship, that the vessel was riding well, and that, although the seas were rough they were not significantly worse than any past storms experienced by the vessel." The Board agrees that there is no mention of those earlier conversations in the report. However, no particular alarm was expressed in the 1830 conversation, and the Board sees no compelling reason to modify the report to show that no particular alarm was expressed before 1830.

The petitioner claims that "The statement in the second paragraph at p. 58 . . . that evacuation of personnel would delay resumption of drilling operations and increase the cost to ARCO is not supported by any evidence in the record." The petitioner did not provide any new evidence to support this claim, but states that the record shows that the previous evacuation did not result in any delay in resuming operations. However, the petitioner believes, as stated elsewhere in the petition, that persons in the drilling crew would be considered essential and would not be evacuated. The Safety Board continues to believe that those persons would not be essential once the well had been secured and the marine riser had been secured onboard the vessel. Accordingly, some delay in resuming operations could be expected after those persons had been evacuated. The Board is not convinced that any changes to its report are necessary regarding this claim. The Board

notes, however, that the previous evacuation occurred in July, as stated on page 23 of the report, and will correct the last sentence on page 58 to state accurately the alternate master's testimony.

Who were "Non-essential"

The petitioner claims that finding 16 should be deleted as creating more potential danger than the alternative rejected. Finding 16 states: "The designation of nonessential personnel for evacuation during severe weather should appear in the individual drillship's heavy weather plan and not be left to the discretion of the master and the Global Marine drilling superintendent." The petitioner indicates that "no personnel were evacuated, not because there was any difficulty in determining who was and who was not essential, but because everyone involved in the operation deemed that evacuation of no one was indicated." The petitioner contends that the Board erred in its analysis that "the only essential personnel on the GLOMAR JAVA SEA, after the drill string had been hung off and the marine riser secured on deck, were those in the marine department and perhaps some Global Marine and ARCO supervisory personnel." The petitioner provided no new evidence to support these claims, and only states that the Board is substituting its judgment on this point for that of many highly experienced witnesses who testified that the entire drilling crew would be essential. The Board is not persuaded to change its findings as a result of this argument. The Board can find no compelling reason to consider the entire drilling crew as essential after drilling operations had been suspended and well-securing operations had been completed. Therefore, finding 16 will not be changed.

Sole Authority of Master

The petitioner disputes the "implication" in finding 38 and "explicit statements elsewhere in the report that the captain's authority on the GLOMAR JAVA SEA in an emergency, and in normal operations as to marine matters and vessel safety, was in any way diluted." The petitioner claims that the Board's finding 38 "should be supplemented by a statement that regardless of the practice on other offshore drilling units, the practice on the GLOMAR JAVA SEA was properly to vest full authority in the master." In support of this position, the petitioner cites Global Marine written policy and operations manuals, job descriptions, telexes regarding actions taken in response to previous storms, and testimony of Global Marine and ARCO personnel.

The commenter disputes the petitioner's claim and states that the Board's conclusions regarding the authority of the master onboard the GLOMAR JAVA SEA were entirely correct. The commenter provides additional testimony from a former GLOMAR JAVA SEA master, a letter from another former GLOMAR JAVA SEA master, and testimony from a former master of another Global Marine vessel in support of his view.

A review of the record of the investigation and of the new material submitted by both the petitioner and the commenter indicates that the thrust of the Board's report is correct. Both the testimony and the exhibits clearly show that the master was relegated to an advisory position unless he declared a state of emergency and assumed sole command. There is no indication in the record that the master of the GLOMAR JAVA SEA assumed sole command of the vessel at anytime within the several days before it sank. This is further reinforced by the fact that the last communication from the vessel was initiated by the assistant rig manager, who was the senior Global Marine employee onboard at that time.

Further, the Board finds no contradiction in its statement that the failure of the master and Atlantic Richfield Company and Global Marine management personnel to remove nonessential personnel from the GLOMAR JAVA SEA contributed to the large loss of life. The Board's report indicates on page 59 that although the master had final authority to order evacuation, testimony shows that such a decision was normally made jointly by the ARCO supervisor, the Global Marine drilling superintendent, and the master. Since this triumverate, in practice, made decisions regarding evacuation, the triumverate failed to remove nonessential personnel.

Therefore, the Safety Board denies the petitioner's request that finding 38 be supplemented by a statement indicating that the practice on the GLOMAR JAVA SEA was properly to vest full authority in the master.

Manning

The petitioner contends that finding 37 "is not only unsupportable from the record before the Board, it is refuted by the testimony of four highly experienced, qualified ship's masters" and, therefore, should be deleted entirely. Finding 37 states: "Global Marine did not have sufficient licensed personnel aboard the GLOMAR JAVA SEA or stationed in China during the typhoon season to safely operate the drillship if the vessel had to move off location and seek shelter." The testimony referenced by the petitioner indicates only that the masters did not feel constrained from getting underway in an emergency without having onboard the crew complement required for navigation. The petitioner provided no evidence that additional licensed personnel were readily available to the GLOMAR JAVA SEA, and no convincing argument that the vessel could be safely navigated for an extended length of time without providing an additional master or chief mate (as indicated on page 71 of the report) to assist and/or relieve the master as necessary. The Safety Board, therefore, denies the petitioner's request that finding 37 be deleted.

Survival Factors

The petitioner claims that findings 18, 19, 22, 23, 24, 26, 27, and 28 contain conclusions about procedures, equipment, and actions that may have affected survivability of personnel from the casualty. The petitioner takes issue with these findings, but in some instances makes no specific request regarding their disposition.

Finding 18 states: "ARCO's lack of a shoreside contingency plan with specific radio procedures during severe weather resulted in confusion as to whether the GLOMAR JAVA SEA had a casualty, had moved off location, or simply lost radio contact for about 42 hours until the wreck was identified by a fathometer survey." The petitioner claims that it is difficult to believe that any kind of contingency plan would have significantly reduced the inevitable confusion and uncertainty concerning what happened. A review of the facts of this case shows that if a severe weather contingency plan requiring periodic radio communications between ARCO and the GLOMAR JAVA SEA had been in effect, the ARCO radio operator at Zhanjiang would have realized that the GLOMAR JAVA SEA was experiencing significant difficulty when a scheduled radio communication was missed. Although the nature of the difficulty would not have been known, and some confusion would have existed anyway, the gravity of the situation would have been apparent immediately. Therefore, the Safety Board partially agrees with the petitioner's claim and will modify finding 18 and the similar statement in paragraph four on page 65 of its report to state that the lack of a contingency plan allowed confusion as to the fate of the GLOMAR JAVA SEA.

Finding 19 states: "The lack of a radio operator at the Zhanjiang offices of ARCO from 2300 to 2330 on October 25 may have prevented vital information concerning the emergency aboard the GLOMAR JAVA SEA from being received ashore." The petitioner claims that related statements in the third full paragraph on page 65 indicating that the search and rescue efforts were somehow delayed by the 30-minute absence of a radio operator are unjustified. The last sentence of that paragraph states: "This information might have initiated emergency response to aid the drillship during the height of the typhoon." The Board continues to believe that some information of importance may have been transmitted from the GLOMAR JAVA SEA to ARCO between 2300 and 2330 if a radio operator had been present and if radio contact had been established. Upon review, however, the Board believes that any request for emergency assistance probably would have been stated early in the MARISAT transmission to Global Marine in Houston at 2341 if earlier attempts to request assistance from ARCO had failed. Accordingly, the Safety Board will make no alteration to finding 19, but will delete the last sentence of the third full paragraph on page 65 of the report.

The petitioner claims that finding 22 and the reference to losing "valuable time" in the first sentence of the second paragraph on page 64 are totally unsupportable and unjustifiable and should be stricken from the report. Finding 22 states: "If ARCO China and Global Marine in China had a contingency plan to notify the Rescue Coordination Center in Kadena, Japan, of the GLOMAR JAVA SEA's position and other pertinent information, Kadena would not have had to waste valuable time obtaining this information from Global Marine in Houston." The petitioner supports this position by providing an affidavit which indicates that it required no more than 10 minutes to provide the requested information when Kadena contacted Global Marine in Houston. Upon review, the Board notes that the circumstances of this case were such that the 10-minute delay during the early morning hours of October 26, 1983, probably did not significantly affect the success of the search for survivors from the GLOMAR JAVA SEA. In other circumstances, a 10-minute delay could be critical. The Board continues to believe that contingency plans should provide for the immediate notification of search and rescue authorities with complete vessel information so that search operations can be initiated as quickly as possible. Complete vessel information should be available to local search and rescue authorities from local sources. Accordingly, the Board partially accepts the petitioner's claim and will modify its report by deleting the "valuable" from the first sentence of the second paragraph on page 64 and by replacing "waste valuable time obtaining" with "obtain" in finding 22.

Finding 23 states: "There is a need for standby vessels suitably equipped for ocean rescue to be assigned to all mobile offshore drilling units, especially for those units, such as the GLOMAR JAVA SEA, which operate in isolated areas." The petitioner claims that this finding "raises questions not appropriately or fully developed in the record before the Board and could well lead to more problems than it solves." The petitioner queries whether a large drillship or a significantly smaller standby vessel is more likely to survive a severe storm, but provided no additional evidence for the Board to evaluate. The Board's analysis of the necessity of standby vessels, both in general and specifically as pertains to this case, begins at the fourth paragraph on page 62 of the report and continues to the top of page 64. The petitioner provided no evidence or analysis which would persuade the Board to change its analysis on this subject. Accordingly, the Safety Board will make no changes to finding 23.

Finding 24 states: "Had the GLOMAR JAVA SEA been equipped with sufficient lifeboats on each side of the drillship to accommodate all persons on board, the persons who went down with the ship may have been able to abandon the drillship before it sank."

The petitioner opines that "whatever may have happened to the starboard lifeboat, there is no basis for concluding that had there been two boats on the starboard side any of the tragic events would have been changed." The petitioner provided no evidence to support this opinion, nor is any persuasive analysis made to refute the Board's analysis on this point which is given in the concluding paragraph on page 60 and the first complete paragraph on page 61. Therefore, the Board will make no changes to finding 24.

Finding 26 states: "The nonreceipt of any distress message from the GLOMAR JAVA SEA indicates a need for improved emergency radio procedures for vessels operating in the South China Sea." The petitioner claims that the nonreceipt of a distress message may have been due to the vessel sinking so suddenly that no one had an opportunity to send a message, and that the equipment aboard the GLOMAR JAVA SEA far exceeded regulatory requirements. No new evidence or analysis was presented. The Board's analysis of this subject begins at the fourth paragraph on page 65 and continues through the first paragraph on page 66. The Board's analysis shows that although the GLOMAR JAVA SEA could transmit on the international calling and distress frequencies of 2182 kHz and 8364 kHz, neither ARCO nor the NHWOC maintained a radio listening watch on these frequencies. Thus, if the GLOMAR JAVA SEA had transmitted a message on either of those frequencies, neither ARCO nor the NHWOC would have received it. The Board agrees with the petitioner that the nonreceipt of a distress message from the GLOMAR JAVA SEA may have been the result of no message being transmitted. The Board did not intend to imply in its finding 26 that additional equipment should have been onboard the GLOMAR JAVA SEA. (The Board's intent is better stated by the last sentence of the first full paragraph on page 66.) Accordingly, the Board will modify its finding 26 by replacing "nonreceipt of" with "inability of ARCO and NHWOC radio operators to receive on the international calling and distress radio frequencies."

Finding 27 states: "Although there are no survivors from the accident, it is probable that some crewmembers successfully abandoned the GLOMAR JAVA SEA in its starboard lifeboat and survived for 36 to 48 hours after the accident." Finding 28 states: "The GLOMAR JAVA SEA's starboard lifeboat probably capsized during the afternoon or night of October 27 or early morning of October 28 and the persons aboard died before any of the rescue airplanes or vessels could locate them." The petitioner claims that these findings are based on pure speculation, that no lifeboat was ever found or positively identified, that the merchant vessel that reported receipt of a distress call with the GLOMAR JAVA SEA's call sign was far beyond the reasonably anticipated range of the lifeboat radio, and that the location of bodies found in the wreck points to the conclusion that no persons boarded a lifeboat. The petitioner provided no new evidence to support these claims. The record of this case clearly shows that an overturned lifeboat was seen during the search for survivors. Although the distance from the merchant vessel that received the distress message to the position given in the distress message was great, it was not so great as to absolutely preclude receipt in the weather conditions that existed. Further, the vessel which reported the distress message would have had no reason to make a false report about the distress message. The facts that many crewmembers were found in their staterooms and that the bosun was found in the lounge do not compel any conclusions regarding the actions of others in boarding a lifeboat. Since there are no survivors, the precise actions of many crewmembers before the vessel sank will never be known, and the Board remains convinced that its analysis of this subject on pages 60 and 61 of the report is correct. Accordingly, the Board will make no changes to findings 27 and 28.

Erroneous Fact Statements

The petitioner claims that the Board's statement in paragraph one on page 12 that the distress signal was later determined not to have come from the GLOMAR JAVA SEA's

emergency position indicating radio beacon (EPIRB) is "puzzling." The petitioner states that there is nothing in the record to preclude the signals as being from the GLOMAR JAVA SEA's EPIRB, and that the EPIRB was later recovered. The petitioner provided no new evidence or analysis in support of this claim. Upon review, the Board agrees that the intermittent distress signal on 121.5 mHz heard by the commercial airplane might have been transmitted by the GLOMAR JAVA SEA's EPIRB. However, if the signal had been transmitted from the location reported by the commercial airplane, it could not have been transmitted by the GLOMAR JAVA SEA's EPIRB, which was recovered more than 120 nautical miles to the northwest on October 29, 1983. Accordingly, the Board will amend the first paragraph on page 12 to state: "It was later determined that a distress signal transmitted from that location could not have come from the GLOMAR JAVA SEA's emergency position indicating radio beacon (EPIRB)."

The petitioner claims that the references to the vessel SUI JUI 201 in the first and third paragraphs on page 12 and in the first and third paragraphs on page 14 should be to the vessel SALVANQUISH, which was hired by Global Marine. The petitioner provided no new evidence or analysis to support this claim. A review of the testimony and exhibits obtained during the investigation shows that there was some confusion regarding the identity and actions of these two vessels. The testimony of one witness indicates that one vessel was identified by both names. It is not possible to determine conclusively from the record if all of the seven references to the SUI JUI 201 should refer to the SALVANQUISH; however, it is clear that these are two different vessels and that both participated in the search. Accordingly, the Board will modify its report to reference the correct vessel in each instance where the record permits a conclusive determination. In those cases where the record is not clear, the report will be modified to refer to "a vessel."

The petitioner claims that the report omits the significant conclusion that the survival systems aboard the GLOMAR JAVA SEA "fully complied with and in fact significantly exceeded all existing regulations." The petitioner provided no new evidence or analysis to support this claim. The survival systems onboard the GLOMAR JAVA SEA are discussed in the report on pages 25, 26, and 61. The report shows that the GLOMAR JAVA SEA had 81 persons onboard and one lifeboat with a 64-person capacity on each side of the vessel. The report notes that the regulations for cargo vessels require sufficient lifeboat capacity on each side of a vessel for 100 per cent of the persons onboard. Therefore, since the GLOMAR JAVA SEA did not have sufficient lifeboat capacity on each side of the vessel for 100 per cent of the persons onboard, the Board believes that the conclusion offered by the petitioner would be inappropriate and will make no changes to the report in that regard. The Board notes, however, that the USCG Certificate of Inspection for the GLOMAR JAVA SEA authorized up to 110 persons onboard while moored at a drilling location without any increase in lifeboat capacity above 64 persons per side.

The petitioner claims that the report "neglects to state that at the required 90-day intervals the lifeboats on the GLOMAR JAVA SEA were lowered to the water" and "neglects to note that the practice of Global Marine in conducting fire, emergency and boat drills was in full compliance with all regulatory requirements." The petitioner provided no new evidence or analysis to support this claim, but refers to the testimony of two former masters of the vessel and to the vessel's "logs." Page 27 of the report contains an accurate description of the testimony of the two former masters. The vessel's deck log for the time immediately preceding the accident sank with the vessel and was not entered into the record. The Board did not criticize the conduct of fire and boat drills

as described by the two former masters, but believes that it would be inappropriate to draw conclusions about the conduct of drills by the master who died in the accident without suitable testimony or evidence.

Miscellaneous Factual Errors

The petitioner claims that exhibits before the Board show that the registered owner of the GLOMAR JAVA SEA is Global Marine Deepwater Drilling Inc., and that the vessel was operated by Global Marine Drilling Company, both being wholly owned subsidiaries of Global Marine Inc. A review of the exhibits does not lead to a conclusive determination regarding owner and operator. However, the Board's report at page 2 indicates the parent companies and subsidiaries for other entities involved in the accident. The Board will accept the petitioner's claim and amend its report accordingly.

The petitioner claims that the second full paragraph on page 5 contains a misleading account of the conversations between the manager of the NHWOC liaison office and the ARCO drilling superintendent in Zhanjiang. The petitioner did not provide any new evidence to support this claim. The petitioner states that the record contains two sources of information about the subject conversation — sworn testimony of the ARCO drilling superintendent and a taped unsworn interview with the Deputy Managing Director of NHWOC, who discussed matters not within his personal knowledge but reported his understanding of conversations between others. The commenter disagrees with the petitioner's claim. The commenter provided copies of written depositions of the Chinese persons involved. A review of the record shows that there is a disagreement as to the time and some of the substance of conversation between the manager of the liaison office of NHWOC and the ARCO drilling superintendent. The disagreement is accurately shown in the second full paragraph on page 5 of the report. The depositions provided by the commenter corroborate the statement of the Deputy Managing Director of NHWOC. Therefore, the Board will make no changes to the second full paragraph on page 5.

The petitioner claims that the drillships referenced in the last paragraph on page 15 were designed by Global Marine Inc., as opposed to Global Marine Drilling Company as indicated in the report. The Board will amend its report accordingly.

The petitioner claims that "the watch engineer would shift liquids as required to maintain the vessel in trim" and that "to state that such shifting occurred 'once an hour' is inaccurate." The report in the last paragraph on page 19 accurately describes the testimony of the alternate chief engineer. The alternate chief engineer testified that ". . . you are normally trimming your vessel perhaps once an hour or maybe sometimes more . . ." Therefore, the Board will make no changes to this paragraph.

The petitioner claims that the first sentence on page 21 is inaccurate because "the letter quoted on the previous page was placed in the operating manual in satisfaction of the requirement." Although the quoted letter was placed in the operating manual, the action of placing the letter in the operating manual did not satisfy the several requirements of the letter that additional specific information be added to the operating manual. Therefore, the Board will make no changes to this sentence.

The petitioner claims that the statement in the second full paragraph on page 23 that the prevailing wind was from 050° true is misleading. The petitioner claims that there were two typical windflow patterns — north-northwest and northeast — and that the heading selection for mooring the vessel was made to account for both windflow patterns. The Board in this paragraph found no fault with the selection of the mooring heading.

Regardless of typical windflow patterns, there can be only one prevailing wind direction, and that is the direction from which the wind most frequently blows. The record and other publications, such as the Sailing Directions for Southeast Asia, clearly show that the prevailing wind was from the northeast. The Board agrees, however, that use of "050° T" is too precise for the purposes of the referenced paragraph, and will change the sentence to show that the prevailing wind was from the northeast.

The petitioner claims that at page 28 in the fifth full paragraph the report fails to note "the significant fact that the ship did not merely 'safely weather' the storm on the voyage to China, but Captain Ludwig reported by telex on December 9 that the vessel 'rode it like a thoroughbred.'" The petitioner has provided a copy of the referenced telex. The Board finds no contradiction between the telex and the statement in the report that the vessel safely weathered the storm. Further, the Board believes that there is insufficient significance in the particular words chosen by Captain Ludwig to warrant amending its report.

The petitioner claims that the end of the final paragraph on page 29 implies that the rig manager "had neglected his duties in not submitting a followup report concerning correction of discrepancies found in the annual Preventative Maintenance inspection audit." The report notes that followup repairs were being made and that "the rig manager had not accomplished his followup responsibilities to determine what discrepancies had been rectified." The report further notes that the followup report was not due until October 28, 1983. However, since the last sentence of the paragraph might be interpreted as indicated by the petitioner, the Board will modify the last sentence of the paragraph to state that at the time of the accident, the rig manager had not yet accomplished his followup duties.

The petitioner claims that a complete history of the vessel should include a reference to the visit and inspection carried out by the ARCO operations manager, the Global Marine drilling group vice president, the assistant rig manager, and the materialsman on October 19-20, 1983. This was a routine visit, and the petitioner provided no convincing argument as to why it should be referenced in the report. No changes to the report will be made in this regard.

The petitioner claims that the "'second guessing' by the Board in the second paragraph on page 59 concerning the handling of anchors is likewise unsupported by the testimony, and the Board has little expertise that would justify its making these conclusions." The petitioner states that the "predicted path and severity of the storm never warranted a decision to depart the drill site." The petitioner argues that the master, in an emergency, could let the anchor chains run free from the wildcats and the vessel could be freed of some or all anchors in literally a few minutes. The petitioner provided no new evidence or analysis to support these claims. Firstly, the expertise of the Board is not at issue in this request for reconsideration. Secondly, the Board's analysis on pages 58-60 speaks to the actions that should have been taken in preparation for Typhoon LEX, not the emergency measures that might have been possible or necessary after the storm hit. Thirdly, the Board's analysis with regard to the track and severity of Typhoon LEX is given on page 73 of the report, and the petitioner has not shown that analysis to be incorrect. Therefore, the Board will make no changes to its analysis of the handling of anchors.

The petitioner claims that the criticisms of the typhoon plan contained in the first paragraph on page 60 evidence a failure to understand the plan. The petitioner states that "the fact that the plan called for securing the well when a typhoon was 1,200 miles away,

and evacuation and releasing of anchors with typhoon center at a distance of 1,000 miles, did not preclude taking those actions when a storm (whether of typhoon strength or less) was closer than the stated distances." While it is clear that actions to protect the vessel can be taken at anytime, a review of the typhoon plan shows that there is no misunderstanding regarding the actions it describes or the time to implement those actions. The typhoon plan is described accurately on pages 21 and 22 of the report, and the petitioner provided no evidence or argument to persuade the Board to change its analysis of the typhoon plan on page 60. Accordingly, no additional changes will be made to the report.

ACCORDINGLY,

(a) The Petition for Reconsideration of the analysis, findings, and probable cause in the marine accident involving the sinking of the United States Drillship GLOMAR JAVA SEA on October 25, 1983, is hereby granted in part.

(b) The Board's original report is revised and a corrected report will be issued to the public.

The Safety Board commends the petitioner for the preparation of the petition and for its interest in marine safety.

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER and NALL, Members, concurred in the disposition of this Petition for Reconsideration.