U.S. Department of Transportation

United States Coast Guard

MARINE CASUALTY REPORT

DRILL SHIP GLOMAR JAVA SEA O.N. 568182

CAPSIZING AND SINKING IN THE SOUTH CHINA SEA, ON 25 OCTOBER 1983 WITH MULTIPLE LOSS OF LIFE

U.S. COAST GUARD

MARINE BOARD OF INVESTIGATION REPORT

AND

COMMANDANT'S ACTION

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16. Abstract

On October 25, 1983, the U. S. drillship GLOMAR JAVA SEA, with 81 persons onboard, capsized and sank in the South China Sea at a position approximately 63 nautical miles southwest of Hainan Island, People's Republic of China, and 80 nautical miles east of the Socialist Republic of Vietnam. Prior to the sinking, the GLOMAR JAVA SEA had secured drilling operations due to the severe effects of tropical storm "LEX" approaching from the east of the drilling site. At 2348 local time, the Assistant Rig Manager, onboard the drillship, called Global Marine's office in Houston, Texas and reported that the drillship had a 15° starboard list of unknown origin and was experiencing 75 knot winds over the bow. Communications were cut off during the conversation, and all attempts to reestablish contact failed. At about 2351 the GLOMAR JAVA SEA capsized and within minutes sank in 317 feet of water. An extensive search was conducted but no survivors were found. In November 1983, a diving expedition found the wreck in an inverted position approximately 1600 feet southwest of the well site. The wreck was searched in March 1984 and 31 of the 36 bodies found were recovered. The remaining 45 persons are missing and presumed dead.

This report contains the U. S. Coast Guard Marine Board of Investigation Report and the Action taken by the Commandant to determine the cause of the casualty and to implement the recommendations of the Board to prevent recurrence.

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DRILLSHIP GLOMAR JAVA SEA, O.N. 568182,
CAPSIZING AND SINKING IN THE SOUTH CHINA
SEA ON 25 OCTOBER 1983 WITH LOSS OF LIFE

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PART I

U.S. Department of Transportation
United States Coast Guard

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16732/GLOMAR JAVA SEA

Commandant's Action MAR 5 1986

on

The Marine Board of Investigation convened to investigate the circumstances surrounding the capsizing and sinking of the Drillship GLOMAR JAVA SEA, O.N. 568182, in the South China Sea, on 25 October 1983, with loss of life

The report of the Marine Board of Investigation convened to investigate the subject casualty has been reviewed and the record, including the findings of fact, conclusions and recommendations, is approved subject to the following comments.

CAUSE OF THE CASUALTY

Generally, causes of marine casualties fall into three categories: human error, vessel related failures or environmental conditions. Frequently, the cause is not the result of a single factor but rather is the result of a sequence of events which culminate in an accident. The actual cause of this casualty and the actual sequence of events cannot be established with certainty. However, the most probable cause was a result of the following combination of factors: the shifting of the vessel's cargo, the loss of the vessel's watertight integrity, a substantial list affecting the vessel's stability, and finally the severe environmental conditions experienced during typhoon "Lex." These factors led to the eventual capsizing and sinking of the drillship GLOMAR JAVA SEA.

A contributing cause of the casualty was the apparent failure of the vessel's personnel to take appropriate action to correct the list.

COMMENTS ON CONCLUSIONS

Conclusion 2. The proximate cause of the casualty cannot be determined. The most probable cause is capsizing due to severe environmental conditions: the impact of one or more unusually large waves, the passage of one or more unusually large swells, unusual wave or swell periods or sequences, or a combination of any or all of those factors, aggravated by the effects of typhoon-strength winds.

Comment. This conclusion is concurred with in part. The probable cause of the casualty cannot be attributed solely to the environmental conditions at the time of the casualty. This vessel was designed and constructed to standards which historically have proved the vessel capable of withstanding similar environmental conditions.

Conclusion 3. Contributing to the casualty was the significant starboard list which had been imposed on the drillship approximately 30 to 45 minutes before the 2348 telephone call to Global Marine's Houston, Texas, offices. The list had an adverse effect on the drillship's stability by shifting the center of

gravity and the center of buoyancy and decreasing the range of positive stability to starboard. The list was most probably the result of the shifting of the drillship's cargo of drilling pipe, well casing, riser sections, and related materials.

Comment. This conclusion is concurred with in part. As the center of gravity shifted, the vessel listed to starboard and there was a decrease in the available righting energy and range of stability. The evidence as developed by the Board is inconclusive as to the cause of the list. While it was the Board's determination that the cause was most likely the result of the shifting of the drillship's cargo etc., it is not improbable that the list may have resulted from the loss of watertight integrity from unknown causes as well as those causes identified in Conclusion 4. Nevertheless, vessel owners should evaluate the means of securing drilling equipment and stores in preparation for storm conditions to determine if the current securing methods are adequate.

Conclusion 4. Many of the weather deck accesses were not securely closed and dogged. It is possible that breaches in the watertight integrity because of improperly closed fittings or storm damage resulted in minor flooding which aggravated the starboard list and the resultant loss of stability by introducing both additional unbalanced loads and uncontrolled free surface effects.

Comment. This conclusion is concurred with. While the actual effects of the lack of complete watertight integrity remain unknown for this casualty, the importance of maintaining the buoyant watertight envelope should be stressed. In particular, the crew should make certain that all closures remain serviceable on a routine basis and are properly secured during approaching storms.

Conclusion 5. The drillship's stability condition may have been adversely affected by attempts to correct the starboard list when the cause of that list was not known. Although required as a condition of the Coast Guard approval of the operating manual, Global Marine had not provided instructions to the Master cautioning against any attempt to correct any unusual list or trim when the cause was not known. That failure evidences a violation of 46 CFR 170.110 and has been referred to the Commander, Fourteenth Coast Guard District for further investigation.

Comment. This conclusion is concurred with in part. The evidence as developed by the Board remains unclear that the cause of list was not known to the vessel personnel who were attempting to correct it. While the Board established that the assistant rig manager did not know the cause of list, it is not clear that other ship's personnel also did not know the cause.

Conclusion 14. Wind conditions at the drill site at 0800, 25 October, were just slightly less severe than forecast. The winds continued to worsen throughout the day. As the storm center neared the drill site, winds of at least 60 kts with gusts to 75 kts should have been anticipated. Judging from the actual versus forecast sea conditions, the Master of the GLOMAR JAVA SEA should have, by late that afternoon, foreseen the possibility that wind conditions significantly worse than those forecast might be experienced at the drill site that night.

Comment. This conclusion is concurred with in part. By late afternoon on 25 October, the master should have anticipated wind conditions more severe than the forecast issued at 0730, 25 October. This determination should have been based not only on the worse than predicted sea conditions, but more importantly, on the revised weather forecast predicting the storm to pass 20 to 25 miles north of the drillship with winds of 60 knots gusting to 75 knots. The findings of fact do not establish that the master did not anticipate the more severe wind conditions.

Conclusion 20. The GLOMAR JAVA SEA was not moved off the well site. How and when the decision to stay anchored was made and who made it are not known.

Comment. This conclusion is concurred with. However, as described in the Coast Guard approved operating manual, the responsibility to decide whether to move the drillship off the well site was that of the master.

Conclusion 22. Had the GLOMAR JAVA SEA gotten underway, the effects of the storm may have been reduced. Considering the path of the storm, which could be approximated from the weather reports, and the proximity of Hainan Island to the north, Vietnam to the southwest, and shoal waters to the south, there were only two directions to sail to gain relief from the storm. The drillship could have moved to the northwest into the lee of Hainan Island, an option which had been discussed between Captain Swanson and Captain Lester whom he had relieved. However, that track entailed the risk of sailing ahead of the storm and perhaps being overtaken by the storm in shallow open water. The other option was to run to the southeast. The swells were coming from 050°T all day on 25 October. The winds and waves, at least from 1600 on, were from about 335°T. The drillship could have put its stern to the wind and run at slow speed away from the storm track into the "navigable semicircle" of the storm, that side of the storm track on which the winds and seas are less severe. This latter course of action would have been in line with procedures recommended by such authoritative texts as the American Practical Navigator (Bowditch), U.S. Navy Hydrographic Office Publication No. 9. In either case, maneuvering to find the best heading and speed would have been possible, and it is possible that the casualty may have been prevented.

Comment. This conclusion is concurred with. However, it needs further clarification. It is true, as with all casualties of this type, the casualty may have been prevented if the vessel had been moved off the drill site and out of the path of the impending storm. This is hindsight. The issue that must be addressed is whether the facts as developed by the board indicate that Captain Swanson was negligent by failing to get underway and out of the path of the storm. Those facts are as follows: the vessel was designed and, indeed, in the past withstood sea and wind conditions of similar magnitude; the weather forecast continued to indicate that the storm's intensity would not exceed the design capabilities of the vessel; the weather forecasts did not indicate that a full-scale typhoon would develop; and communications with the ship prior to 2300, 25 October did not indicate that the vessel was experiencing major difficulty. Under these facts, I will not substitute my judgment (aided by hindsight) by stating that the master's failure to move his vessel was inappropriate.

Conclusion 25. Other than allowing the drillship to drift to the southwest, the failure of the anchor chains did not contribute to the capsizing. The anchors and chains served only to hold the drillship over the well site, not to hold it upright. Thus the failure did not cause the loss of any righting force. Also, the locations of windlasses and fairleads were such that after the failures, the remaining chains did not impose any significant heeling or tripping loads on the hull.

Comment. This conclusion is concurred with in part. When the anchors are deployed, the weight of the chains and/or cables would be balanced. Although they are not intended to hold the vessel upright, the chains and/or cables would produce a dampening effect on the movement of the vessel. After the three anchor chains failed, the weight of the remaining chains - mostly on the port side of the vessel - would produce a heeling moment to port and adversely affect the stability of the vessel. Whether this condition contributed to the casualty is unknown.

Conclusion 36. The hull damage noted during the wreck surveys was the result of the forces imposed on the drillship's structure by hydrostatic pressure as it sank and the impact when the drillship struck the sea floor.

Comment. This conclusion is concurred with. The fractures initiated at welds located in the side shell and moved toward the deck and bottom. They stopped in a ductile, rather than a brittle, mode when they reached the deck and bottom plating. If the fractures had occurred while the vessel was still afloat, they very likely would have run completely across the main deck and bottom plating. In a seaway these are the areas of highest stresses on a vessel.

Conclusion 45. There is evidence of violation of 47 CFR 83.472 with regard to portable emergency lifeboat radios, on the part of the owner and operator of the GLOMAR JAVA SEA. This matter has been referred to the Commandant (G-M) for referral to the Federal Communications Commission (FCC).

Comment. This conclusion is concurred with. The evidence of violation of 47 CFR 83.472 has been referred to the FCC.

Conclusion 46. The effectiveness of the ITT/MACKAY Type 401A radio, when deployed in the GLOMAR JAVA SEA's lifeboat, cannot be determined. However, since a distress signal was picked up a considerable distance away, it must be concluded that having the wrong radio on board had no significant effect on the outcome of the casualty.

Comment. This conclusion is concurred with in part. Although the ITT/MACKAY Type 401A radio apparently functioned as designed, the need to deploy the antenna and ground wire through an open hatch may have contributed to the loss of the lifeboat and those on board as noted in Conclusion 43.

Conclusion 55. One distress signal transmitted by the drillship's emergency position indicating radio beacon (EPIRB) was received by two commercial aircraft. One distress signal transmitted by persons using the portable emergency lifeboat radio was received by a merchant vessel. No other distress signals were received. It is unlikely that any distress signal was transmitted from the drillship itself.

Comment. This conclusion is concurred with. The International Maritime Organization (IMO) is working to improve international cooperation in Search and Rescue (SAR). This will help nations establish appropriate coast radio stations and coast earth stations which are associated with a rescue coordination center to continuously monitor for distress alerts. It will standardize international SAR procedures, and establish SAR regions for which coastal countries would accept responsibility. Such efforts should contribute to minimizing the effects of casualties such as the GLOMAR JAVA SEA in the future by eliminating delays in alerting and providing more rapid SAR response.

COMMENTS ON RECOMMENDATIONS

Recommendation 1. The Coast Guard reexamine the minimum manning scales for drillships while moored and working to ensure that enough qualified personnel are available to allow the ship to get underway in an emergency. This issue is of particular concern for drillships operating in remote areas where additional qualified personnel are not immediately available under all conditions. The Marine Board feels that at least two qualified deck watch officers should be on board, since, as with the GLOMAR JAVA SEA, it may not be possible to bring other personnel to the ship even if they are available ashore. A vessel's ability to get underway for more than a few hours is severely limited if only one deck watch officer is on board.

Action. This recommendation is concurred with. During development of manning scales for self-propelled drilling units, the Coast Guard determined that due to their unique operating requirements, only one licensed deck officer, the master, was necessary when the unit was moored on station. Because of the casualties involving drilling units, the Coast Guard determined that guidance, specifically addressing the manning of these vessels and special license qualifications, was necessary. Accordingly, the Coast Guard published a Supplemental Notice of Proposed Rulemaking (50 FR 43366) on October 24, 1985, containing proposed manning scales which will clarify the requirements on self-propelled drilling units. The proposal requires a master and two additional licensed ballast control operators, at least one of whom must hold an unlimited mate's license, to be on board at all times when under tow or moored on station. These persons will have the capability to assist the master in all marine evolutions and the licensed mate could assume the deck watch if the vessel had to get underway in an emergency. When the drilling unit is underway independently on a voyage of less than 400 miles, at least two licensed ballast control operators, both of whom must hold unlimited mates' licenses, must be on board in addition to the master.

Recommendation 2. The Coast Guard look into the apparent practice of some marine drilling companies counting members of the drilling crew who hold Merchant Mariner's Documents toward the complement of certificated seamen required by the Certificate of Inspection. Persons serving or employed in any capacity, other than as a member of the marine crew or for any reason not available full-time for watch-standing duties, should not be credited toward required manning levels, with the exception of lifeboatmen.

Action. This recommendation is concurred with. The Coast Guard will survey the industry to determine the extent of the problem and what action, if any, is necessary to ensure that the required marine crew is not diverted from the duties of the vessel. However, to the extent permitted by law, the use of crew on board a vessel is subject to the master's discretion, as the master is ultimately responsible for the vessel's safety. The manning specified on the Certificate of Inspection is intended to reflect those minimums of marine trained personnel necessary to safely operate the vessel.

Recommendation 3. The Coast Guard reemphasize to the maritime community the need for routine communications checks on a regular basis for vessels operating in remote areas and during adverse weather. Support vessels operating in or near the same area and shoreside support stations should be included in the checks. Vessel operators should be encouraged to develop formal guidelines for actions to be taken by shoreside personnel and support vessels in the event an emergency arises or communications are suddenly lost.

Action. This recommendation is concurred with. Vessel owners, charters, operators, or agents are reminded of the statutory requirement found at 46 U.S.C. 2306 to immediately notify the Coast Guard and use all available means to determine the status of the vessel when having reason to believe (because of lack of communications with or non-appearance of a vessel or any other incident) that the vessel may have been lost or imperiled. The Coast Guard will continue to emphasize to the maritime community the need to maintain communications with vessels in remote areas. An article will be published in the Proceedings of the Marine Safety Council summarizing this casualty and highlighting lessons to be learned including the need for routine communication checks and the need to develop formal guidelines for shoreside personnel and support vessels in the event an emergency arises or communications are lost. In addition, wide distribution of this report will be made to marine industry associations.

Recommendation 4. The Coast Guard reexamine current regulatory requirements for lifeboat drills and lifeboatman certification. It appears that environmental conditions may often preclude conducting full drills at sea. Further, it is safe to assume that all lifeboat equipment, such as emergency lifeboat radios and antenna, is not routinely deployed and checked in service. The ideal place to conduct such drills is in port. However, on modern vessels, port calls are generally of very short duration and often hectic with crew changes and ship's business. Also, many vessels such as drillships and other drilling units may only rarely enter port. Thus, some other solution is needed. Another concern is the wide range of lifeboat and liferaft types and designs on modern vessels. An experienced seaman can easily find himself confronted with lifesaving equipment he has never seen before.

The Marine Board feels that the solution to these problems may be the development of formal training standards for lifeboatmen. Training could be through a program similar to that now available for Radar Observer endorsements on deck officers' licenses or through certified company-run training programs. It would include "hands on" training, possibly a formal examination, certification by the Coast Guard, and periodic requalification. The certification would describe the type of equipment the individual is

qualified to handle. This would ensure that at least one or two individuals on a vessel would have seen the equipment in operation. Requirements for periodic drills would remain along with requirements for operational tests of emergency equipment. The overall effect would be to enhance the crew members' abilities to survive in an abandon ship situation without adversely affecting vessel schedules or causing delays while drills are conducted in port.

Action. This recommendation is concurred with in part. The regulatory requirements for lifeboat drills should be strengthened. However, mandatory shore based training for the merchant mariner's document endorsement as lifeboatman would not ensure the lifeboatman is sufficiently familiar with all of the many types of lifesaving equipment which might be encountered aboard merchant vessels. Effective and realistic drills must be encouraged to ensure competence with installed lifesaving equipment. The Coast Guard has undertaken a regulatory project to completely revise the lifesaving regulations for major inspected vessels including mobile offshore drilling units. This revision is based, in part, on the 1983 Amendments to the International Convention for the Safety of Life at Sea, 1974 (SOLAS). An Advance Notice of Proposed Rulemaking (ANPRM) was published in the Federal Register on 31 December 1984 (49 FR 50745). The Coast Guard anticipates that there will be a number of regulations proposed under this project that are intended to address onboard training in lifesaving equipment. Once these rules are adopted, personnel would be required to receive additional onboard training. This additional and ongoing training using the specific equipment aboard the vessel, should improve the overall qualification of lifeboatman. Upgrading the present regulatory requirements for certification is considered unnecessary at this time.

Recommendation 5. That current regulatory requirements for the annual servicing of hydraulic releases for inflatable liferafts be revised. The current requirement is not nearly as visible as the servicing requirement for the liferafts themselves; thus it is probably overlooked more often than would be expected. This is especially true when rafts are serviced overseas. The Marine Board feels that a potential solution is to make the hydraulic release a required part of the equipment for any inflatable liferaft. The release could be permanently or at least securely affixed to the raft or its container. When the raft is removed from the vessel for servicing, the hydraulic release would go with it. Servicing and inspection would be accomplished on the liferaft and release simultaneously and would eliminate deficiencies such as that noted on the GLOMAR JAVA SEA.

Action. This recommendation is concurred with in part. The Coast Guard is proposing, through an ANPRM (49 FR 50745), regulations to relocate the hydraulic release servicing requirements adjacent to the liferaft servicing requirements. Additionally, the Coast Guard is releasing a Navigation and Vessel Inspection Circular (NVIC) on hydraulic releases which will highlight the requirements for servicing them.

Hydraulic release testing facilities require special equipment which may not be available at all liferaft servicing facilities. Also, there are new hydraulic releases which presently are required to be secured to the deck of the vessel making attachment to the raft container infeasible.

Recommendation 6. Requirements for outfitting primary lifesaving equipment with EPIRBs be implemented as soon as practicable. The Marine Board is aware that current lifesaving equipment requirements of both SOLAS and Coast Guard regulations are undergoing major revision and that requirements for additional EPIRBs will be included in the new regulations. Consideration should be given to making those requirements applicable retroactively to existing vessels. The possible benefits accruing from such a requirement were recognized by the families of several members of the GLOMAR JAVA SEA's crew, and recommendations to that effect were submitted to the Marine Board. Those recommendations were forwarded to the Commandant for consideration.

Action. This recommendation is concurred with. The Coast Guard is proposing, through an ANPRM (49 FR 50745), a requirement for EPIRBs on survival craft on both new and existing vessels.

Recommendation 7. The Coast Guard and lifeboat manufacturers investigate the possibility that personnel attempting to reconnect the falls on covered or enclosed lifeboats are exposed to significant risk of personal injury. If such risk exists, design changes for new boats or modifications for existing boats may be necessary or desirable.

Action. This recommendation is concurred with in part. The Coast Guard is aware of the problems involved in reconnecting the falls of lifeboats with launching arrangements similar to those found on the GLOMAR JAVA SEA. The Coast Guard is proposing, through an ANPRM (49 FR 50745), regulations to address these problems for new lifeboat installations. As a result of this regulatory effort, the Coast Guard will determine whether it is feasible to modify lifeboat installations for existing vessels. Under the current Executive Order 12291, the cost of the regulations must be balanced against the benefits derived. If it is determined that the benefits exceed the cost, then the Coast Guard would expand the existing regulatory project to include changes to davits and winches on existing vessels.

Recommendation 8. The Coast Guard and the FCC make the current requirements for emergency lifeboat radios and the differences between the requirements for open lifeboats and enclosed lifeboats more visible for both vessel inspection personnel and the marine community. To the knowledge of the Marine Board, there are only three lifeboat radios currently approved, and only one of those is approved for enclosed lifeboats. However, it is apparent that even that basic information is not well known in either government or industry sectors and cannot be readily determined from current FCC regulations. Further, since radio equipment inspections on U.S. flag vessels may be conducted by foreign governments acting on behalf of the United States, the FCC should ensure that any other agency which might act on its behalf is fully apprised of the current equipment requirements.

Action. This recommendation is concurred with. On 29 May 1985, the Coast Guard issued Navigation and Vessel Inspection Circular (NVIC) 4-85, which covers recalls and other corrective measures for lifesaving equipment. The purpose of this NVIC is to provide information to operators and marine inspectors on a number of recalls and corrective actions that should be taken

on various items of lifesaving equipment. Enclosure (7) to NVIC 4-85 includes a notice covering the need for vessels with totally enclosed lifeboats to carry the Model 403A radio and covers the need to erect the antennas and to test the equipment. The FCC will be informed of the general lack of knowledge as to the type of radio required in lifeboats.

Recommendation 9. The Coast Guard initiate whatever action is necessary to effect a complete review by both regulatory bodies and equipment manufacturers of current requirements and standards for both enclosed lifeboats and emergency lifeboat radios. The purpose of such a review would be to consider possible changes to lifeboat design and/or radio equipment which would eliminate the need for any hatches or doors to be open to accommodate the falls, radio antennas, ground wires, or any other equipment. The lifeboat should be capable of being made watertight immediately upon boarding and maintained in that condition after launching.

Action. This recommendation is concurred with. The Coast Guard is proposing through an ANPRM (49 FR 50745) a requirement, if adopted, for release hooks to be relocated above the deck and accessible through a hatch. The lifeboat could then be launched from inside the boat and watertight integrity maintained. Retrieving the boat would have to be accomplished by an individual having no more than head and arms outside the boat.

The review of the requirements for emergency lifeboat radios is being accomplished through the development of the Future Global Maritime Distress and Safety System (FGMDSS). The details of the FGMDSS are still being worked out by the Radiocommunications Subcommittee of IMO, but it is clear that long range distress communications for the new system will be provided by satellite and a worldwide network of HF radio stations providing radiotelephone and radiotelegraph (direct printing) capabilities. The new system will include a satellite EPIRB on the ship to provide the initial distress alert and location, and will also include EPIRBs with a radar locating device for the survival craft. The portable lifeboat radio for long range communications is not part of the FGMDSS as the radio equipment mentioned here will preclude the need for its use. A VHF (Channel 16) radiotelephone will be provided for short range on scene communications. None of this equipment will necessitate the opening of the lifeboat.

Recommendation 10. The Coast Guard amend the current regulations pertaining to operating manuals for mobile offshore drilling units to include:

a. a definition of "non-essential personnel," and

b. requirements for

(1) identifying those persons who can be considered "non-essential" during each stage of the preparations for passage of a severe storm;

(2) developing, for each drilling locale, specific guidelines, keyed to prevailing weather and storm patterns, for determining whether or not partial or complete evacuation is necessary or desirable;

(3) direct evacuation when environmental conditions approach the design limits for the unit; and

(4) specific procedures for actually conducting a partial or complete evacuation during each stage of storm preparations.

Action. This recommendation is concurred with in part. The Coast Guard has a regulatory project (50 FR 39734) published 30 September 1985 to amend the operating manual requirements. This proposed regulation, if adopted, will require that safety provisions - including procedures for evacuation of personnel - be included in the operating manual. The proposed regulation would incorporate many of the operating manual requirements of the IMO Code for the Construction and Equipment of the Mobile Offshore Drilling Units (MODU Code) and address public comments concerning the evacuation plan received as a result of the ANPRM published on 1 June 1984. Any guidance on evacuation should be sufficiently detailed to allow the master or person in charge to safely determine when and who should be evacuated. Because there are many variables involved in determining when an evacuation should occur, the unit operating manual should never substitute for the judgment of the master or person in charge.

Recommendation 11. In the absence of specific Federal regulations, all MODU operators:

a. examine, and revise as necessary, the severe weather preparations sections of unit operating manuals to ensure that they provide adequate guidance for unit personnel to:

(1) identify and designate, for each stage of storm preparations, "non-essential personnel";

(2) determine, for the current work site, on the basis of forecast weather conditions and prevailing storm patterns, the likelihood that evacuation may be desirable or necessary or unit design limits approached; and

(3) actually conduct a full or partial evacuation at any stage of storm preparations;

b. recognize that current Federal regulations require that unit operating manuals address preparations for the passage of any severe storm, not just one that has actually reached hurricane or typhoon status; and

c. ensure that all marine crew, drilling crew, and supervisory personnel understand that storm plans and prescribed preparatory actions apply to all potentially severe storms whether or not they actually have or are forecast to reach hurricane or typhoon strength.

Action. This recommendation is concurred with. See my comments on Recommendation 10. A copy of this report will be given wide distribution to MODU operators.

Recommendation 12. All drillship operators examine the command structure on all drillships to ensure that one individual is clearly identified as the absolute authority on board. The very character of a drillship demands, for all matters other than well control, that that individual must be the Master. All written directives -- operating manuals, procedure manuals, etc... -- should reflect that assignment of authority. And, more importantly, all operating personnel must understand and accept it.

Action. This recommendation is concurred with. A clear chain of command and a clear designation of authority are essential on all drillships. The master must have full unequivocal authority regarding safety matters and evacuation of personnel at all times.

Recommendation 13. The Coast Guard amend the regulations in 46 CFR 109.107 to require that on all self-propelled MODUs and particularly drillships, the licensed Master, required by the Certificate of Inspection, be the individual designated as "person in charge."

Action. This recommendation is concurred with in part. The Coast Guard published an ANPRM (50 FR 11741) on 25 March 1985, which specifically addresses 46 CFR 109.107. Additionally, the Coast Guard has published a Supplemental Notice of Proposed Rulemaking (50 FR 43366) which addresses licenses and manning of MODUs. These regulations, if adopted, will identify the single individual who has the sole responsibility for marine safety and evacuation of personnel on all MODUs.

Recommendation 14. This investigation be closed.

Action. This recommendation is concurred with.

[redacted]

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Admiral, U. S. Coast Guard
COMMANDANT

PART II

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16732/GLOMAR JAVA SEA
28 May 1985

From: Marine Board of Investigation
To: Commandant (G-MMI)

Subj: DRILLSHIP GLOMAR JAVA SEA, O.N. 568182, CAPSIZING AND SINKING IN THE SOUTH CHINA SEA ON 25 OCTOBER 1983 WITH LOSS OF LIFE

Ref: (a) Commandant (G-MMI) letter 16732/GLOMAR JAVA SEA of 3 November 1983
(b) MSM 72-6-30(B) and (D)
(c) MSM 72-6-35D

1. The investigation into the loss of the Drillship GLOMAR JAVA SEA is complete.

2. The report of the investigation is enclosed.

[redacted]
Chairman

Encl: (1) Report of the Marine Board of Investigation (Original + 4 copies)
(2) Record of Investigation (Transcript/Exhibits) (Original + 1 copy)
(3) Administrative File

Copy: Commander, Atlantic Area (w/1 copy of encl. (1))
Commander, Pacific Area (w/1 copy of encl. (1))
Commander, Eighth Coast Guard District (w/1 copy of encl. (1))
Commander, Fourteenth Coast Guard District (w/1 copy of encl. (1))

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FOREWORD

The sinking of the GLOMAR JAVA SEA marked the first time a U.S.-flag drillship has been lost. The investigation was unique in that it too marked a number of firsts.

The Marine Board convened outside the United States to take sworn testimony. The ongoing operations of Global Marine and ARCO China in Hong Kong and the Peoples Republic of China precluded bringing key personnel to the United States in a timely or workable fashion. As a result the Marine Board went to Hong Kong. To avoid the problems associated with taking sworn testimony on foreign soil the Marine Board was convened at the American Consulate in Hong Kong. The Marine Board also took testimony in Houston, TX.

The drilling project in which the GLOMAR JAVA SEA was involved was a joint undertaking of Chinese and American companies. The casualty took place in Chinese waters. All routine support services for the project were being provided by Chinese companies.

It was desirable to interview a number of the Chinese oil company personnel, radio operators, and supply boat crew members who were involved in the drilling project. Since it was not possible at that time to bring those persons to the United States or Hong Kong, the Chairman of the Marine Board of Investigation and a National Transportation Safety Board representative went to the Peoples Republic of China to interview them and obtain written statements.

No survivors from the casualty have been found. There has been a great deal of speculation that some of the crew escaped the drillship in a lifeboat and made landfall in the Socialist Republic of Vietnam. Reports of survivors in Vietnam received a great deal of publicity. Those reports were thoroughly investigated by the Department of State but could not be substantiated.

All of these matters and the actions associated with the rest of the investigation created enormous logistical tasks and more than a few problems for the Marine Board. A great many persons, companies, and agencies outside the Coast Guard and the National Transportation Safety Board aided in resolving them. The Marine Board takes this opportunity to express its appreciation to all whose assistance helped the investigation to progress.

The Marine Board also takes this opportunity to express special appreciation to the staff of the American Consulate, Hong Kong, for their support and assistance throughout the investigation.

Finally the Marine Board is especially appreciative of the efforts and cooperation of Global Marine, Inc. and Atlantic Richfield Company and their subsidiaries, the American Bureau of Shipping, and the China National Offshore Oil Company, without which the investigation could not have been completed.

FINDINGS OF FACT

1. TOPICAL SUMMARY

On 25 October 1983, the U.S. drillship GLOMAR JAVA SEA, with 81 persons onboard, was moored over a well site in the South China Sea, approximately 63 nautical miles southwest of Hainan Island, Peoples Republic of China, and 80 nautical miles east of the Socialist Republic of Vietnam. The drillship was feeling the effects of tropical storm "Lex" to the east and had discontinued drilling operations, waiting for the weather to improve. At 2348 local time (1048 CDT), Global Marine Drilling Company's Assistant Rig Manager, onboard the drillship, called the company's office in Houston, Texas, via satellite telephone link, and informed management personnel that the drillship had a 15° starboard list of undetermined origin, was experiencing 75 kt winds over the bow, and that all personnel were up and had donned life preservers. Communications were cut off during the conversation, and all attempts to reestablish contact failed. At about 2351 the GLOMAR JAVA SEA capsized and within minutes sank in 317 feet of water. An extensive search was carried out, but no survivors were found. A side scan sonar survey and a diving expedition in November 1983 found the wreck in an inverted position approximately 1600 feet southwest of the well site. The drillship had sustained a great deal of damage, including 2 major hull fractures. During a search of the wreck in March 1984, 36 bodies were found, and 31 were recovered. The remaining 45 persons are missing and presumed dead.

2. PRELIMINARY STATEMENTS

a. Time Zones: The area of the South China Sea in which the GLOMAR JAVA SEA was operating was in time zone "-8," which was 8 hours ahead of Greenwich Mean Time (GMT). Unless noted otherwise, all times in this report will be based on the 24-hour clock and will be local time at the drill site. At the time of the casualty, the United States was on daylight savings time, and Houston, Texas, was in Central Daylight Time (CDT), zone "+5," 5 hours behind GMT. On 30 October 1983, daylight savings time ended, and Houston, Texas, went on Central Standard Time (CST), zone "+6," 6 hours behind GMT.

b. ARCO China

(1) ARCO China Inc., a wholly-owned subsidiary of Atlantic Richfield Company (ARCO), was the operator for purposes of the oil exploration operations.

(2) Throughout the investigation, the interests of Atlantic Richfield Company and ARCO China Inc., were collectively represented. For the purposes of this report, both companies, singly or collectively, without distinction, are referred to simply as "ARCO China" or "ARCO".

c. Global Marine

(1) Global Marine Deepwater Drilling, Inc., a wholly-owned subsidiary of Global Marine Drilling Company, was the registered owner of the GLOMAR JAVA SEA.

(2) Global Marine Drilling Company, a wholly-owned subsidiary of Global Marine, Inc., was the operator of the GLOMAR JAVA SEA.

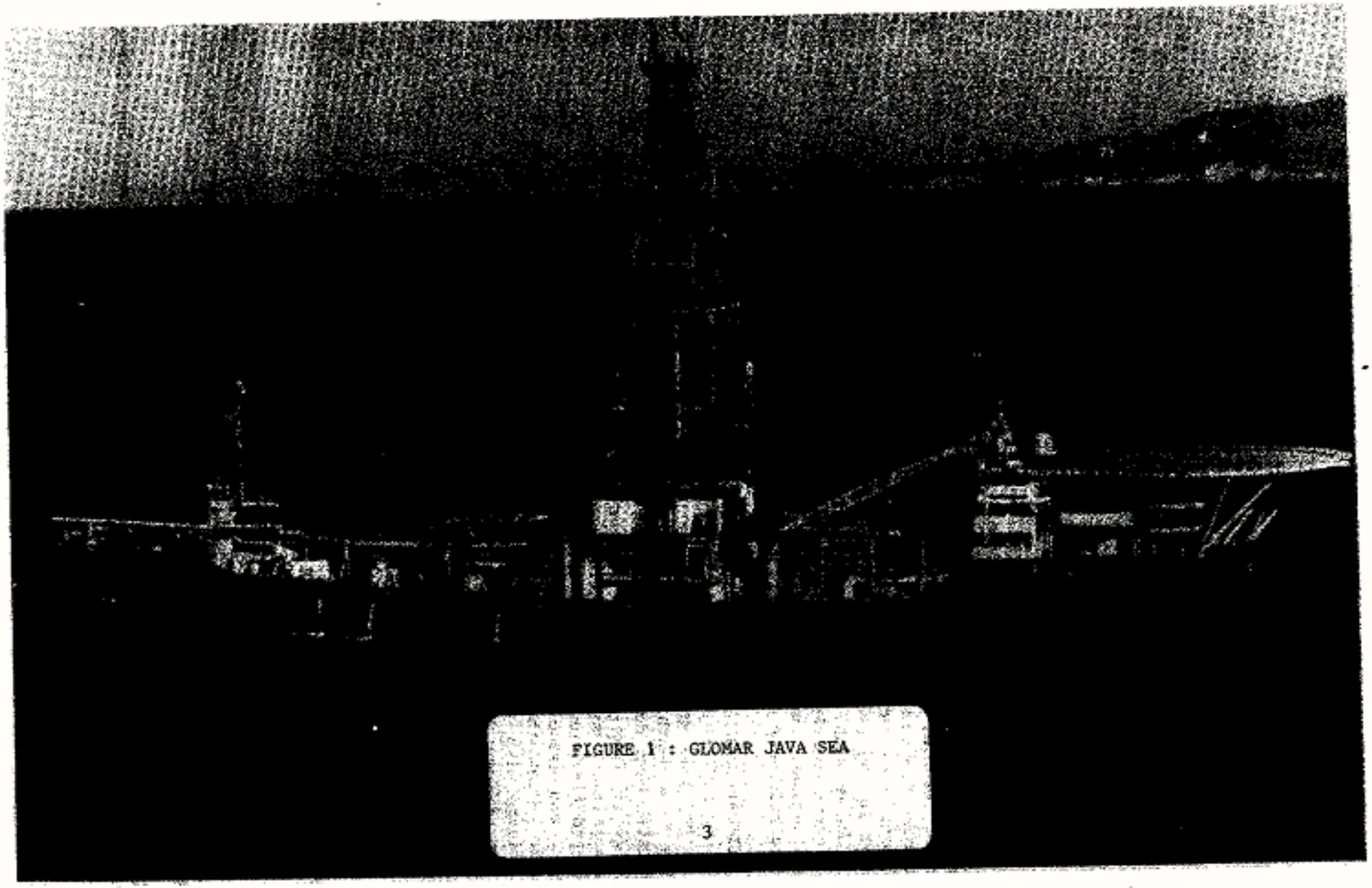

FIGURE 1 : GLOMAR JAVA SEA

(3) The parent company, Global Marine, Inc., was the designer of the GLOMAR JAVA SEA. That company was until 1977 also the owner and operator of the drillship.

(4) Throughout the investigation, the interests of Global Marine, Inc., and its subsidiaries were collectively represented. For the purposes of this report, the parent company and its subsidiaries, singly or collectively, without distinction, are referred to simply as "Global Marine."

3. VESSEL DATA

a. Vessel Description

The GLOMAR JAVA SEA was a 400 foot long, 5,930 gross ton drillship of conventional hull form. Built in 1975, it was the sixth and final vessel of a series designed by Global Marine, Inc., and built by Levingston Shipbuilding Company, Orange, Texas. The drillship was built and classed (Maltese Cross - A1 - Circle E - Drilling Unit - AMS) in accordance with the American Bureau of Shipping (ABS) Rules for Building and Classing Steel Vessels. The original vessel in the series (GLOMAR GRAND ISLE) was designed in accordance with the 1967 Rules with design acceptance extended, with some modifications, to the subsequent vessels in the class. The GLOMAR JAVA SEA was inspected by the Coast Guard during construction and initially certificated upon completion. It was maintained under certification since that time.

The GLOMAR JAVA SEA was designed with a "drill well" located at approximately amidships. The 142' derrick designed by Global Marine and positioned squarely over the drill well had a 1,000,000-pound load rating and allowed for drilling wells to a depth of 25,000 feet. Immediately forward of the derrick on the superstructure deck (03) level was an elevated drill pipe racker which could hold 23,580 feet (262 triple lengths) of 5" diameter drill pipe while the vessel was working. Immediately aft of the derrick on the boat deck (02) level was an elevated flat for storage of well casing. The drill floor with the draw works, rotary and associated equipment, was located at the superstructure deck (03) level. Below the drill floor on the main deck was a variety of equipment associated with the drilling operation. Below the main deck, aft, under the casing rack was a storage hold for casing and drill pipe. Aft of that hold also below the main deck were the machinery spaces with the propulsion motor room on the lower level and the generator room on the upper level. Below the main deck immediately forward of the drill well were the liquid drilling mud tanks. Continuing forward were the mud and cement pump room, bulk dry mud and cement storage, and ballast tanks. Also in the forward part of the vessel below the main deck were quarters for approximately 10 persons. The remainder of the below deck volume was taken up by tankage, including double bottom tanks throughout most of the vessel's length, storage areas, and workshops.

Above the main deck, aft, above the machinery spaces was a 5-level deckhouse topped by the pilothouse. Aft of the deckhouse cantilevered over the stern was the heliport. The main deck level of the house contained crew staterooms, change and shower rooms, the hospital, laundry, workshops, and the steward's storeroom. Aft of those spaces were the aft anchor chain lockers.

The poop deck (01) level contained the galley, messroom, freezer, and crew's lounge. Aft of those spaces were the aft anchor windlasses.

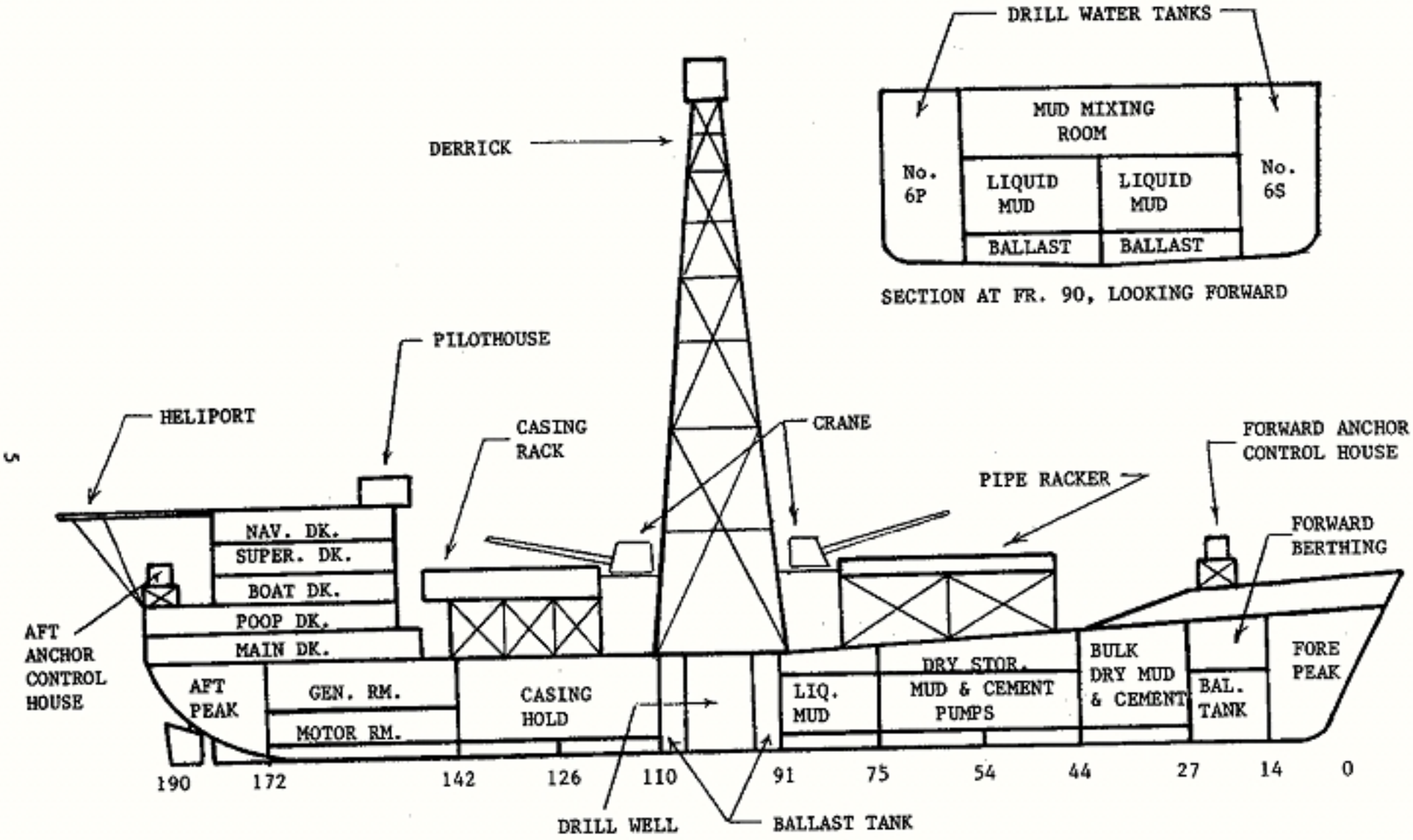

FIGURE 2: Drillship GLOMAR JAVA SEA, Inboard Profile

The boat deck (02) level contained crew staterooms including the Chief Engineer's room. The lifeboat davits and the aft anchor windlass control room were located on this deck.

The superstructure deck (03) level contained crew staterooms, the ARCO and Global Marine company offices, and the emergency generator room. The lifeboats in their stowed positions were on this level.

The navigation deck (04) level contained crew staterooms including those of the Master and Radio Officer, the Master's office, the radio room, and the chart room. The anchor windlass master control panel was located in the chart room. The bridge deck (05) level contained the pilot house and the heliport.

On the main deck at the forecastle was the forward anchor windlass machinery room.

On the focsle deck (01) level were the forward anchor windlasses. The forward anchor windlass control room was a raised structure accessed from this deck.

b. Communications Capabilities

The GLOMAR JAVA SEA was outfitted with the communications equipment normally found on a U.S.-flag merchant vessel. In addition, ARCO and Global Marine installed other equipment to facilitate routine business communications.

The drillship's radio room was located on the navigation deck (04) level, starboard side, adjacent to the chart room. With the exception of 2 VHF radiotelephone units located in the pilothouse and the EPIRB, all of the communications equipment was located in or immediately outside the radio room.

All of the communications equipment except the portable emergency equipment was powered from the ship's service electrical system. All of the equipment in the radio room could be supplied from the emergency generator. In addition, the emergency transmitter, keyer, and receiver on the main console and a VHF (156-158 mHz) radio telephone unit in the radio room had emergency battery power supplies. The main radio installation was a marine radiotelegraph console. It contained an intermediate frequency transmitter (estimated range 500 n. miles), a high-frequency transmitter (estimated range 6,000-8,000 n. miles), and an emergency transmitter (estimated range 150-200 n. miles when operating on the back-up battery power supply). The console design included a feature which provided for automatic broadcast of a distress signal on 500-kHz which would activate the automatic alarm on other vessels. Also in the console were 2 receivers and 2 keyers, 1 of each had a back-up battery power supply, and an automatic alarm activated by an incoming signal on 500 kHz. In addition to the radio telegraph, the vessel had 3 permanent radiotelephone installations for routine marine communications including compliance with bridge-to-bridge radio communication requirements.

In addition to the radio equipment above, the drillship had a variety of other equipment which had been placed aboard by ARCO and Global Marine. There were 2 additional radiotelephone units. One, referred to as the "company radio" (estimated range 300 n. miles), was for communications with the company offices in Zhanjiang and TianDu, the supply vessels, and the helicopters. This radio had teleprinting as well as voice capabilities. The government of the Peoples Republic of China had assigned a working frequency for ARCO's use, and this

radio operated on that frequency. The other unit was a VHF radio intended for communications with the helicopters but rarely used.

A MARISAT satellite telecommunications terminal was installed in the radio room with a remote handset located in the ARCO Drilling Supervisor's office. The terminal had both voice and teleprinting capabilities. In general, the unit operated exactly like a standard telephone or telex terminal installation with both direct dial and operator assist features. It also had a distress signal capability with 2 different modes of operation - one was to simply press a specially marked distress call button; the other was to switch the system to the "distress" mode and start the normal call initiating process. In both cases, the "operator" is alerted, but no specific data is transmitted.

The drillship had 2 portable distress signalling devices required by Federal regulations. An emergency position indicating radio beacon (EPIRB) and a portable lifeboat radio. The EPIRB was mounted on the aft bulkhead of the pilothouse in a rack that would allow it to float free if the vessel capsized or sank. Upon floating free or being manually deployed, the EPIRB (which has a weighted bottom and is stored upside down) automatically rights itself. This activates the transmitter which broadcasts on international distress frequencies.

The emergency lifeboat radio was an ITT Mackay Marine Type 401A portable radio-telegraph transmitter/receiver. This was confirmed by the Master and the Radio Officer from the drillship's alternate crew and by one other former Master. It was mounted in a rack in the chart room immediately adjacent to the radio room and the Radio Officer's stateroom. The Radio Officer was responsible for taking it into his assigned lifeboat when the need arose. Everything necessary to use the radio - antenna, instructions, etc. - was contained in a single package designed for relatively easy carrying. Power was provided by a hand-cranked generator built into the unit. The radio could be operated in manual or automatic mode.

Manual operation entailed sending International Morse Code using a telegraph key. That was the only way in which any signal other than a fixed-form distress signal could be sent. Operation in the automatic mode required no special skill or training. In this mode, simply cranking the transmitter resulted in transmission of the automatic alarm and "SOS" signals on 500 kHz alternating each minute with "SOS" and a 30-second "dash" on 8364 kHz.

c. Anchor System

The GLOMAR JAVA SEA was equipped with ten anchors, five at the bow and five at the stern, each weighing 30,000 pounds. The anchors were numbered 1 through 10 starting with No. 1 on the centerline at the bow, No. 2 and 3 on the starboard bow, No. 4 and 5 on the starboard stern, No. 6 on the centerline at the stern, No. 7 and 8 on the port stern, and No. 9 and 10 on the port bow.

Anchors No. 1 and 6 were fitted with more than 2,000 feet of 3-inch wire cable. The other eight anchors were fitted with more than 2,000 feet of 2-3/4-inch anchor chain.

Each anchor had its own windlass. The windlasses could all be controlled from a master control panel in the chart room on the navigation deck (04) level. The five bow anchor windlasses could also be controlled from the forward windlass

control room on the focsle deck (01) level forward. The five stern anchor windlasses could also be controlled from the aft windlass control room on the boat deck (02) level aft of the deck house.

Each anchor windlass was equipped with a tensiometer which provided a visual display of the tension in the chain or cable. The tensiometer readouts were at the master windlass control panel.

The GLOMAR JAVA SEA was designed to moor over a well site using the anchors deployed in a predetermined pattern which considered prevailing environmental factors such as currents and anticipated weather. Global Marine provided detailed guidelines for the drillship's Master to use in selecting an anchor pattern. Those guidelines were contained in "Global Marine Drilling Company Procedures Manual 5: Marine Operations," a copy of which was onboard the drillship, and covered a wide range of patterns, noting the advantages, disadvantages, and restrictions associated with each pattern. The usual practice was to use eight anchors on the drill site with No. 1 and 6 not being deployed. Global Marine had specific instructions that, in the event of a hurricane, if they had been deployed, the No. 1 and 6 anchors were to be retrieved. These requirements were intended to ensure that there were at least two anchors on board in the event the drillship slipped its anchors to run from the approaching storm.

Global Marine also provided guidelines on the use of the ship's main propulsion engines to ease the tension in the mooring chains during a storm. When the weather forces were between 0 and 30° off the drillship's centerline, the Master was advised that the main engines would assist in reducing the mooring tensions. When the weather forces were 30° to 45° off the centerline, the Master was cautioned on the possibility of undesirable effects on the mooring system if the engines were used. And, when the weather was coming from more than 45° off the centerline, the Master was advised not to use the ship's engines to reduce mooring tensions. The guidelines went on to state that when using the engines to reduce mooring tensions, the Master was to be on watch on the bridge.

d. Lifeboats: The GLOMAR JAVA SEA was equipped with two 30-foot, motor propelled, covered, fiberglass lifeboats manufactured by the Marine Safety Equipment Company of Farmingdale, New Jersey. They were certified for 64 persons each. One lifeboat was located on each side of the drillship just outboard of the after house at the boat deck (02) level. The lifeboats were stored in gravity type davits manufactured by Marine Safety Equipment Company. To lower the lifeboat, a person had to release the gripes and locking bar, then lift the winch brake handle to allow the lifeboat to descend to the embarkation deck or water. This could be done from the boat, without the need for anyone on board the drillship to assist. However, it did require that the door on the lifeboat be open. Each lifeboat was equipped with Rottmer releasing gear that required someone in the boat to unlatch and move the releasing lever in the lifeboat over 180 degrees to release the boat falls from the hooks located on the bow and stern of the lifeboat. The lifeboat would then be free to move away from the drillship.

e. Vessel and Equipment Summary

(1) Identification

(a) Name: GLOMAR JAVA SEA

(b) Registry: United States
(c) Documentation Number: 568182
(d) Homeport: Galveston, TX
(e) Gross Tons: 5,930
(f) Net Tons: 3,930
(g) Call Sign: WFDS
(h) Owner: Global Marine Deepwater Drilling, Inc.
811 West 7th Street, Los Angeles, CA 90017
(i) Operator: Global Marine Drilling Company
7500 San Felipe, Houston, TX 77210
(j) Master: Gustaf F. Swanson
(k) License: Master, Steam and Motor Vessels of Any Gross Tonnage, Oceans; Radar Observer

(2) Builder Data

(a) Builder: Levingston Shipbuilding Company
(b) Place Built: Orange, Texas
(c) Date Built: 1975
(d) Builder's Hull Number 715

(3) Hull Particulars and Dimensions

(a) Length Overall: 400 feet
(b) Length Between Perpendiculars: 380 feet
(c) Beam Molded: 65 feet
(d) Depth Molded at Side: 26 feet 9 inches
(e) Draft (Designed): 21 feet
(f) Lightship Displacement: 6,122 Long Tons
(g) Deadweight: 5,097 Long Tons
(h) Loaded Displacement: 11,220 Long Tons
(i) Hull Material: Steel

(4) Propulsion Particulars

(a) Type: Diesel Electric
(b) Number of Diesel Generators: 6
(c) Number of Propulsion Motors: 6
(d) Number of Shafts: 2
(e) Total Shaft Horsepower: 4,500

(5) Capacities

(a) 5" Drill Pipe (in Pipe Racker): 23,580 feet
(262 triple sections (3 X 30 feet))

(b) Casing and Pipes:

1/2 Casing Rack - 400 Long Tons
Casing Hold - 400 Long Tons

(c) Liquid Mud, Reserve Tanks: 2,484 Barrels
(d) Active Mud: 605 Barrels
(e) Bulk Dry Mud: 9,790 Cubic Feet
(f) Bulk Dry Cement: 6,590 Cubic Feet

(g) Sacked Dry Materials: 12,000 Cubic Feet
(h) Drill Water: 14,705 Barrels
(i) Wash Water: 1,515 Barrels
(j) Potable Water: 512 Barrels
(k) Fuel Oil (Diesel), 95%: 9,588 Barrels
(l) Helicopter Fuel, 95%: 2,208 Gallons
(m) Lube Oil, 95%: 326 Barrels
(n) Berths:

1 Forward - 10
2 Aft Staterooms - 74
3 Hospital - 6

(6) Drilling Capabilities

(a) Water Depth: 1,000 feet
(b) Drilling Depth: 25,000 feet
(c) Derrick Load: 1,000,000 pounds

(7) Lifesaving Equipment

(a) Lifeboats:

1 Required Total Capacity: 110 Persons
2 Number Onboard: 2
3 Capacities: 64 Persons Each
4 Manufacturer: Marine Safety Equipment Company
5 Type: Enclosed; Motor Propelled
6 Material: Fiberglass Reinforced Plastic
7 Dimensions: 30' X 10' X 4.33'
8 USCG Approval Number: 160.035/472/1
9 Date Built: 1974

(b) Liferafts:

1 Required total Capacity: 55 Persons
2 Number Onboard: 3
3 Capacities: 2 for 20 Persons Each
1 for 15 Persons
4 Manufacturers:
(1) 20 Persons Rafts: B.F. Goodrich
(2) 15 Persons Raft: Switlik Parachute Company
5 Type: CO_2 Inflatable

(c) Ring Lifebouys:

1 Total Number Required: 12
2 Number Onboard:
(a) with lights and lines: 6
(b) with lights, lines, smoke signals, and quick release capacities: 2
(c) others: 4

(d) Life Preservers (Personal Floatation Devices):
1 Total Number Required: 138
2 Number Onboard:

(a) Full Use: 158
(b) Work Vests: 6

(8) Communications Equipment

(a) Radiotelegraph:

1 frequencies available -- 405 - 535 kHz; 2,000 - 26,000 kHz
2 capabilities -- transmit, receive; coded word, fixed distress signal
3 emergency automatic alarm transmitter/keyer and receiver on 500 kHz
4 location -- radio room
5 principal use -- routine marine communications

(b) Radiotelephone (single sideband):

1 frequencies available -- 1,600 - 23,000 kHz
2 capabilities -- transmit, receive; voice
3 location -- radio room with remote microphone and speaker on bridge
4 principal use -- routine marine communications

(c) Radiotelephone (single sideband):

1 frequencies available -- 4,6,8 mHz
2 capabilities -- transmit, receive; voice, teleprinter
3 location -- radio room
4 principal use -- communications with ARCO and GMDC offices in China and with work boats and helicopters

(d) Radiotelephone (VHF; portable):

1 frequencies available -- 120 - 130 mHz
2 capabilities -- transmit, receive; voice
3 location -- pilothouse
4 principal use -- communications with helicopters

(e) Radiotelephone (VHF; 2 units):

1 frequencies available -- 156 - 158 mHz
2 capabilities -- transmit, receive; voice
3 locations -- radio room, pilothouse
4 principal use -- communications with work boats; bridge-to-bridge communications

(f) Satellite Telephone (MARISAT):

1 frequencies (fixed, preset by Mfr.)-- 1,636.5 - 1644 mHz
2 capabilities -- transmit, receive; voice, teleprinter; fixed distress signal
3 location -- radio room with remote handset in ARCO representative's office

4 principal use -- communications with GMDC offices and others in the United States and other countries.

(g) Portable Lifeboat Radio:

1 frequencies available -- transmit 500 kHz, 8364 kHz; receive 492 - 508 kHz, 8,266-8,745 kHz
2 capabilities -- transmit, receive; coded word, fixed distress signal
3 location -- bulkhead mounted storage rack in radio room
4 principal use -- emergency broadcast from lifeboat upon abandoning ship

(h) Emergency Position Indicating Radio Beacon (EPIRB):

1 frequencies (fixed) -- 121.5 mHz; 243 mHz
2 capabilities -- transmit; fixed distress signal
3 location -- mounted in rack on exterior of aft bulkhead of pilothouse
4 principal use -- float free and automatic broadcast in the event vessel capsizes or sinks

(i) Facsimile Receiver:

1 for receipt of facsimile weather plots
2 capabilities -- receive weather plots
3 location -- chart room
4 principal use -- receive weather plots from Chinese weather service

f. Inspection History

The GLOMAR JAVA SEA underwent Coast Guard plan review and initial inspection for certification during construction. Simultaneously, it was surveyed for classification by the American Bureau of Shipping (ABS). The initial inspection and classification were completed on 30 October 1975. The drillship was maintained under certification and in class continuously since that time.

The GLOMAR JAVA SEA underwent biennial recertifications by the Coast Guard, with partial reinspections at about the midpoint of each certificate's term. The ship was examined on drydock approximately every 2 years. Also, the American Bureau of Shipping (ABS) conducted periodic hull, machinery, and load line surveys.

The last Coast Guard drydock examination and the last ABS drydock, annual hull and machinery, and annual Load Line surveys were conducted simultaneously in November, 1982 at San Francisco. External structural members and hull plating were checked for damage and defects, and some ballast tanks were internally examined. At that time some localized deep pitting was found in way of exterior (hull) plating of ballast tanks surrounding the drill well. Permanent repairs were made by cutting out the deteriorated plating and inserting new plate of the same grade and thickness as the original. Some set in areas were noted in the hull plating. Permanent welded repairs were made in way of damage to internal structural members between frames 109 and 125 and to fractured welds at frames 128-129, port side. The plating damage in those areas, in way of frames 4 and

145-176 on the port side, and in way of frames 168-170 on the starboard side was determined to be superficial and no repairs were considered necessary at that time. During the drydock examination the vessel's sea valves were opened for inspection. Some routine repairs were made to several valves.

The starboard tailshaft was drawn for examination. The port tailshaft was examined in place. Wear-down readings were taken on both shafts. Also, equalizing lines were installed between the No. 5 port and starboard wing drillwater tanks and the No. 5 port and starboard double bottoms. In general, the Coast Guard and ABS records of the drydock examination show that the drillship was in sound structural condition with no significant deficiencies. The Coast Guard Marine Inspector completed his inspection on 29 November 1982 and found the drillship fit for its intended route and service. The ABS Surveyor completed his surveys on 30 November 1982 and found the drillship fit to be retained in class.

The last Coast Guard inspection for certification was conducted at the drill site between 13 and 17 October 1983. ABS conducted annual hull and machinery, annual load line, and cargo gear surveys during that same period.

During the course of the inspection the attending Coast Guard Marine Inspector examined all of the drillship's safety equipment. The records from that inspection show that all required lifesaving equipment was onboard the vessel. The lifeboats were inspected and weight-tests were performed during which the fully loaded boats were lowered to the embarkation deck. A boat drill was conducted during which the port lifeboat was lowered to the water. At no time during the inspection or the drill was either lifeboat released and exercised in the water. The inspection report indicates that that was due solely to the sea conditions at the time. The three inflatable liferaft installations were visually examined. The inspection records show that all three liferafts had been serviced within the previous 11 months (annual servicing is required). All three liferafts were equipped with hydraulic release devices (commonly referred to as hydrostatic releases) and weak links. However, only one of the hydraulic release devices had been serviced within the previous 12 months (again, annual servicing is required). Of the other two, one had gone approximately 20 months and the other approximately 35 months since last being serviced. Twelve ring lifebouys and 138 personal flotation devices (PFDs) were required; 12 lifebouys, 158 PFDs and 6 work lifevests were onboard and fully serviceable at the end of the inspection. The emergency lifeboat radio was tested when the boat drill was conducted. The Coast Guard Marine Inspector testified about the drill: "good response" and "done well".

A number of minor deficiencies were noted and corrected during the inspections. In addition, the following discrepancies noted by the Coast Guard Marine Inspector remained outstanding at the end of the inspection:

- annual servicing of the fixed CO_2 fire extinguishing system for the engineroom and all semi-portable fire extinguishers was to be completed by 1 January 1984.

- hydrostatic testing or internal examination of the air receivers for the riser tensioning system was to be completed by the next drydock examination (due in November 1984).

- new relief valves were to be installed on the air receivers

for the riser tensioning system by 8 January 1984.

- data on the Marine Sanitation Device was to be submitted by 8 December 1983 for Coast Guard approval.

- minor electrical wiring deficiencies in classified areas (drill floor, mud pumps) were to be corrected by 17 November 1984.

In addition to the inspection for certification and annual surveys, a damage survey was also completed. Minor damage had been sustained to the bulwark between frames 48 and 80 and to the side shell plating at frame 150, port side, as the result of contact with the Chinese workboat NAN HAI 209 on 10 January 1983. In this case the damage was superficial and immediate repairs were not considered necessary. Damage had also been sustained to the side shell plating and internal members between frames 119 and 142, port side, as the result of contact with the work boat NAN HAI 209 on 23 August 1983. Temporary repairs were made by rewelding all fractured and torn welds. The remainder of the damage was minor in nature and immediate repairs were not considered necessary.

In addition to the periodic Coast Guard inspections and ABS surveys, Global Marine and the drillship's crew conducted their own inspections. Global Marine conducted formal inspections annually; the last one was in August of 1983. The vessel's crew routinely inspected the lifeboats during weekly drills and the previous Master had the lifeboats stripped of all equipment for his inspection approximately three weeks before the casualty.

g. Operating History: The GLOMAR JAVA SEA was delivered to Global Marine in September 1975. The drillship was under contract to the Atlantic Richfield Company (ARCO) from the time it was built until ARCO assigned the contract to ARCO China for the work in the South China Sea.

The GLOMAR JAVA SEA operated in the Gulf of Mexico from late 1975 to September 1981. It was then moved to a drilling site off the coast of California where it operated until November 1982. The latter half of November 1982 was spent at the Triple A Shipyard in San Francisco, California, undergoing repairs as well as Coast Guard and American Bureau of Shipping examinations.

The drillship departed the United States on 1 December 1982 and arrived in the South China Sea on 7 January 1983.

4. PERSONNEL DATA

a. Manning Summary: A total of 81 persons were on board the GLOMAR JAVA SEA when it sank. That total included the marine crew, the drilling crew, operator (ARCO China) and subcontractor representatives, support personnel (interpreters, radio operators, etc.), and trainees. The marine crew, principal drilling crew members, and with one exception, operator representatives were citizens of the United States. The ARCO China Drilling Engineer was a Canadian citizen residing in the United States. The majority of the lower-level drilling crew (roughnecks, roustabouts), service personnel, and trainees were citizens of the Peoples Republic of China. The rest of the personnel were subcontractor representatives (drilling mud engineers, etc.) of various nationalities. A breakdown of the entire crew by nationality is as follows:

United States	37	Great Britain	4
Australia	1	Philippines	1
Canada	1	Singapore	2
China	35		

b. Key Personnel Background Data: The following are background summaries for those personnel onboard the GLOMAR JAVA SEA who exercised some degree of command control over the operations of the drillship.

[redacted] Master

Captain [redacted] was [redacted] years of age. His educational background included nautical science studies at Washington State Technical School. He started going to sea as a cabin boy at age [redacted] He obtained his Third Mate's license at age [redacted] his Chief Mate's license at age [redacted] and his Master's license at age [redacted]

From 1954 to 1963 he served in a variety of capacities, from Third Mate through Master, on commercial merchant vessels. From 1963 to 1981 he served as Master of civilian-crewed ships of the U.S. Navy. He served as Master of the GLOMAR CORAL SEA (a sistership of the GLOMAR JAVA SEA) for a short period in 1981. He had previously served for a short period of time in 1982 as Master of the GLOMAR JAVA SEA.

[redacted] Drilling Superintendent

Mr. [redacted] was [redacted] years of age. From 1960 to 1964 he worked as derrickman for a shoreside drilling operator. From 1964 to 1967 he worked for Santa Fe Drilling on a semisubmersible drilling unit. He was hired by Global Marine as a derrickman in 1967. He was promoted to driller in 1968 and to toolpusher (drilling foreman) in 1972. He served in that capacity until June 1982 when he was promoted to drilling superintendent and assigned to the GLOMAR JAVA SEA. All of his experience with Global Marine was onboard drillships. It appears from company records that Mr. [redacted] held a Merchant Mariner's Document as Able-Bodied Seaman and Lifeboatman; however, Commandant (G-MVP) had no record of that document.

[redacted] Senior Drilling Supervisor, ARCO China Inc.

Mr. [redacted] was [redacted] years old. From 1959 until 1966 he worked in equipment maintenance and operation for land-based drilling operations. From 1966 to 1979 he worked for a variety of SEDCO subsidiaries as a Rig Mechanic (1966-1972), Subsea Engineer (1972-1974), and Rig Superintendent (1974-1979). He joined ARCO International Oil and Gas in 1980.

In addition to his drilling qualifications, he had in the past held a license as Master of Column-Stabilized or Self-Elevating Motor Drilling Vessels of Any Gross Tons Upon Oceans Under Tow or Engaged in M&O Exploration, with Radar Observer Endorsement. Records provided by the Commandant (G-MVI) show that his last license expired 21 September 1981. He also held a Merchant Mariner's Document as Able-Bodied Seaman and Lifeboatman.

[redacted] Assistant Rig Manager, Global Marine Drilling Company, Zhanjiang

Mr. [redacted] was the assistant to the shore-based Rig Manager at Zhanjiang. He was a Mechanical Engineer who had held a variety of jobs, including 3 years in

drilling equipment supply, prior to joining Global Marine in 1978. He served in a variety of engineering jobs until 1 September 1983 when he was assigned as Senior Staff Engineer for the GLOMAR JAVA SEA. He had been the Assistant Rig Manager for approximately one month.

The Rig Manager or his assistant made periodic visits to the vessel. On 25 October 1983 the Rig Manager was in the United States, and Mr. [redacted] was onboard the GLOMAR JAVA SEA. It was only his second visit to the drillship.

c. Record of Dead and Missing: A total of 81 persons were on board the drillship. No survivors have been found. Thirty-one bodies were recovered from the wreck during the diving expedition in March 1984. Five other bodies were found in the wreck but were not recovered or identified. The remaining forty-five persons are missing and presumed dead. See Appendix A for personal data on the individual crewmembers.

5. DRILLING CONTRACTS

In September of 1982 China National Offshore Oil Company (CNOOC) entered into a contract with ARCO China and Santa Fe Minerals (ASIA), Inc. (a subsidiary of Santa Fe International Corporation) for exploration and exploitation of petroleum resources in a defined area in the South China Sea. ARCO China was designated as the operator in this petroleum venture, but was not the operator of the drilling vessel contracted for the exploration phase of this project. ARCO China engaged Global Marine to perform the drilling operations using a self-propelled drillship. The contract between CNOOC and ARCO China included provisions that ARCO China was to provide training for Chinese nationals in all phases of petroleum exploration activities, including exploration and drilling in the field and support activities on shore. ARCO China was also to use their best efforts to persuade Global Marine to provide training in the specialized techniques of drilling to appropriate CNOOC employees. ARCO China was to give first priority to hiring Chinese nationals provided CNOOC offered qualified personnel for the specific activity. If qualified Chinese nationals were not available, ARCO China could employ foreign (non-Chinese nationals) personnel to perform those activities. These provisions in the contract resulted in Chinese nationals working on board GLOMAR JAVA SEA in the lower technical skill areas in the drilling crew, as radio operators and interpreters, and in the marine crew serving in capacities not requiring a Coast Guard document. (The probability that Chinese seamen served in place of the required Ordinary Seamen is addressed separately.) Other Chinese personnel were on board in trainee status.

6. THE DRILL SITE

The drill site, designated as Ledong 30-1-1, was at latitude 17° 17' 49"N, longitude 108° 56' 29" E in the Yingge Basin near the south boundary of the Gulf of Tonkin in the South China Sea. That position is approximately 63 nautical miles south of Hainan Island, Peoples Republic of China, and 80 nautical miles east of the Socialist Republic of Vietnam. The normal sea water temperature in this area is approximately 80°F year round.

The northern part of the South China Sea has been divided by the Chinese into two oil exploration zones designated Nanhai East and Naihai West. The Ledong 30-1-1 site was in the Nanhai West zone.

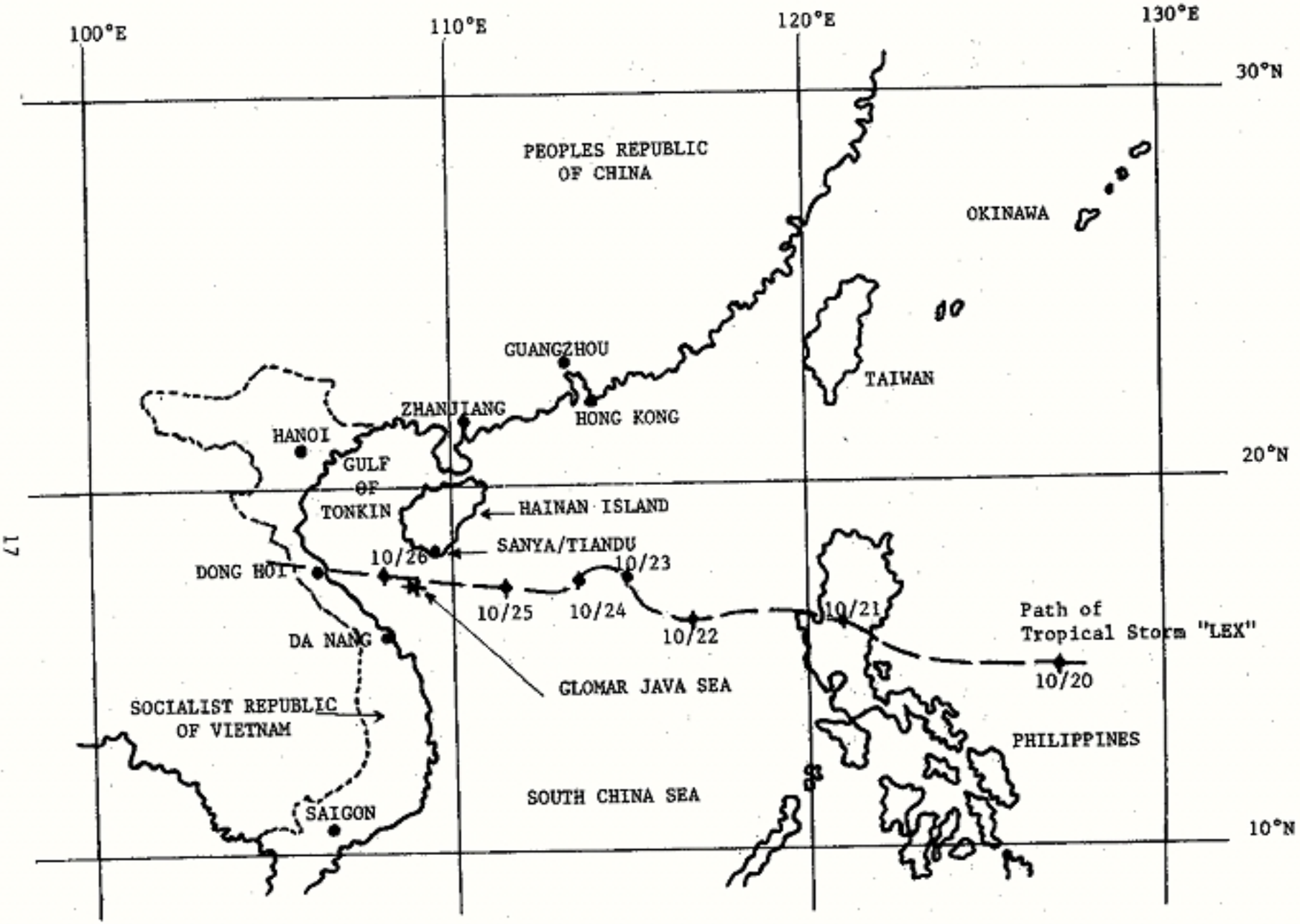

FIGURE 3: Location of the Drill Site

The South China Sea is subject to severe weather conditions virtually year round. The summer monsoon season stretches from May through August, and the winter monsoon season from October through March with transition periods in April and September. The area is also affected by severe tropical cyclones from May through November. The general area where the GLOMAR JAVA SEA was working has been shown to have a 42% probability of the occurrence of a tropical storm with wind speeds of 34 knots or more [Sailing Directions (Planning Guide) for Southeast Asia, 1st Edition, 1979, published by the Defense Mapping Agency]. Although referred to by some as "typhoon alley," the area is no more vulnerable to tropical storms than other South China Sea areas.

The maximum recorded tropical cyclone conditions, recorded in May 1971, included a maximum sustained (10-minute, 10-meter) wind speed of 80 knots, a maximum significant wave height of 37.9 feet, a significant period of 13.7 seconds, and a maximum wave crest elevation of 44.6 feet. The maximum nontropical storm (October-November 1970) had a maximum sustained wind speed of 36 knots, a significant wave height of 19.1 feet, a significant period of 9.1 seconds, and a maximum wave crest elevation of 12.7 feet. [Hindcast Study -- Offshore Hainan Island -- South China Sea performed by Oceanographic Services, Inc., for ARCO International Oil and Gas Company in December 1980.]

7. LOCATIONS OF SHORESIDE SUPPORT

The principal support base was at Zhanjiang on the mainland of the Peoples Republic of China, north of Hainan Island. Both Global Marine's and ARCO China's principal supervisory and management personnel, support staffs, and logistics personnel were based there. ARCO China maintained a communications center there, staffed with radio operators and translators, and equipped with single sideband radio, telex, radio facsimile receiver, and telephone installations.

The supply vessels supporting the drillship were based at the port of Sanya on the southern tip of Hainan Island, Peoples Republic of China. Neither Global Marine nor ARCO China maintained offices there, however, and the supply vessels normally operated between Zhanjiang and the drillship.

TianDu was a Chinese military facility and airfield near Sanya. ARCO China maintained a communications center there. In addition, the helicopters supporting the GLOMAR JAVA SEA were based at TianDu.

8. ARCO CHINA ORGANIZATION

ARCO China's senior company official, the Vice President and General Manager, had offices in Hong Kong. Next in line was the Operations Manager, whose offices were in Zhanjiang. He supervised a variety of support personnel including Chinese radio operators and translators. Immediately below him was the Drilling Superintendent to whom the ARCO China personnel on board the drillship reported. Onboard the drillship, the Drilling Supervisor was the senior ARCO China representative; he supervised a Drilling Engineer and a Geologist.

There were two persons available for almost all ARCO China positions; they worked alternating 28-day shifts. ARCO China also had a group of Chinese employees, radio operators, a translator, and a supervisor, who operated the communications center at TianDu.

9. GLOBAL MARINE ORGANIZATION

Global Marine Drilling Company's Operations Department was subdivided into 4 drilling groups, each headed by a Drilling Group Vice President based in Houston, TX. Each group was responsible for approximately one-fourth of Global Marine's fleet of drilling vessels. A Rig Manager was assigned to oversee the operation of each drilling vessel.

The GLOMAR JAVA SEA was in Drilling Group II. The Drilling Group Vice President had his office in Houston, TX. The Rig Manager was based in Zhanjiang. His office staff consisted of an Assistant Rig Manager, a Materialsman, an Accountant, and a clerical staff. He was also the immediate supervisor of the two Drilling Superintendents who alternated on 28-day hitches onboard the drillship.

Working under the Drilling Superintendent onboard the drillship were three positions given equal status in the Global Marine organization: Master; Chief Engineer; and Toolpusher. There were two Masters and two Chief Engineers who alternated on 28-day hitches. There were four Toolpushers, two on each 28-day hitch, who worked alternate 12-hour shifts or "towers." The Master was in charge of the marine deck crew. The Chief Engineer was in charge of the marine engineering crew. Toolpushers were in charge of the drilling crews. Those crews worked 12 hours on, 12 hours off, on 28-day hitches, with approximately one-fourth of the crew changing each week.

10. CHINA NATIONAL OFFSHORE OIL CORPORATION

China National Offshore Oil Corporation (CNOOC) was a state-owned company of the Peoples Republic of China. That company was responsible for exploration and exploitation of the country's oil resources. CNOOC and its state-owned subsidiaries Nan Hai West Oil Company, China Nanhai Oil Joint Service Company, and Nan Hai West Shipping Company, provided personnel, supply vessels, and other services in support of the oil exploration operation in which the GLOMAR JAVA SEA was employed.

11. SUPPLY VESSELS AND HELICOPTERS

ARCO China contracted with Chinese companies to provide logistic support for the transportation of personnel and materials to and from the drillship. CAAC, a subsidiary of the Chinese national airline company, operated two Bell 212 helicopters under contract. The helicopters were based at TianDu and were the principal means of transporting personnel.

Nan Hai West Shipping Company operated two 200-foot supply vessels in support of the drilling operation. The NANHAI 205, built in Norway in 1975, carried a crew of 23. The NANHAI 209, built in Japan in 1979, carried a crew of 27. Both vessels were capable of a maximum speed of 13 kts. They were equipped with radar, satellite navigation systems, and VHF radio installations in addition to the single sideband radio provided by ARCO China. The supply vessels alternated work weeks so only one was attending the drillship at any given time. The idle vessel would be either in Zhanjiang for loading or in Sanya.

The helicopters and the supply vessels were under the operational control of ARCO China. Depending on the situation, their services were ordered either by the Drilling Supervisor onboard the drillship or by support personnel at

Zhanjiang. The drillship's Master could direct the movements of the supply vessels only when they were coming alongside. Communications with both the supply vessels and the helicopters were conducted through the Chinese interpreters and radio operators onboard the drillship.

12. COMMUNICATIONS IN THE DRILLING AREA

The GLOMAR JAVA SEA had a comprehensive marine communications center, with 2-way single sideband (SSB) and VHF radiotelephone (voice), radiotelegraph (code), and telex capabilities, plus radio facsimile reception capabilities and a satellite telephone system. The ARCO China communications center at Zhanjiang ("ARCO Zhanjiang Radio") had SSB radiotelephone, telex, and facsimile capabilities. The ARCO China communications center at TianDu ("ARCO TianDu Radio"), the principal communications station because of its close proximity to the drill site, had only SSB radiotelephone capabilities. The supply vessels (NANHAI 205 and NANHAI 209) had both SSB and VHF radiotelephone capabilities.

The common communications link was the single sideband (SSB) radiotelephone. Commonly referred to as the "company radio," all of the SSB radio units were supplied by ARCO China. The units were capable of operating on 4 different frequencies but normally operated on the Chinese Government-assigned frequency of 6521.9 kHz. The drillship and Zhanjiang had teleprinter (telex) capabilities on their SSB installations.

Routine daily reports were transmitted from the drillship to Zhanjiang using the telex mode. Other communications between the drillship and the shore bases were via the SSB radio. Weather reports were received at the drillship and at Zhanjiang by radio facsimile transmission.

Communications between the shore bases and the supply vessels was normally via the SSB radio; however, the drillship usually communicated with the supply vessels using the VHF radio telephone because it provided better reception in very short-range situations. While direct communications between the drillship and the helicopters was possible, such communications were rare; normally, the drillship contacted the helicopters through TianDu.

The drillship was manned by a Coast Guard- and FCC-licensed Radio Officer and 2 Chinese radio operators. The Radio Officer was usually on duty from 0600 to 1800 each day, while the 2 operators alternated on 12-hour watches to provide continuous communications capabilities. ARCO TianDu Radio was manned by 4 radio operators, an interpreter, a driver, and a supervisor. The radio operators alternated watches to provide 24-hour communications.

ARCO Zhanjiang Radio was staffed with 3 radio operators during the typhoon season. The radio operators did not always effect a face-to-face relief because the watch schedule did not provide for 24-hour coverage. No operator was scheduled from 2300 to 2400 or 0600 to 0700. Thus, there were occasional lapses in coverage, and, on 25 October 1983, no radio operator was present from 2300 to 2330.

The government of the Peoples Republic of China required that all radio communications be initiated between the Chinese radio operators and then turned over to the participating parties. This practice was routinely observed; however, there was no physical or technical impediment to other persons initiating communications. To facilitate communications, ARCO China maintained

interpreters on the staffs at Zhanjiang and TianDu. Interpreters were also included in the drillship's crew.

The NANHAI 205 had a crew of 23 persons, the NANHAI 209 had a crew of 27. Radio communications, apparently, were frequently handled by the Master or a person on watch rather than a designated radio operator. From the testimony of former and alternate drillship crewmembers, it is apparent that the drillship often experienced difficulty contacting the supply vessels at night. The persons involved felt that the difficulty arose because the supply vessel crews turned off the radios at night. While that couldn't be confirmed, it appears that the drillship's radio operators and the supply vessel crews routinely used the VHF rather than the SSB radio when the vessels were at or near the drill site. The supply vessels apparently turned off the SSB at those times. Also, the supply vessels routinely reported to their base only every 6 hours, and it appears that the radio was frequently unattended between reports. It is reasonable to assume that such practices resulted in difficulties in contacting the supply vessels, particularly when they were just "standing by."

In general, communications between the drillship, the workboats, and shoreside personnel were on an "as necessary" basis. Other than the daily drilling reports, which were sent about the same time each day, there were no routine communications checks or schedules. The drillship had been instructed by ARCO China to contact Zhanjiang or Sanya and the NANHAI 205 hourly while the storm warnings were in effect. Available communication records do not show that hourly checks were being made. However, persons on the drillship talked to persons ashore or on the NANHAI 205 at least 6 times between 2210 and 2315 on 25 October 1983, and were in voice contact with Global Marine's Houston, TX, office when communications were lost.

Neither ARCO China nor Global Marine had established procedures on actions to be taken in the event of a loss of communications with the GLOMAR JAVA SEA. The loss of communications was reported to ARCO China supervisory personnel at about 0030, 26 October. Shoreside personnnel tried throughout the night to contact the drillship and the NANHAI 205 which was near the drill site. At about 0620, 26 October, they finally contacted the NANHAI 205 and directed it to go to the drill site.

13. WEATHER DATA SOURCES

Through contractual arrangements made by ARCO China and Global Marine, two weather services provided weather data.

Meterological Service Company of the China Nanhai Oil Union Service General Company, at Guangzhou, Peoples Republic of China (routinely referred to as "Meteo"), issued weather forecasts and, when appropriate, storm warnings, on a routine basis. Under routine conditions, forecasts were issued approximately every 6 hours. Under storm conditions, forecasts or storm warnings were issued more frequently. On 24 and 25 October 1983, tropical cyclone forecasts were issued every 6 hours, and environmental weather forecasts approximately every 3 hours.

The Japanese Meterological Service (routinely referred to as "weather fax"), in Tokyo, Japan, transmitted surface weather maps via a radio facsimile system on a daily basis. On 24, 25 and 26 October 1983, that service also broadcast, every 6 hours, storm warnings for shipping.

Both the drillship and the communications center at ARCO China's Zhanjiang office had radio facsimile receivers. They received the weather data transmissions simultaneously.

14. ANCHOR ARRANGEMENT

The GLOMAR JAVA SEA was equipped with 10 anchors. Usual practice was to use 8 anchors to moor the drillship over a well site. However, from the time the drillship arrived at the Ledong 30-1-1 drill site, nine anchors, all but No. 1, were deployed. The reason for this started with No. 7 windlass becoming inoperative at the previous drill site. When it was time to move, a work boat picked up the anchor and towed the ship to the new site with the No. 7 chain. When the anchors were deployed at the new site, No. 7 and 8 were too close together with No. 7 being out of position. No. 6 was then deployed approximately where No. 7 would normally be positioned. No. 7 windlass was subsequently repaired, but the anchors were left in the original positions. The anchor positions were as follows:

	True Bearing	Relative Bearing
Drillship Heading	339°	0
No. 1	-	-
No. 2	17°	42°
No. 3	50°	75°
No. 4	90°	115°
No. 5	126°	151°
No. 6	185°	210°
No. 7	226°	251°
No. 8	230°	255°
No. 9	270°	295°
No. 10	305°	330°

In each case approximately 1,700 feet of chain or cable was deployed.

Two licensed Masters were on board during the move and the anchor deployment. Captain [redacted], who was just completing his four-week tour of duty and his relief, Captain [redacted] (Captain [redacted] was subsequently relieved by Captain [redacted], the Master at the time of the casualty). Both men testified that prevailing conditions were considered and that the anchor pattern chosen was appropriate to the locale. The pattern generally agreed with the guidance provided for the Master in Global Marine's "Procedures Manual 5 -- Marine Operations". The pattern was also approved by the shoreside supervisory personnel at Zhanjiang.

The anchor pattern approximated pattern number 6 in the Marine Operations Manual and allowed for changes of approximately 30° to each side of the original heading to compensate, if necessary, for changes in weather or sea conditions, to limit vessel motions, or to reduce the strain on one or more chains. Such a change would be effected by slacking some chains and heaving in on others to pivot the vessel in place. This procedure was known to each of the Masters and the vessel's heading was changed from 335°T to 339°T sometime after it was anchored at the drill site.

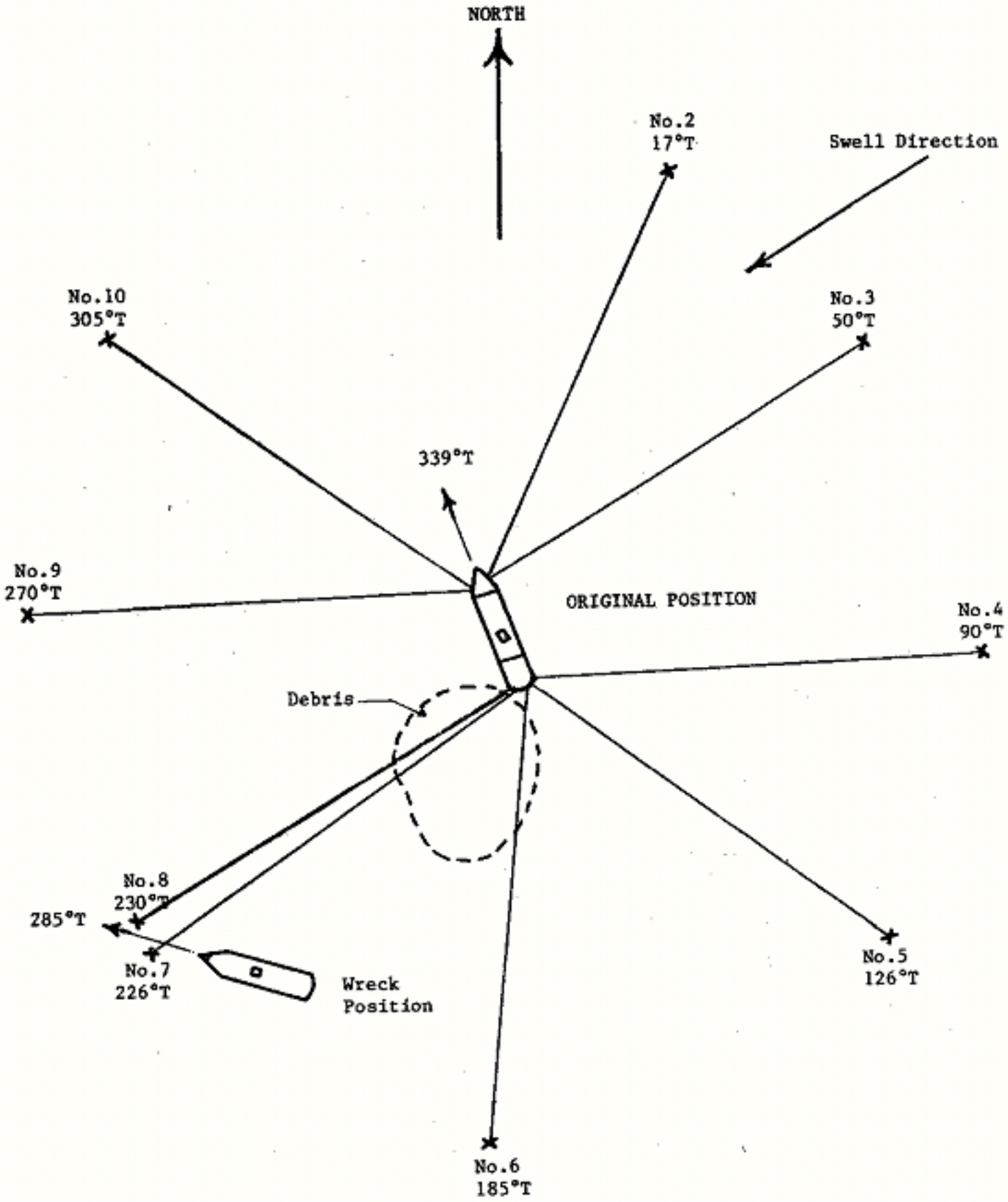

FIGURE 4: GLOMAR JAVA SEA's Anchor Pattern on 25 October 1983

The anchor system was designed to permit the retrieval or release of the anchors under controlled conditions as well as uncontrolled release under emergency conditions. Normal practice in retrieving the anchors entailed a supply vessel picking up the anchor and carrying it to the drillship while the drillship took in the chain or cable. However, the anchors could also be released rather than being retrieved. The chains had detachable links which could be opened to drop the anchor and part of the chain. Cutting the chains and wires was also an option. The anchors could also be released by disengaging the windlass clutches and brakes and allowing the chains or cable to run out. Under controlled conditions, a buoy known as a "breakaway buoy" or "baseball buoy" was attached to the loose end of chain by a wire pendant. When the chain was released, the buoy both marked the end and provided a means for retrieving it. However, connecting the buoys was a lengthy process which would not have been used in an emergency.

The five forward windlasses could be controlled from a raised control house accessed from the focsle deck (01) level at the bow. The five aft anchors could be controlled from a control house at the boat deck (02) level aft of the deckhouse. In addition, all of the windlasses could be controlled from a master console on the navigation deck (04) level. The control system was an electrohydraulic system. The use of any of those control stations required that hydraulic pumps powered from the GLOMAR JAVA SEA's ships service generators be operable. The alternate Chief Engineer testified that those hydraulic pumps could not be supplied from the emergency power system. If normal electrical power was not available, the anchors could be released manually only at the windlasses. However, the testimony of the alternate Master and another former Master indicates that this may not have been common knowledge. One felt that release of the anchors from the navigation deck could be accomplished without any electrical power, and the other felt that release could be effected with only emergency power.

15. TROPICAL STORM "LEX"

The tropical disturbance which became tropical storm "Lex" was first detected by the U.S. Joint Typhoon Warning Center, Guam, Mariannas Islands, in the vicinity of the Marshall Islands on 14 October 1983. The disturbance moved westward and, on 16 October, began to intensify. See Figure 3. The disturbance continued to intensify, and at 0400, 20 October, as it approached the Philippines, a tropical cyclone formation alert was issued. The disturbance continued to intensify while moving west-northwest, and at 0800, 22 October, it was designated as tropical depression "Lex," and an initial warning was broadcast. At 0653, 23 October, "Lex" was upgraded to tropical storm status.

The U.S. Joint Typhoon Warning Center cited sustained winds of 65 kts for "Lex" at 0200, 25 October, and classed "Lex" as a "typhoon." The agency cited maximum sustained winds of 70 kts with gusts to 85 kts at 0800, 25 October, after which time the storm's intensity decreased. No other agency cited wind speeds that high, and no other agency classed "Lex" as a typhoon (sustained wind speeds over 64 kts).

The meteorological data services supporting the drilling operation cited maximum sustained winds of 60 kts with gusts to 75 kts near the storm's center, with somewhat less severe conditions initially forecast for the drillship's position. As the storm's predicted path shifted toward the drill site, the conditions forecast for the drill site approached but never exceeded those forecast for the

storm center. At its peak, those services classed "Lex" as a severe tropical storm (wind speeds 48-63 kts). "Lex" began weakening as it passed south of Hainan Island. The U.S. Joint Typhoon Warning Center downgraded it to a tropical storm at 0200, 26 October. It continued to weaken while passing through the Gulf of Tonkin, making landfall near Dong Hoi, Viet Nam, on 26 October with maximum sustained winds of 50 kts.

Although described variously as a "typhoon," "tropical cyclone," "severe tropical storm," and other titles, the storm known as "Lex" will be, for the purposes of this report, referred to simply as "tropical storm 'Lex'" as that was the highest storm classification used by the weather services providing information to the drillship.

16. TYPHOON PLAN

The GLOMAR JAVA SEA was in compliance with the requirements in Title 46, Code of Federal Regulations, Subchapter I-A, Rules for Mobile Offshore Drilling Units, Part 109 (46 CFR 109) to have on board specific instructions for preparing for a severe storm and preparing to move the drillship. Global Marine had published four distinct sets of instructions or guidelines: (1) GLOMAR JAVA SEA Operating Manual; (2) Global Marine Drilling Company Procedures Manual 5 - Marine Operations; (3) Global Marine Drilling Company Critical Procedures; and (4) Typhoon Plan for GLOMAR JAVA SEA.

The Operating Manual was required by Coast Guard regulations and was the only one of those four documents submitted to the Coast Guard for approval. Procedures Manual 5 - Marine Operations contains a segment entitled Heavy Weather Procedures which is identical to the Coast Guard-approved Operating Manual. The Critical Procedures Manual contains a segment entitled Hurricane Procedures and Evacuation. All of those documents describe a three-phase approach to severe storm preparedness with significant differences in the content of the instructions and guidance for each of the three phases. Since the Heavy Weather Procedures segment of the Procedures Manual 5 - Marine Operations is identical to the Operating Manual, the former can be deleted from this comparison. The Typhoon Plan, written specifically for the GLOMAR JAVA SEA's operations in the South China Sea, differs from the other documents.

In the Operating Manual, Phase I commences when a hurricane or significant low-pressure system is identified within 1000 miles of the location. This phase consists of planning and some preparation without disrupting drilling operations or altering the mooring system. Phase I includes a requirement to identify those persons on board who are not essential to operations that will take place during the storm and thus could be evacuated if such action was later deemed appropriate. However, the instructions for Phase I do not provide guidelines for determining which personnel are "nonessential" -- that is left up to the Master. The Operating Manual also provides a formula to calculate when Phase II should be implemented. The formula is based on that perimeter of the storm where 40 mile-per-hour winds are first encountered. Phase II entails securing the well, the ship, and all the drilling equipment, pulling the marine riser, disconnecting the guide wires, picking up required anchors and dropping the remainder, or evacuating the ship. Phase III is not defined in terms of time, distance to the storm or weather conditions. It consists of evacuation of the

nonessential personnel identified in Phase I and movement of the ship if necessary. Movement of the vessel is at the Master's discretion.

The instructions in the Critical Procedures Manual are more detailed than those in the Operating Manual. In the Critical Procedures Manual, Phase I commences when a hurricane or tropical storm is within 1000 miles of the drillship's location and is very similar to the Phase I guidelines in the Operating Manual. The beginning of Phase II is not calculated. It is defined as the time when the hurricane or tropical storm is within 750 miles of location. As with the Operating Manual, during Phase II the well is secured, the marine riser brought on board but the guide wires remain in place, and all nonessential personnel (identified during Phase I) are sent ashore. Phase III begins with the hurricane or tropical storm within 500 miles of location. The guide wires are buoyed for easier retrieval if they are disconnected. All anchor chains except numbers 2 and 10 are disconnected at the 2000' link in the chain lockers. The decision to move the vessel would be made during Phase III, but the person with the authority to make this decision is not identified.

Personnel from Global Marine developed a heavy weather procedure for the GLOMAR JAVA SEA as required by the Operating Manual. That procedure is the Typhoon Plan. It was reviewed by ARCO China and Global Marine management. Although no formal approval was given to the document, testimony of senior management officials of both companies indicated the document was accepted. The Typhoon Plan is divided into two phases. Phase I begins with a typhoon or hurricane 1200 miles from the drillship. During Phase I the well is secured, the marine riser brought on board, nonessential personnel identified, marine personnel brought on board to comply with Coast Guard manning requirements, and the ship is generally made ready for the storm. Phase II starts with the storm 1000 miles away. The Phase II instructions include a check list and options for releasing or buoying off anchors (depending on the availability of the supply vessel), putting nonessential personnel ashore, and securing all watertight closures. The plan specifically states that the decision to move off the well-site is made jointly by the ARCO China representative, the Global Marine Drilling Superintendent, and the Master. The Alternate Master of the GLOMAR JAVA SEA wrote to the Rig Manager and suggested additions to the Typhoon Plan. The Alternate Master suggested that as many anchors as possible be retained on board if the ship were to move. He also suggested that if there was insufficient warning to allow moving the drillship to the south, the only alternative left would be to move it to the northwest side of Hainan Island and anchor in an area where the water depth was about 35 meters. There was no written acceptance or rejection of those suggestions by either Global Marine or ARCO China management personnel and a revised Typhoon Plan was not submitted for management approval. However, testimony showed that key management personnel in both companies were aware of those suggestions.

The various heavy weather plans dealt with preparing for the passage of hurricanes and "typhoons". Persons testifying during the investigation put a great deal of emphasis on the fact that "Lex" never reached typhoon strength (neither the drillship nor shoreside management had access to the U.S. Joint Typhoon Warning Center reports). Also, at the time "Lex" was first classed as a "tropical depression" it was only 460 miles from the drill site. For these reasons, it was held, the exact requirements of the plans were not applicable.

The drillship prepared for the storm by securing the drilling operation. That action was consistent with the intent of the heavy weather plans.

17. NONESSENTIAL PERSONNEL NOT EVACUATED

Both the Critical Procedures Manual and the Typhoon Plan give guidelines on the evacuation of "nonessential personnel," but neither document attempts to define this term. The Coast Guard-approved Operating Manual requires that a determination be made of who will stay with the vessel, but provides no guidelines on making this determination. The decision as to which personnel would be evacuated in the event of a typhoon or other emergency was left to the three men in charge of the drillship's operations - the Master, the ARCO China Drilling Supervisor, and the Global Marine Drilling Superintendent.

Testimony from persons who had served in those positions revealed that there was no set definition of "nonessential personnel" applicable to the GLOMAR JAVA SEA. Varied opinions included: the Department Head decides; anyone who wants to go ashore can; the marine crew and drilling crew are essential, but third party personnel can be evacuated; the Captain will consider each request; and, it depends on the weather and whether or not a helicopter can land on the ship, or a supply vessel come alongside.

There were no communications to or from the GLOMAR JAVA SEA concerning evacuation of any personnel because of tropical storm "Lex." There is nothing to indicate that persons on the drillship felt that evacuation was necessary or desirable. On the contrary, at about 1830, 25 October, the ARCO China Drilling Supervisor on the drillship told the ARCO China Drilling Superintendent in Zhanjiang that the vessel was riding well and everyone felt comfortable. That was the last communication between the drillship and shoreside management personnel until the satellite call to Houston at 2348.

There were two possible ways to evacuate personnel from the drillship - by helicopter, or by boat which in effect meant using the supply vessels. Dependence on the helicopters had drawbacks in that they normally flew only during daylight hours and could not operate in severe weather conditions. Also, with the drillship rolling, heaving, and pitching in heavy seas, landing on it would be hazardous, if not impossible. While not as hampered by night and weather, the supply vessels also could not evacuate the drillship's crew under severe conditions. The supply vessel had to moor to the drillship to effect the transfer of people, and such mooring was not possible in heavy seas or with the vessels moving to any great degree. Those limitations meant that evacuation had to occur before the environmental conditions deteriorated or not at all.

Persons who had served on the drillship as well as shoreside management personnel testified that on the basis of prior experience, they were not concerned about the weather. Many of them also testified that, given the option of leaving on a supply vessel or riding out the storm on the drillship, they would stay on the drillship, confident that they and it had ridden out worse weather than that forecast for the drilling area as a result of typhoon Lex. There is nothing to indicate that the persons onboard the drillship felt differently.

There is no reason to believe that any personnel on board the drillship were designated "nonessential," nor that any consideration was given to evacuation before such action became impossible.

18. EVENTS LEADING UP TO THE CASUALTY

The GLOMAR JAVA SEA departed the United States on 1 December 1982 and arrived in the South China Sea offshore Hainan Island, Peoples Republic of China, on 7 January 1983. Between 9 January and 31 August the drillship drilled 2 wells, one at (latitude and longitude) 17.8°N, 109.3°E, and the other at 17.5°N, 109°E. On 31 August the drillship commenced a move, under tow by a supply vessel, to position 17°17'49"N, 108°56'29"E, designated as well site Ledong 30-1-1, to drill another well. The move was completed on 1 September 1983.

At the well site the drillship was anchored in 317 feet of water, heading 335°T. (The drillship's heading was subsequently changed to 339°T to compensate for prevailing environmental conditions.) Four bow anchors and five stern anchors were deployed in a spread pattern.

On 22 October the GLOMAR JAVA SEA was engaged in routine drilling operations at the Ledong 30-1-1 site. At 0800 that morning there were 83 persons on board. The drillship reported experiencing winds of 12 kts from 065°T and swells of 5 feet from 050°T. The drillship was rolling 1° and pitching 1.5°. The NANHAI 209, one of the contracted supply vessels, was standing by near the drill site.

In its 1030 forecast, the contracted weather service (Meteo) advised the drillship of a tropical depression labeled "Lex" approximately 460 miles to the east with winds of 32 kts, moving west-northwest at 10 kts. A plot of the forecast showed the storm was predicted to make landfall on the coast of Hainan Island approximately 100 miles northeast of the drillship during the early hours of 24 October. The ARCO China Drilling Supervisor and Global Marine Drilling Superintendent on board the drillship decided that since they had planned to change the drill bit at that time, they would do so but would not lower the drill string (drill pipe with bit attached) completely to the bottom of the well. Instead, they would lower the drill string only as far as there was casing in place, about 6,300 feet. They would then use the rams in the blowout preventer to "hang off" the drill string in the well. They would then disconnect the drillpipe above the blowout preventer and bring that portion back aboard the drillship. Next they would disconnect the marine riser and bring it back aboard. At that time the drillship would be free of the well except for the relatively light guide wires. This was a standard precaution when severe weather conditions were forecast. The Drilling Supervisor advised his superior, the ARCO China Drilling Superintendent, in Zhanjiang by radio of those plans. The Drilling Superintendent concurred.

At 1630 the drillship received a forecast which upgraded "Lex" from a tropical depression to a tropical storm. Winds had increased to 35 kts with 45 kt gusts. "Lex" was now 420 miles from the GLOMAR JAVA SEA. It was continuing to move west-northwest at 10 kts, but the predicted path was more westerly than before. It was now predicted to pass 50 to 60 miles to the northeast of the GLOMAR JAVA SEA during the morning of 24 October. At the well site the winds had shifted to 330°T at 5 kts, seas were from 330°T at 2 feet, and the swell remained from 050°T at 4 to 5 feet. During the day two service hands (subcontractor representatives) left the drillship, bringing the total persons on board to 81. The NANHAI 209 returned to Zhanjiang, and the relief vessel, NANHAI 205, was on location as the standby vessel.

The 1800 weather forecast placed tropical storm "Lex," as of 1700, 390 miles away with winds still at 35 kts. The storm was moving west-northwest at 10 kts

and was predicted to pass 55 miles to the northeast of the drillship with maximum winds of 50 kts. The 2000 forecast, issued at 2230, placed "Lex" 360 miles to the east, still moving west-northwest at 10 kts with winds of 40 kts gusting to 50 kts. The storm was now predicted to pass approximately 45 miles to the north-northeast of the drillship.

By 0000 on 23 October the drilling crew had completed hanging off the drill string. The crew then began pulling the marine riser package. The marine riser was on deck and secured by 1015. During that time the winds had increased slightly to 6-8 kts from 000°T, and the swell increased to 6 feet, still from 050°T. The drillship was experiencing a 4 foot heave and about a 3° roll. The next two weather advisories predicted a path which would have "Lex" pass 55 miles north-northeast of the drillship with winds of 50 kts.

During the day the storm took a dramatic turn northward, slowing its speed of advance to 5 kts, not increasing in strength, and now predicted to pass north of Hainan Island, approximately 200 miles away from the GLOMAR JAVA SEA. By 1600 the crew had secured the GLOMAR JAVA SEA for the storm. The local winds had increased to 10-12 kts from 350°T. The swells continued from 050°T, increasing to 8 feet. The vessel roll and heave were 3° and 4 feet, respectively, and the anchor tensions were normal. The NANHAI 205 was anchored about 1.5 miles away and had normal communications with the drillship.

During the night of 23 October, the swells continued to build, reaching 12 feet by morning. The drillship was now heaving 16-24 feet, rolling 7-12°, and the winds had shifted to 030°T at 10 kts. The 0500 advisory showed that the storm had remained stationary for the past 12 hours and had not intensified. It was still predicted to move to the northwest and pass well to the north of the GLOMAR JAVA SEA.

At 1050 on 24 October the Captain of the NANHAI 205 reported to the drillship that drill casing had broken loose on his aft cargo deck. He received permission from the GLOMAR JAVA SEA to weigh anchor and sail into the wind while resecuring the casing. The 1030 weather advisory showed the storm increasing in strength, with winds now 45 kts gusting to 55 kts, and moving slowly northwest. It was approximately 250 miles due east of the GLOMAR JAVA SEA and was predicted to pass well to the north of the drill site.

By 1600, the swell height at the drill site had increased to 16-18 feet. Winds were at 10 kts and waves were at 2 feet.

The environmental weather forecast for the drill site, issued at 1800, 24 October, predicted that the weather at the drill site over the next two days would be somewhat worse than indicated in that morning's forecast. For the early morning of 25 October, that forecast predicted winds of 22-33 kts with gusts to 40 kts, maximum seas of 8-10 feet and a 16-18 foot swell. It also predicted that those conditions would worsen during the day with winds increasing to 28-40 kts with gusts to 47 kts, seas of 10-13 feet and a 16-20 foot swell.

By 1830 the NANHAI 205 was anchored near the GLOMAR JAVA SEA with its engines secured for the night. The last weather advisory on 24 October was issued at 2230 and gave the 2000 position of the storm as being 235 miles east of the drillship, moving west-northwest at 3 kts.

At 0000, 25 October, winds at the drill site had increased to 20-25 kts. Seas were at 10-12 feet with a 16-18 foot swell. These conditions approximated those forecast for that morning.

At 0730 the NANHAI 205 got underway to ride out the storm.

The environmental weather forecast for the drill site, issued at 0730, 25 October, predicted worse weather for that day than did the previous night's forecast. For the morning and early afternoon it predicted winds up to 40 kts with gusts as high as 47 kts, seas up to 13 feet and a swell of 16-20 feet. The forecast called for conditions to worsen during the day to winds of up to 55 kts with gusts of 56-63 kts, seas up to 16 feet, and an 18-21 foot swell.

By 0800 the winds at the drill site had increased to 25-30 kts, somewhat less severe than forecast. However, the sea conditions -- waves of 20-24 feet and a swell of 18-26 feet -- were already exceeding the forecast conditions.

At 0850 the GLOMAR JAVA SEA's radio operator talked with the radio operator at TianDu. The operator on the drillship reported that the wind and waves were heavy, that he was not feeling well, and that he had no official information to pass. About the same time, Mr. Li Shian, a Liaison Officer with Nan Hai West Oil Company's Drilling Department, met with ARCO China's Drilling Superintendent in ARCO China's office in Zhanjiang to suggest that ARCO China move the GLOMAR JAVA SEA off the well location because the "typhoon" would pass through the drillship's position. The Drilling Superintendent said he believed the storm would pass north of the GLOMAR JAVA SEA and that the drillship was prepared for the storm. The ARCO China Drilling Superintendent also pointed out that there was no protected area for GLOMAR JAVA SEA to run to considering the predicted storm path, shoal waters to the south, and Vietnam to the southwest.

At 0930 two rows of protective wooden decking on the aft part of the NANHAI 205's cargo deck were carried away by boarding seas.

The weather forecast at 1030 placed "Lex" 145 miles east of the GLOMAR JAVA SEA as of 0800. The storm was moving west-northwest at 7 kts, with winds increasing to 60 kts, gusting to 75 kts. The storm was predicted to hit the southern coast of Hainan Island, approximately 65 miles north of the drill site. At the drill site, the wind and sea conditions continued to worsen.

At 1100, Mr. [redacted], Assistant Manager of Nan Hai West Shipping Company, telephoned ARCO China's liaison for logistics in Zhanjiang. Mr. [redacted] was concerned about preparation of the NANHAI 205 for the "typhoon." The logistics liaison said the storm was not yet classified as a typhoon, that the drillship was not intending to move off station, and that the supply vessel was to stay with the drillship.

By noon the GLOMAR JAVA SEA was heaving and rolling heavily, and the swell was still increasing. Tropical storm "Lex" had increased speed to 8 kts and was still moving west-northwest consistently tracking to the south of the predicted paths. It was just under 100 miles east of the drill site with winds of 60 kts, gusting to 75 kts. The GLOMAR JAVA SEA had normal radio communications with TianDu, passing the latest storm information. The NANHAI 205, approximately 6 miles northwest of the drillship, reported 2-mile visibility due to rain.

At about 1300, the wire and chain used to secure the well casing on the supply vessel's cargo deck parted. The casing was loose on deck and one piece was lost overboard. The supply vessel's Captain reported that loss to the GLOMAR JAVA SEA. Waves were continuously breaking on the supply vessel's deck making it too dangerous to attempt repairs to the casing securing system. The drillship asked if help was needed; the supply vessel replied "No." The supply vessel was rolling 20 to 30°.

At 1400 the GLOMAR JAVA SEA called the NANHAI 205 to pass the 1100 storm advisory. By 1500 the supply vessel was 8 miles from the drillship heading into the wind which was coming from the northwest. At 1552 when they turned on their radio to call the drillship for a routine radio check, the supply vessel reported experiencing winds of 55 to 60 kts.

By 1600 the sustained winds at the drill site had increased to 45-50 kts -- still not as severe as forecast. However, the seas were now at a height of 32-38 feet with a 30-foot swell.

At 1614 the ARCO China Drilling Superintendent in Zhanjiang talked with his Drilling Supervisor on the GLOMAR JAVA SEA. The Drilling Supervisor reported that the ship was "dry and okay" and that the NANHAI 205 had casing loose on deck but was still standing by. The 1400 weather advisory was not broadcast until 1630. The storm was continuing to move west-northwest at 8 kts and was 90 miles east of the drill site. Winds were still 60 kts, gusting to 75 kts. It was forecast to pass 20 to 25 miles north of the GLOMAR JAVA SEA at about 2400, 25 October. The GLOMAR JAVA SEA was experiencing swells of 30 feet from 050°T and waves of 38 feet from 000°T. The drillship was rolling 9°, pitching 4°, and heaving 24 feet. ARCO China's Chief Geologist in Zhanjiang talked with his representative on the drillship who reported that the weather was rough, but not any rougher than previous storms.

At 1740 the Nan Hai West Shipping Company advised the NANHAI 205's Captain by message that the storm would pass over the supply vessel's position and that he was to put his stern to the wind and leave the area. By 1800 the supply vessel was having difficulty steering at slow speed and was rolling 35 to 40°. The Captain changed course to 150°T and increased speed to 3-4 kts. The 1700 weather advisory, issued at 1800, placed the storm 75 miles east of the drill site. The storm had moved west during the past three hours. The forecast was still for a west-northwest track at 8 kts, to pass 20 miles north of the GLOMAR JAVA SEA.

At 1800 ARCO China's Drilling Supervisor on the drillship told his supervisor in Zhanjiang that the drillship was riding well and having no difficulties. He said everyone was comfortable and the NANHAI 205 was nearby.

At 1800 the environmental weather forecast for the drill site predicted winds of 55 kts with gusts of up to 71 kts and combined seas in excess of 40 feet. Sea conditions at the drill site were already worse than that. By 1900 the NANHAI 205 had closed GLOMAR JAVA SEA to approximately 5 miles and had VHF radio contact with the drillship. The GLOMAR JAVA SEA reported rolling 9-10°.

At 2000 the NANHAI 205 was at the well site. Ten minutes later a refrigerated storage container on the supply vessel's cargo deck broke loose and was driven by the waves under the towing winch. The supply vessel was rolling 40°. The

supply vessel had lost lighting in the engineroom; engineroom personnel were using flashlights. The drillship reported rolling 20 to 30°.

At 2100, the GLOMAR JAVA SEA's radio operator told the radio operator in Zhanjiang that the drillship was experiencing waves of 37-39 feet from 330°, a 30 foot swell from 050°, and winds from 330° at 50 kts, gusting to 60 kts. The radio operator in Zhanjiang called the GLOMAR JAVA SEA operator at 2210 to get a local weather report. The drillship's radio operator said the wind and waves were heavier and that the waves were beating on the deck, sounding like thunder.

There were four more communications between those two radio operators within the next two hours, passing weather information. The last communication was at 2255.

The Zhanjiang radio operator got off duty at 2300 without a face-to-face relief. He left a note for the next operator saying there was a "typhoon," the GLOMAR JAVA SEA was rolling very much, and to pay attention to the drillship and to radio TianDu.

At 2300, after unsuccessfully trying to call Zhanjiang, the GLOMAR JAVA SEA called TianDu and reported that the wind and waves were very heavy, that the Global Marine Drilling Superintendent had asked them to put on their life jackets, and that the ship was rolling. He asked that this be passed to radio Zhanjiang. At 2315 the NANHAI 205 called the drillship, reported rolling 30-40°, and said they would have to get underway sailing into the wind. They had a radio check using the single side band (SSB) radio but decided VHF was better and that that would be their primary radio. The NANHAI 205 was 16 miles from the GLOMAR JAVA SEA.

At 2330 the relief radio operator arrived at the Zhanjiang office and tried to contact the drillship. At about 2335, the operator at TianDu, having heard the call, informed Zhanjiang of the drillship's 2300 call saying that the ship was "listing very much". Neither station was able to contact the drillship.

At 2348 the Assistant Rig Manager on board the GLOMAR JAVA SEA called the Global Marine Drilling Group Vice President in Houston, Texas, via the satellite telephone link. He reported that the drillship had a 15° starboard list, was experiencing 75 kt winds over the bow, that everyone was up with lifejackets on, that they did not know what was causing the list, and that they had pumped out the starboard drilling mud tanks on deck. The call was cut off at that point. It had lasted no more than 3 minutes. Attempts to reestablish contact from Houston failed.

At 2350, after being unable to reestablish contact with the drillship, the radio operator at TianDU informed his superiors that contact had been lost at 2300.

By 2400, according to available meteorological data, the seas at the drill site had increased to 42 - 48 feet and winds were 60 kts gusting to 75 kts.

19. COMMUNICATIONS SUMMARY

The following is a summary of significant communications between the GLOMAR JAVA SEA and the communications centers at Zhanjiang and TianDu and the supply vessels between 0700, 25 October 1983 and 0730, 26 October 1983. Unless

otherwise indicated communications involved only the Chinese radio operators at the respective stations.

25 October 1983

0715-0727 Zhanjiang received a telex from drillship [2]

0720 NANHAI 205 contacted GLOMAR JAVA SEA and, with drillship's permission, sailed against the wind to ride out storm. [6]

0730 Environmental weather forecast with tropical storm warning:

Winds 55 kts/gust 65 kts at center. [1]
0730 Received at Zhanjiang. [2]

0745 Zhanjiang received a telex from drillship. [2]

0800 Tropical cyclone forecast: Severe tropical storm. [1]

0800 Weather Fax severe tropical storm warning. [1]

0800-0815 Mr. [redacted], ARCO China, Zhanjiang, talked with drillship. [2]

0815-0845 Zhanjiang received 2 telexes, including weather data, from drillship. [2]

1030 Environmental weather forecast with tropical storm warning:

Winds 60 kts./gusts 75 kts. at center. [1]
1030-1037 Received at Zhanjiang. [2]

1105-1120 Schlumberger representative talked with drillship; ship reportedly "rolling very much". [2]

1130 TianDu talked to drillship and Zhanjiang.

1138 Drillship reported to TianDu Radio "... wind and wave are heavy now" and then repeated weather data and summary of typhoon progress. [3]

1254-1256 Zhanjiang received a telex from drillship. [2]

1330 Environmental weather forecast with tropical storm warning:

Winds 60 kts./gust 75 kts at center.
1330-1415 Received at Zhanjiang. [2]

1330 Mr. [redacted], Global Marine, Zhanjiang, talked to Mr. Jennings on drillship. [8]

1400 Tropical cyclone forecast: severe tropical storm. [1]

1400 Weather Fax severe tropical storm warning. [1]

1427-1429 Zhanjiang sent a telex to drillship. [2]

1443-1446 Zhanjiang received a telex from drillship. [2]

1507-1513 Zhanjiang received a telex from drillship. [2]

1552 NANHAI 205 talked to drillship [6]

1602-1612 Zhanjiang sent 3 telexes to drillship. [2]

1614-1619 Mr. [redacted] ARCO China, Zhanjiang, talked with Mr. [redacted] on drillship.[2][8]

1621-1623 Zhanjiang sent a telex to drillship. [2]

1624-1632 Mr. [redacted] ARCO China, Zhanjiang, talked with Mr. Manfrida on drillship. [2][8]

1630 Environmental weather forecast with tropical storm warning:

Winds 60 kts./gusts 75 kts. at center.
1632-1637 Received at Zhanjiang. [2]

1648-1658 Drillship sent "afternoon report" to Zhanjiang via telex; report included weather observations at the drill site. [2][8]

1720 Drillship informed TianDu that "wind force is increasing". [3]

1800 Environmental weather forecast with tropical storm warning:

Winds 60 kts./gusts 75 kts. at center [1]
1810-1820 Received at Zhanjiang. [2]

1820-1825 Mr. [redacted] ARCO China, Zhanjiang, talked with Mr. Reed on drillship. [2][8]

1850-1852 Zhanjiang received a telex from drillship. [2]

1852 Zhanjiang received telex from drillship concerning an "order for goods". [4]

1900 Master of NANHAI 205 talked to drillship; vessels approximately 5 nautical miles apart; drillship reports rolling 9°-10°. [6][7]

1900-1915 Mr. [redacted] at Zhanjiang talked with drillship. [2][4]

1915 TianDu talked to drillship and confirmed that NANHAI 205 was in the vicinity of drillship. [3][5]

2000 Tropical cyclone forecast: severe tropical storm. [1]

2000 Weather Fax severe tropical storm warning. [1]

2010 NANHAI 205 talked with drillship; drillship reported rolling 20°-30°. [6]

2100 NANHAI 205 talked to drillship; drillship reported rolling 20°-30°; NANHAI 205 rolling more than 40°. [7]

2100-2115 Radio operator at Zhanjiang talked to drillship and obtained weather at drill site: "...10 scale of wind ... 11 scale of gust ..."; 37' wave height with maximum of 39'; 330° wave direction; 50° swell direction; 30' swell height. [4]

2210-2215 Zhanjiang talked to drillship (TianDu overheard conversation); drillship reported "... wind and wave are most heavy now; the ship is rocking, rolling, and pitching. The waves are beating on the deck which sounds like thundering. Please pay attention to keep contact." [3][4][5]

2230 Environmental weather forecast with tropical storm warning:

Winds 55 kts./gusts 65 kts. at center [1]
2230-2237 Received at Zhanjiang [2]

2237 Radio operator at Zhanjiang called drillship concerning receipt of weather data. [4]

2250 Drillship called Zhanjiang and reported satisfactory reception of weather data. [4]

2250 NANHAI 205 received "No. 16 typhoon emergency warning" issued by Hainan Weather Station. [6]

2255 Radio operator on drillship reported to Zhanjiang "... still the same ... wind and wave [are] heavy ... rolling and pitching very much ...". [4]

2300 Radio Operator "02" at Zhanjiang got off duty; Operator "03" got on duty but was not in the radio room. [2]

2300 Drillship reported to TianDu "wind and wave are too heavy now, the foreigners (drilling superintendent) asked us to put on life jackets. Please relay this to Zhanjiang." [3][5]

2300 TianDu called Zhanjiang "several times but no answer". [3]

2308 TianDu radio operator initiated unsuccessful telephone call to advise his supervisor of loss of communications with drillship. [3]

2310 TianDu called drillship and NANHAI 205 "but couldn't get answer". [3][4][5]

2315 TianDu tried unsuccessfully to contact drillship. [3]

2315 Communications between NANHAI 205 and drillship "normal". [6]

2315 NANHAI 205 advised drillship of the "No. 16 typhoon warning" issued by the "Hainan Weather Station"; also, that NANHAI 205 was rolling 30°-40° and needed to sail against the wind. The Master of the NANHAI 205 asked the drillship's radio operator "how are you?". The radio operator replied "still OK". NANHAI 205 determined that the single

side band radio was operative but decided to use the VHF instead. [7]

2325 TianDu tried unsuccessfully to contact drillship and Zhanjiang. [3]

2330 Relief radio operator at Zhanjiang arrived at the radio room. [4]

2335/2336 TianDu contacted Zhanjiang after several unsuccessful earlier attempts. TianDu told Zhanjiang "JAVA SEA called you just now at 2300, but you did not answer. The ship was listing very much. The foreigners asked all crews to put on life jackets". [3][5]

2343 TianDu relayed to Zhanjiang the report they received from the drillship earlier and that communications were lost at 2300. [3][4][5]

2345 TianDu tried unsuccessfully to contact drillship. [3]

2348 Mr. [redacted] onboard the drillship contacted Mr. [redacted] at Global Marine's offices in Houston, TX via satellite telephone link and reported that the drillship had assumed a 15° starboard list of undetermined origin and that the drillship was experiencing 75 kt. winds "over the bow". Conversation was cut off by loss of communications. [8]

2350 TianDu and Zhanjiang tried unsuccessfully to contact drillship. TianDu radio operator informed his supervisor of the situation. [3]

2400 NANHAI 205 attempted unsuccessfully to contact drillship via VHF.[6][7]

26 October 1983

0005 TianDu talked to Zhanjiang and suggested that "ARCO's manager" be informed that contact with the drillship had been lost. [3]

0010 TianDu tried unsuccessfully to contact drillship and NANHAI 205. [3]

0015 NANHAI 205 attempted unsuccessfully to contact the drillship by VHF. [6]

0025 ZHanjiang "[reported to] Mr. Huang Bang Jie that [drillship] was rolling very much, crews had put on life jacket. Lost contact from 2310 on Oct. 25 to 0025 on Oct. 26". [2]

0025-0650 Numerous unsuccessful attempts to contact the drillship and NANHAI 205 were made by both Zhanjiang and TianDu. [2][3][5]

0030 Radio operators at Zhanjiang sent a messenger to wake up ARCO China Inc. personnel. [8]

0145 NANHAI 205 attempted unsuccessfully to contact the drillship by VHF. [7]

0420-0630 TianDu attempted unsuccessfully to contact Zhanjiang. [5]

0620 NANHAI 205 attempted unsuccessfully to contact the drillship by VHF and single sideband; NANHAI 205 contacted Zhanjiang and TianDu by single sideband. [7]

0650 TianDu heard NANHAI 205 calling the drillship. [3][4]

0653-0654 NANHAI 205 reported to Zhanjiang "Sea condition is abnormal [sic], no way to determine ship location. Far from the [drillship] cannot see [drillship], 12 scale of wind force". [2]

0655 TianDu communicating normally with NANHAI 205. [3]

0705-0730 "...[NANHAI] 205 searching by radar". NANHAI 205 reported wind force decreased to "8-9 scale". [2]

1110 NANHAI 205 arrived at well site. [6]

NOTES:
[1] From weather service forecasts and storm warnings.
[2] From "Radio Log of ARCO Zhanjiang Radio".
[3] From "Radio Log of ARCO TianDu Radio".
[4] From "Related Informations About ARCO Zhanjiang Radio on Oct. 25,1983".
[5] From "Informations Concerning ARCO TianDu Radio on Oct. 25 and 26, 1983".
[6] From "Log of NANHAI 205".
[7] From "Related Informations About NANHAI 205 Working on Oct. 25,26, 1983.
[8] From testimony.

20. SEARCH AND RESCUE OPERATION

At 0330, 26 October (1430, 25 October, CST), after failing to reestablish contact with the drillship, Global Marine's Houston, TX office notified the Twelfth Coast Guard District (CGD12) rescue coordination/operations center in San Francisco, CA that contact had been lost approximately 4 hours earlier with the drillship experiencing a 15° starboard list and 75 kt winds at position 17-17.49N, 108-6.30E. At 0345 CGD12 relayed that information to the Department of the Air Force, Western Pacific Rescue Coordination Center (WESTPAC RCC), Kadena, Okinawa. WESTPAC RCC assumed control of the search and rescue (SAR) operation, but CGD12 continued to monitor the SAR activities. At 0400 CGD12 contacted Global Marine and obtained the radio call sign and telex and telephone (MARISAT) numbers for the drillship and relayed that information to WESTPAC RCC.

WESTPAC RCC issued an urgent marine broadcast seeking information on the drillship. They also attempted to contact the drillship through a USAF C-130 aircraft which was within 300 nautical miles of the well site. Neither attempt produced any results.

At 0620, when radio contact was reestablished with the supply vessel NANHAI 205, ARCO China and Nan Hai West Oil Company directed the vessel to "sail with full speed to the original location where the JAVA SEA (sic) was drilling". The NANHAI 205 arrived at the drill site at 1110 and found the anchor bouys in place but no sign of the drillship. During the next two hours the supply vessel spotted 3 personal flotation devices (life preservers), a box of flares, and a rubber fender in the water.

The NANHAI 205 checked the immediate area then returned to the drillsite. Upon reaching the drillship's last known position, at 1845, the supply vessel found a

"fuel track ... and smell of fuel". At that point ARCO China personnel at Zhanjiang began planning a survey of the sea floor. Later that day the Hong Kong Marine Department advised WESTPAC RCC that the supply vessel had arrived at the drillsite and "bouys at the last known position indicated that the vessel had abandoned the position in a high seas situation and marked its anchor chains". Late in the evening of 26 October Global Marine informed WESTPAC RCC that two airliners had reported receiving a distress signal on 121.5 mHz that morning. The RCC then alerted U.S. Navy Forces at Cubi Point, Philippines, of the situation. Approximately one hour later, at 0747, 27 October, the first of the SAR forces, a U.S. Navy P-3 aircraft, was launched to investigate the source of the distress signal.

The distress signal reported by the two airliners was being transmitted on 121.5 mHz, one of the two frequencies on which EPIRBs transmit. The airliners -- one Lufthansa, the other Cathay-Pacific -- reported the signals to Kaitak Airport in Hong Kong. In neither case was the position of the source of the signal accurately determined. Although the signal was reported early in the morning it was late evening before it was confirmed and relayed to WESTPAC RCC.

During the course of the search a variety of debris was sighted. It included personal flotation devices (life preservers), fenders, wood planks, and other materials, some of which were recovered. The most significant sightings are described here.

At 1307 (0507 GMT), 27 October the merchant vessel WILLINE TOYO, several hundred miles away, picked up a distress signal on 500 kHz, the international distress frequency on which emergency lifeboat radios transmit. The signal used the GLOMAR JAVA SEA's call sign, WPDS, and gave a latitude and longitude of 17°41N and 107°42E. No other signals were reported on 500 kHz.

At 1415 the supply vessel NANHAI 205 started a fathometer survey of the sea bed at the drill site. That survey showed a 20-meter high mound on the sea bed and gave the first indication that the drillship may have sunk.

In the afternoon ARCO China, Global Marine, and Chinese personnel left Zhanjiang to set up a SAR center in Sanya. Other personnel stayed at Zhanjiang to provide communications links to Hong Kong, Houston, and WESTPAC RCC and to serve as liaison with Chinese offices and as translators between English-speaking and Chinese search forces.

At 2023 the Hong Kong Marine Department informed WESTPAC RCC of the distress signal received by the WILLLINE TOYO. However, due to the weather conditions and darkness, aircraft were unable to investigate.

At 0810, 28 October a Chinese helicopter reported a "capsized lifeboat" with its propeller showing at position 17°23N, 108°20E. While a variety of debris, including several Yokohama fenders were spotted, the item described as a "capsized lifeboat" was not seen by any other party in the search, was not seen again after the initial sighting, and its identity was never confirmed. At 1816 the Chinese tug SUI JUI 201 recovered an empty inflatable liferaft at position 17°24N, 108°18E. That liferaft was later positively identified by its serial number and servicing markings as having come from the GLOMAR JAVA SEA. Later that evening U.S. Navy aircraft spotted what was possibly another liferaft. 2 strobe lights were later spotted at the same position but vessels in the area found no sign of a liferaft or the lights.

At 0900, 29 October a British Petroleum helicopter assisting in the search picked up a distress signal described only as an "SOS". Between 0900 and 1029 the crew took 9 directional readings on the signal and tried unsuccessfully to locate its source. Receipt of the signal was not reported to any other participant in the search; it only came to light more than a week after the active search was terminated. What little information there is on this incident is vague and inconclusive.

At 1020, 29 October the Chinese Naval vessel 950 recovered an emergency position indicating radio beacon (EPIRB) at position 17°32N, 107°38E. That EPIRB was in the general debris pattern and probably came from the drillship. At 1420 a spherical bouy, used to mark the loose end of an anchor chain in the event the chain had to be released, was recovered. That bouy bore markings which proved that it came from the drillship. At 1434 U.S. Navy aircraft reported 5 strobe lights at position 17°30N, 107°37E but, again, surface vessels could not locate them. At 1709 U.S. Navy aircraft spotted "fresh sea dye marker" and what appeared to be a person in the water at 17°27N, 107°54E. Ships were directed into the area but were unable to locate any person.

On 30 October a portion of a temporary building used by drilling fluid engineers on the drillship was spotted. That the building came from the GLOMAR JAVA SEA was verified by visible markings on the building itself. The hulk of what seems to have been a small wooden fishing vessel was also sighted within the debris pattern. That vessel was not identified and there is nothing to indicate that its presence was significant to the casualty.

On 31 October the side scan sonar survey of the sea bed at the drill site was completed. The results of that survey indicated that the drillship lay on the ocean floor.

The active search involved U.S. Navy and Air Force planes, Chinese Navy ships and helicopters, private helicopters operated by British Petroleum, and at least one other vessel hired by Global Marine. The U.S. Navy P-3s and Air Force C-130s logged a total of 21 sorties, over 215 flight hours, and covered more than 70,000 square miles. Those planes were prohibited from searching coastal waters of Vietnam and certain areas under Chinese control; however, those areas were searched by Vietnamese and Chinese forces. Coordination of the search was hampered by language differences and differences in the communications equipment available to the various groups involved. The search forces were hampered initially by 60 kt winds, seas in excess of 15 feet, and rain. However, with repeated coverage of many areas and considering the scope and pattern of the search, WESTPAC RCC placed the probability of detection at over 90 percent. The RCC estimated the life expectancy of persons in the water to be at least 80 hours and possibly longer. The active search continued for 180 hours. The search was terminated on 4 November because it was believed that by that time any survivors would either have been located or would have drifted ashore. A private vessel hired by Global Marine continued to search well beyond the 4 November cut-off of the official search; however, that vessel turned up nothing significant.

The crews of the ships and aircraft risked their lives to pursue the search under extremely adverse weather conditions. Some of the vessels involved sustained damage themselves during the search.

21. EPIRB RECOVERED

At 1020, 29 October 1983, during the search for survivors of the casualty, an emergency position indicating radio beacon (EPIRB) was found floating at position 17°32'N 107°38'E. The EPIRB was recovered by a Chinese Navy vessel identified only as "950" which was assisting in the search. The EPIRB, as with all of the materials recovered during the search, was put aboard one of the Chinese supply vessels which also participated in the search. All of those materials were delivered to a Global Marine employee at Zhanjiang for safekeeping. As a result of these circumstances, the exact details of the recovery including whether or not the EPIRB was operating are not known.

The EPIRB recovered was not marked with the name of any vessel. Company records did not provide enough information to positively identify the unit as the EPIRB purchased for the GLOMAR JAVA SEA. However, it was recovered within the pattern of debris known to have come from the drillship. Further, there are no records of other U.S.-flag vessels operating in that area of the South China Sea at the time, and no records of any vessel having been lost at about that time. Also, no vessel or company has reported the loss of an EPIRB in that area.

The EPIRB was turned over to the Marine Board by Global Marine. It was eventually delivered to the Coast Guard's electronics laboratory at the U.S. Coast Guard Station, Alexandria, VA, for examination and testing. In general, the examination showed that in all probability the EPIRB operated properly when deployed, that its battery went dead as the result of normal transmitting, and it may have operated effectively for as long as 5 days.

EPIRB signals were picked up by 2 commercial aircraft (Cathay Pacific and Lufthansa) and reported to Kaitak Airport in Hong Kong. Those reports, received less than 5 hours after the last known communication with the drillship, placed the source of the signal 70 nautical miles south of the drill site. It is not known how that position was determined.

22. THE STARBOARD LIST

At 2348, in the last known communication with the drillship, the GLOMAR JAVA SEA reported to Global Marine's offices in Houston a 15° starboard list of undetermined origin. The drillship's crew reported that they were trying to correct the list and had dumped or were in the process of dumping the starboard liquid mud tanks. The conversation was cut short after just a few minutes when communications were lost and contact could not be regained.

The only other reference to a "list" was in a radio conversation at 2336 between a Chinese radio operator at Zhanjiang and his counterpart at TianDu. The latter was relaying the content of an earlier conversation at 2300 with the radio operator on the drillship. The record of that earlier conversation does not mention a list; however, it does show that conditions were bad enough to dictate that the crew don life preservers.

23. THE DIVING EXPEDITIONS AND WRECK SURVEYS

A. November 1983

Early in the search and rescue operation it became apparent that the GLOMAR JAVA SEA may have sunk. At that time Global Marine began planning a diving expedition to conduct an underwater search of the drill site and, if the drillship was found, survey the wreck.

The SMIT MANILA, a 150 foot long salvage vessel was hired by Global Marine, outfitted with a small saturation diving system and a remote control submersible equipped with an underwater video camera, and sent to the drill site. Onboard, along with the divers were representatives of Global Marine, including the Alternate Master of the GLOMAR JAVA SEA, and a Marine Project Superintendent familiar with the drillship.

The SMIT MANILA arrived at the drill site on 4 November 1983. The survey team found the anchor bouys and plotted their locations. They also found two "breakaway bouys" (anchor chain marker bouys) marked "7" and "8", which were partially crushed and apparently connected to something on the sea floor. They also noted the "smell of fuel oil" within the anchor bouy pattern.

The SMIT MANILA conducted a sonar survey of the area around the drill site and found a large hump on the otherwise flat sea floor. The salvage vessel anchored over that hump. The remotely controlled submersible was deployed and the wreck was located. It was identified by its appearance.

The SMIT MANILA worked from 4 November through 30 November. It left the wreck site twice -- once because of severe weather and once to resupply. Although hampered by bad weather at the drill site, the divers did succeed in conducting an external survey of the wreck. The survey positively identified the drillship and showed that it was resting upside down with the port side approximately 10° higher than the starboard side, heading approximately 270°T. The heliport and navigation deck were buried in the sea floor. The bow was partially buried and the sea floor was plowed up around it. The survey also showed a large fracture at about frame 91 on the starboard side. That fracture is addressed separately. The survey turned up no sign of the two lifeboats. The divers were able to look into the ship through a broken airport (porthole) that had no deadlight cover, but saw nothing of consequence.

During the survey portions of some of the anchor chains were recovered. During recovery it became apparent that chains No. 2,3,and 4 were broken. Portions of those chains were subsequently returned to the United States for examination and testing. The failures are addressed separately.

The weather condition in late November so hampered the diving operations that little progress was made. On 30 November, with no prospect of better conditions in the immediate future, the operation was terminated.

B. March 1984

Shortly after the November 1983 wreck survey Global Marine began planning a second diving expedition. That expedition, to take place after the winter storm season in the South China Sea ended, would include an internal search of the drillship. In meetings and correspondence prior to the expedition, the Marine Board worked with Global Marine and other involved parties to ensure that all necessary and desirable actions would be carried out.

The TENDER CARRIER, a 265 foot long dynamically positioned diving support vessel, was hired by Global Marine for the expedition. That vessel was equipped with a 10-man saturation diving system, a 3-man diving bell, a 1-man submersible, sophisticated electronic positioning systems, and a side scan sonar system. In addition to nine divers and assorted technical personnel, the following Global Marine personnel, all intimately familiar with the drillship,

were on board: the Vice President for Drilling Group II; the Vice President of Engineering and Construction; and, the Marine Project Superintendent and the Alternate Master who had participated in the November 1983 wreck survey. A Coast Guard officer, the Administrative Assistant to the Marine Board, was also on board. Prior to leaving the United States that officer had accompanied the Marine Board on a visit to a sistership of the GLOMAR JAVA SEA. As a result of that visit he had numerous photographs of the vessel's arrangements and structural details for reference during the wreck survey. In addition, immediately before leaving for the drill site the divers and other personnel involved visited a similar Global Marine drillship for familiarization. Finally Global Marine provided a specially prepared model of the drillship and plans of its arrangements and structure.

The TENDER CARRIER arrived at the drill site on 7 March. The underwater work was completed on 22 March.

A side scan sonar survey of the area around the well site was conducted. The position of the wreck relative to the well site was accurately determined. Apparent locations of anchors and chains were noted. A large quantity of debris, apparently drill pipe or casing, was found on the sea floor approximately 100 yards southwest of the well site.

The hull survey was conducted using the submersible as well as the divers. They were equipped with underwater video cameras and were in voice contact with the support vessel. The video results of the survey were taped.

The hull survey showed extensive damage to the hull at the bow. The forecastle was crushed. The sideshell was buckled vertically approximately 80 feet from the stem. There was extensive longitudinal buckling of the sideshell along both sides. In addition to the major fracture near frame 91 starboard, other localized damage was noted. A summary of the damage is addressed separately.

A grid system was laid out on the hull using cables and rope to provide reference marks for measuring hull deformation. Other measurements were obtained by comparing hydrostatic pressures at different points to provide relative differences in depths between points. Among other things, the various measurements showed that the hull was crushed down from its original depth of 26 feet 9 inches to approximately 20 feet. The damage was plotted on copies of shell expansion drawings for the drillship.

Coupons were cut from the hull plating in way of the major fracture. The locations for those coupons had been determined and approved prior to the wreck survey. Prior to cutting them the divers marked the hull to show where the cuts would be made. The locations were verified on the support vessel using the video cameras before cutting commenced. Upon being brought to the surface the coupons were carefully washed and coated with a preservative. They were marked and stamped for identification. The samples were wrapped and crated and placed in a shipping container. They were then air freighted to Houston and subsequently delivered to a laboratory for examination and testing.

The search of the wreck showed that some doors and hatches were closed and dogged. In some cases doors were closed but not dogged. In other cases the doors were missing and the dogs were missing as well. The cover for the large hatch leading into the casing hold was missing; all of the dogs were broken.

Part of the search was concentrated around the lifeboat installations in an attempt to determine if either of the two lifeboats had been launched. The results of that part of the search are addressed separately.

The search of the exterior showed that both of the drillship's cranes were still with the drillship.

The disposition of the drillship's derrick was not determined. During the side scan sonar survey an object that was possibly a part of the derrick was noted on the sea floor between the wreck and the well site. During the hull survey, it was noted that what appeared to be a part of the derrick lay under the drillship trailing past the hull to port. However, in neither case was the nature or identity of the object verified.

The survey also showed that anchor chains No. 7 and 8 were draped over the No. 6 anchor cable. However, it was not determined whether or not those chains and cable -- or any others -- were intertwined. Chains No. 5, 9, and 10 led straight away from the wreck.

The internal search of the drillship was intended primarily to search for bodies, recover vessel logs and clocks, check the settings on distress signalling devices, and look for anything else that might help in determining what happened.

The search was, in general, limited to the accommodation spaces -- crew quarters, galley, lounge, etc. The navigation deck (04 level) and the pilothouse (05 level) were buried in the mud and could not be searched safely. Thus normal log keeping stations and the communication installations were not examined.

No vessel records or logs of any consequence were recovered. Three clocks were recovered. Their condition is addressed separately.

A total of thirty-six bodies were located. One was found outside the drillship, in the vicinity of the lifeboat installations, with a small diameter line wrapped around its leg. That body was recovered. Thirty-five bodies were found inside the drillship. Thirty of them were recovered. Four of the five bodies not recovered were in the navigation deck. They could not be safely recovered. The fifth body not recovered was in the quarters. It was initially marked for recovery but was later overlooked when the diver became disoriented. Where the bodies were found is addressed separately.

24. ANCHOR CHAIN FAILURES

The GLOMAR JAVA SEA had 9 anchors deployed at the time of the casualty. A plot of the anchor chain bearings prepared by the Master after the vessel was moved to the final drill site and information from the vessel's logs and routine reports provided information on the original anchor positions. Information obtained during the diving expeditions and wreck surveys in November 1983 and March 1984 verified the final locations of the anchors, anchor chains and cable, and the wreck. Those surveys also showed that anchor chains No. 2 and 3, deployed from the starboard bow and leading forward at relative angles of 42° and 75° respectively, and No. 4, deployed from the starboard stern and leading aft at a relative angle of 115°, were broken. It has not been determined if they broke simultaneously or one at a time.

Based on the lengths of chains recovered during the surveys, chains No. 2 and 3 broke approximately 900 feet from the drillship, and chain No. 4 broke at or very near the fairlead at the anchor windlass.

During the November 1983 survey, portions of chains 3 and 4 were recovered. A metallurgical examination of links from those chains showed, in the words of the metallurgist, "... significant permanent deformation - elongations [almost 10% in 1 link] and thinning of cross sections ...". The metallurgist concluded that the links had been subjected to "applied loads that were higher than the yield strength of the material", that they showed evidence of "high load - low cycle fatigue fracture" and that the fracture in the kenter shackle recovered from chain No. 3 was produced "by essentially a single overload". Although no mechanical tests were performed, Brinell hardness tests "indicated strength levels well above the minimum requirement of API Spec. 2F". For 2-3/4" chain that specification calls for an ultimate tensile strength of 93,000 psi with an expected yield of more than 55,000 psi. The proof and breaking test loads required under that specification (590,000 lbs. and 889,000 lbs, respectively) exceed those specified by the American Bureau of Shipping for extra-high strength grade 3 chain for use on vessels classed by that Society.

25. GENERAL DESCRIPTION OF HULL DAMAGE

The drillship is lying on the sea floor in a nearly inverted position. There is an eight foot high mound of sea bottom material plowed up in front of the drillship's stem. The hull forward of frame 59 shows significant transverse buckling across the keel and longitudinal buckling of the side shell near the shear strake on both the port and starboard sides. There are heavy folds in the stem plate. There appears to be a series of longitudinal buckles on the port side of the hull from frame 59 to frame 140. The hull is crushed down approximately 6 feet from its original 26'9" depth to a current depth of just over 20 feet.

The most dramatic hull fracture is at frame 91 on the starboard side in way of the No. 6 and 7 starboard wing tanks. This fracture is discussed in detail separately. On the opposite side of the hull at frame 91 there is a deep transverse indent measured from just above the bilge keel at a depth of one foot increasing to eight feet moving toward the main deck and then decreasing gradually up to the shear strake.

The starboard side shell plating has a severe buckle running fore and aft of frame 91, where the major fracture occurred. The heavier 1-1/3" shear strake plate is gently set in at a constant slope and the 9/16" plate immediately below the shear strake is folded like a ribbon with smooth folds.

A thorough survey of the interior of wing tanks No. 6S and 7S showed massive buckling of some longitudinal and transverse stiffeners and the transverse watertight bulkhead at frame 91. Also it appears that the hull on the starboard side near frame 91 buckled sufficiently to cause the inboard side of the hull plating to come in contact with the inboard longitudinal bulkhead, a distance of about twelve feet, and then pull away approximately 1½ feet.

One penetration of the inboard longitudinal bulkhead of wing tank No. 6S was found. It is in the vicinity of frame 85, about 12 feet below the main deck. It is "X" shaped and appears to be caused by a buckled transverse angle being

forced up against the inboard bulkhead and then punched through. The cross legs of the "X" are about 12" long.

The forecastle transverse bulkhead at frame 27 is crushed on both sides of the centerline watertight door so that the forecastle (01) deck is nearly touching the main deck on the port and starboard sides. There are deep indents or buckles in the hull at frame 59 on both the port and starboard sides. The main deck is fractured in way of the forward starboard substructure in an "L" shape. The deck in way of the forward port substructure has a 21" fracture on the outboard side of the substructure leg. The moon pool, which is between frames 95 and 106, is intact.

26. CONDITION OF LIFEBOAT INSTALLATIONS

One of the objectives of the wreck surveys was to determine, if possible, whether or not the lifeboats had been launched. The November 1983 survey showed no sign of either boat. The March 1984 survey confirmed that neither boat was in its cradle.

A part of the March 1984 survey concentrated on the lifeboat installations. The condition of the port side installation differed significantly from that on the starboard side.

A. Port Side

On the port side, both davit arms were missing and the channels they rode in were damaged. The falls led into the mud; the blocks were not visible. An attempt was made to pull the falls clear of the mud to see what was attached. On both falls all that came out was a broken cable. On one, the break was clean and shiny, as would be expected from a new break. However, the end of the other cable was black and deteriorated, as would be expected for an old break that had been exposed to the elements for some time.

The winch drums were examined. The fall cable lay neatly in only a few of the thirty grooves on each drum. The rest of the cable was loosely jumbled around the drums as though it suffered a backlash when a heavy load was suddenly removed. Its condition was compared to a snarled fishing reel.

The pelican hooks on the securing gripes were also examined. One was broken; the other was severly distorted.

B. Starboard Side

On the starboard side, the aft davit arm was not found. However, the starboard arm was found lying on the sea floor and it was recovered. Neither the davit arm itself nor the sheaves and connections showed any sign of damage.

The falls led into the mud; the blocks were not visible. An attempt was made to pull the falls clear of the mud to see what was attached. On both falls all that came out was a broken cable. In both cases the break was clean and shiny, as would be expected for new breaks.

The winch drums were examined. The fall cables lay neatly in twenty-five of the thirty grooves on each of the drums. The leading strands lead loosely to the davits.

The power switch for the winch motor was in the "on" position.

The pelican hooks on the securing gripes were hanging open. There was no sign of any damage or deformation.

The tricing pennant showed no sign of damage or deformation.

27. CLOCKS RECOVERED

Four mechanical clocks were found on board the GLOMAR JAVA SEA during the March 1984 wreck survey. Three of those clocks were recovered. In each case, before being moved, the clock was videotaped to provide a record of the position of the hands.

Each of the three clocks recovered was a 12-hour mechanical, key-wound, bulkhead mounted clock of a type routinely found on ships. In each case the glass protecting the hands and face was broken and the hands were crushed back against the face.

The recovered clocks were found in the messroom, crews lounge, and ARCO China Drilling Supervisor's office. The messroom clock showed a time of thirteen minutes before the hour of eleven. The other two showed five minutes before the hour of twelve. There were no legible indications of "A.M." or "P.M..

A fourth clock was found in stateroom No. 14 on the boat deck (02) level. It showed a time of fifteen minutes after the hour of eight. It was not recovered.

28. BODIES FOUND AND RECOVERED

A total of thirty-six bodies were located during the March 1984 diving expedition. One body was found outside the drillship, in the vicinity of the lifeboat installations, during the hull survey. The other thirty-five were found in the accommodation areas.

Thirty-one of the bodies were recovered. Of the five bodies not recovered, four were on the navigation deck; the fifth was in the boat deck quarters area.

On the navigation deck, one body was found inside the Master's office. It was discovered when the diver reached through a tear in the bulkhead in an attempt to recover books he could see. However, the door was severely damaged and the diver could not enter the office. Three bodies were seen in the radio room. However, the doorway into that space was crushed down to an 18-inch by 48-inch opening, and entry was not attempted. Several methods of gaining access to those spaces were considered. The navigation deck was completely below the mud line and only interior access was possible. Also, access would require that portions of the internal bulkheads be cut away, possible weakening the damaged areas to the point of collapse. That meant the divers would have had to work their way through the quarters and would be far from help if a problem arose. In the end, the diver's supervisor concluded that it was too dangerous to attempt entry into those spaces.

The body found outside the hull was in the vicinity of the aft boat falls of the starboard lifeboat installation. A thin line similar to that used for line-throwing guns was wrapped around one leg. One end was on the line tangled in the boat gripe installation, the other led into the debris. The actual

nature of the line, how the body became entangled in it, and why the individual was outside when the ship sank have not been determined.

The bodies, other than those in the Master's office and radio room, were numbered as they were found. In most cases they were marked for recovery after the search of a given area was completed. In this manner the first twenty-seven bodies found were identified as # 1 through # 27. They were labeled accordingly upon recovery. Five more bodies were found after # 27 however, for some reason the same numbering system was not carried through to the final labeling of the body bags. Those five bodies were subsequently labeled # X1 through X5.

The numbers assigned indicate that 32 bodies were marked for recovery. But only 31 were recovered. Examination of the logs and records maintained during the wreck survey and search show that the body identified as # 25 was not recovered.

Bodies # 24 and # 25 were found in stateroom No. 16; # 26 AND # 27 in stateroom No. 14, the Chief Engineer's stateroom. They were marked for later recovery. During the recovery process, the diver's hoses got hung up or tangled while he was working in stateroom No. 16. The diver became disoriented and confused and could find only one of the two bodies previously located in that room. The dive team, fearing possible entrapment, did not reenter that area.

The damage to interior bulkheads and doors, confusion over numbering of the spaces (the numbering system actually used on the drillship differed from the designations used on the ship's plans), the poor visibility, and the physical difficulties and dangers inherent in underwater searches of wrecks made the diver's tasks extremely difficult. Under the circumstances, it is a credit to the diving team that only one such occurrence affected the body recovery operation.

The majority of the bodies were found in cabins on the boat deck (02) level or in the lounge on the poop deck (01) level. In general, the bodies were fully clothed, most wearing life preservers.

After recovery the bodies were placed in a refrigerated container and taken to Hong Kong. A multi-national team of expert pathologists working with dental and medical records and other information provided by families and employers, undertook identification of the bodies. A series of exhaustive examinations, careful cross-checks, and duplicate verifications resulted in identification of all of the thirty-one bodies recovered.

Table 1 is a summary of where each of the thirty-two bodies was found. As that table shows, the bodies of the key senior personnel -- Master, Chief Engineer, Radio Officer, Drilling Supervisor, Drilling Superintendent, Assistant Rig Manager -- were not recovered.

29. WATERTIGHT INTEGRITY

Reports from the divers conducting the survey in March 1984, with support from the video tapes taken at the same time, indicate that many of the weather deck doors were not completely dogged closed for maximum watertight integrity. For example, the "booby hatch" door on the main deck leading down to the casing hold appeared to have three dogs open and three dogs in place. The main deck watertight door to the sack storage room was undogged, but was buckled in such a

way that it appeared the two middle dogs may have been in place when the vessel sank. The port weather door on the poop deck leading to the passageway between the lounge and the galley had only one dog in place. The weather door on the starboard boat deck had three dogs in place and three open. The after weather door on the poop deck was open. The after door on the boat deck had only one of four dogs in place. The watertight door to the after windlass room was open. All dogs were open on the port weather door on the boat deck. The starboard passageway weather door on the superstructure deck had one dog in place and three open. The watertight door to the emergency generator room was hooked in the open position. The main deck remote open-close indicator for the shaft alley watertight door indicated the shaft alley door was open.

30. TRANSFER OF LIQUIDS TO CORRECT LIST AND TRIM

Weight distribution on the GLOMAR JAVA SEA was constantly changing during drilling operations, resulting in minor changes to list and trim. The drillship's engineering crew routinely transferred liquids between tanks to correct the list and trim. That action was often taken without the prior knowledge of the Master or the Chief Engineer.

On the evening of 25 October, when the starboard list was reported to Global Marine's office in Houston, the drillship's crew was already adjusting liquid loads to correct the list -- even though the cause of that list was not known. Although it should have, the Operating Manual for the GLOMAR JAVA SEA did not caution the Master against such action. The Coast Guard approved the operating manual, subject to certain comments, on 11 January 1980. The approval letter required, in part, that a section be added "stating that the Master is advised to take action to determine the cause of any unexpected heel or trim before taking corrective action". That section had not been added to the Operating Manual.

31. TECHNICAL STUDIES

A. Intact and Damage Stability Studies

It was necessary to determine whether or not the GLOMAR JAVA SEA met the stability standards in effect at the time of its building. At that time Coast Guard regulations established only intact stability criteria for drillships. However, the American Bureau of Shipping (ABS) did have damage stability requirements.

At the request of the Marine Board, the Coast Guard's Marine Technical and Hazardous Materials Division conducted both intact and damage stability studies. The intact stability study showed that the drillship satisfied the applicable intact stability criteria.

There was reason to believe, from testimony of alternate crew members, that the No. 6 and No. 7 starboard wing tanks (drill water and fuel oil tanks, respectively) were empty at the time of the casualty. The damage stability study considered the drillship with both of those tanks flooded, a damage condition in excess of that prescribed by the applicable ABS Rules. The study showed that if those tanks were flooded, the GLOMAR JAVA SEA, with no other forces acting on it, would have assumed a heel angle of approximately 14°. The study also showed that in that flooded condition the drillship would capsize if a 70 kt beam wind were applied on the port side. As already stated, this damage condition exceeded the applicable damage criteria. The study showed that the

drillship did in fact satisfy the applicable ABS damage stability criteria and the ABS intact stability as well.

The study also showed that the stability information contained in the Coast Guard-approved Operating Manual was conservative when compared to the drillship's stability characteristics.

B. Vessel Loading Study

It was desirable to identify as accurately as possible, the drillship's actual loading condition at the time of the casualty. Global Marine offered to conduct a study for that purpose. The Marine Board accepted that offer.

Considered in the loading study was the testimony of alternate crewmembers who had left the drillship only a few days before the casualty, daily reports submitted by the drillship prior to the casualty, and records of materials and supplies known to have been placed on board.

The thoroughness and detail of the study and the close agreement between its results and other available information created a high degree of confidence that the study provided an accurate picture of the GLOMAR JAVA SEA's loading condition on 25 October 1983. That loading condition was used in the structural and hydrodynamic studies.

C. Structural Study

At the request of the Marine Board, the Coast Guard's Marine Technical and Hazardous Materials Division performed structural calculations to determine whether or not the drillship's section modulus satisfied the applicable structural criteria, the ABS "Rules for Building and Classing Steel Vessels, 1967", which were in effect and adopted by the Coast Guard at the time the drillship was built.

The calculations showed that drillship's section modulus exceeded the applicable requirements.

D. Hydrodynamics and Stress Studies

To aid in trying to determine the cause of the major hull fractures, it was necessary to determine as accurately as possible, the magnitude of the stresses experienced by the drillship's hull on 25 October 1983. As a preliminary step, it was necessary that the motions of the drillship due to wind and seas be calculated. The American Bureau of Shipping offered to conduct the necessary studies. The Marine Board accepted that offer. The parameters and assumptions for the study were prescribed or approved by the Marine Board.

For the motions study, the wind, sea and swell conditions chosen were based on available meteorological data for the drill site at 2400, 25 October 1983. The conditions chosen were conservative -- when some degree of uncertainty existed more severe conditions were assumed. The results of this study were used to calculate the stresses imposed on the anchored drillship's hull as a result of its reaction to the wind and seas.

The stress study showed that under the assumed environmental conditions, the maximum hull stresses would not have exceeded 50 percent of the minimum yield

strength of the drillship's hull plating. That minimum yield strength was determined by actual tests conducted on the plate samples cut from the drillship's hull.

E. Metallurgical Study

Sample coupons were cut from the drillship's hull during the wreck survey in March 1984. The locations and sizes of the coupons were determined in advance in a meeting with representatives of the Parties in Interest to the investigation. The primary area of interest was the major transverse fracture in the vicinity of frame 91. The locations of the coupons were marked on the drillship's hull by divers and verified by the Marine Board representative via an underwater video system.

The coupons were cut, brought to the surface, cleaned, marked for identification, coated with preservative, and shipped to Houston, TX. They were subsequently delivered to Failure Analysis Associates for examination and testing. The use of that company was proposed by Global Marine and, after examination of the credentials of the company and its personnel, approved by the Marine Board. The procedures used to identify, mark, and track the coupons from initial cutting through the testing and the careful record keeping at each stage provided an excellent record of custody and ensured that the identity of each sample tested was preserved.

Failure Analysis Associates proposed a series of tests aimed at determining the physical and chemical properties of the samples as well as procedures for analysis of the fracture surfaces themselves. The Marine Board approved the proposals with some modifications.

The metallurgical study showed that the steel in the samples met the standards established by the American Bureau of Shipping and adopted by the Coast Guard with respect to thickness and quality. It also revealed that the major transverse fracture had two crack initiation points, one near the waterline and the other just below the bilge keel, in the vicinity of frame 91. The two cracks merged in the side shell. At the initiation points both cracks were brittle fractures. Coupons taken at points further along the fracture showed that the failure mode changed from brittle to ductile fractures and remained so to the termination points.

Both cracks started at welded joints. In both cases the cracks started at the inside of the hull plating in the heat affected zone of a weld. One started where a longitudinal side shell stiffener was attached to the hull plate. The other started where the transverse watertight bulkhead at frame 91 was attached to the hull plating. In both cases the examinations showed that the weld structures were normal and there were no defects or abnormalities in the welds. They also show that there were no signs of prior failures, damage, or repairs at those points. The metallurgist who presented the results of the study testified that it is not unusual to find cracks starting at such points if the structure experiences high local stresses.

The fracture surfaces in the samples did not show any sign of coming together, after the fractures occurred, with sufficient force to mar the surfaces.

The study also showed that there were no crack arresters or other features at the termination points of the cracks.

F. Stress Analysis of Hull Plating at Wing Tanks No. 6 and 7 Starboard

Failure Analysis Associates conducted two stress analyses on the drillship's hull plating in way of wing tanks No. 6 and 7 starboard. One analysis examined the effects of a uniform hydrostatic pressure loading on the hull in which the pressure gradually increased, simulating the increase in hydrostatic pressure as the ship sank. The other analysis examined the impact load necessary to create a stress equal to the yield stress of the hull plating.

The increasing hydrostatic presssure analysis concluded that the hull plating near frame 91 would experience yield when the drillship had sunk to a depth of 98 feet.

The impact loading analysis concluded an impact load of 325,000 pounds would be required to produce yield stresses in the hull plating near frame 91. The analysis also concluded that impact from floating objects such as a small fishing boat could not induce stresses large enough to fracture the hull.

32. WITNESS DATA

All available personnel with recent service onboard the GLOMAR JAVA SEA were interviewed as were all key shoreside management and support personnel of both Global Marine and ARCO China. All who appeared to be able to provide any significant information were called to testify. In addition, key Chinese personnel were interviewed in the Peoples Republic of China by the Chairman, Marine Board of Investigation and a representative of the National Transportation Safety Board. Finally, Coast Guard and American Bureau of Shipping inspection personnel and a wide range of technical personnel were called to testify. See Appendix B for a brief summary of the witnesses.

33. VISIT TO GLOMAR CORAL SEA

On 1 and 2 February 1984 the members of the Marine Board of Investigation, along with the Board's Administrative Assistant, examined the drillship GLOMAR CORAL SEA, both afloat and on drydock, in Mobile, AL. The GLOMAR CORAL SEA, built in 1974, is a sistership of the GLOMAR JAVA SEA. The ships were virtually identical with respect to hull design, structural features and other major features (hatches, derrick, etc.). Deck arrangements were generally the same but many equipment installations including anchors, windlasses, generators, and control systems were different. Unlike the GLOMAR JAVA SEA, the GLOMAR CORAL SEA was equipped with open lifeboats. However, the lifeboat winches on both vessels were the same.

The purpose of the examination was to allow the Marine Board, and its Administrative Assistant, who would be the Coast Guard representative on the wreck survey expedition, to become familiar with the vessel's design and arrangements. Particular attention was paid to the hull structure in way of the No. 6 drillwater and No. 7 fuel oil tanks, frames 90 and 91, and the moon pool. There was no sign of any current or past structural failure, structural deficiency, or deterioration in any of those areas. The only hull damage noted was localized in the moon pool and was the result of materials and equipment handling during routine operations.

Since the winch installations were the same as those on the GLOMAR JAVA SEA, one of the GLOMAR CORAL SEA's lifeboats was lowered from the normal stowage position

to the boat deck embarkation area. Examination of the winch drums showed the fall cables remained in 25 of the 30 groove turns on the drums. Examination of the wreck subsequently showed cable remained in 25 of the 30 turns on the GLOMAR JAVA SEA's starboard winch drums.

34. SATELLITE COMMUNICATIONS LINK

The GLOMAR JAVA SEA was equipped with a Scientific-Atlanta Model 3055M satellite communications terminal through which the drillship was linked to a commercial telephone and telex satellite relay system. The International Maritime Satellite Communications System (INMARSAT) is based in London, England. INMARSAT uses land-based switching/transmitting/receiving stations called "coast earth stations" (CES). Calls originating on shore are routed via commercial telephone/telex networks to the CES, transmitted to a system satellite, and retransmitted to a receiving terminal. Calls originating from ship stations are transmitted directly to the satellite, relayed to the CES, and switched onto commercial networks. Management of the system in the United States and operation of the U.S. coast earth stations is handled by Communications Satellite Corporation (COMSAT). The maritime satellite communications services provided by that company as well as the system itself are known as MARISAT. That term was also routinely used to identify the terminal on the drillship.

The Communications satellites are in geostatic orbits. Each satellite provides coverage for a specific portion of the earth's surface. Some geographical areas are covered by more than one satellite. In the South China Sea the GLOMAR JAVA SEA had access to both the Pacific Ocean and Indian Ocean satellites.

Operation of the MARISAT system on the drillship was relatively simple. The antenna for the terminal was aimed at the satellite initially by manually entering azimuth and bearing angles and energizing a direct input from the drillship's gyro compass system. The antenna then automatically tracked the satellite. Actual use of the system was then essentially the same as using any standard telephone or telex terminal. For telephone use dialing an access code opened the channel to the satellite. The call could then be made by direct dial or with operator assistance.

The Scientific-Atlanta Model 3055M terminal aboard the GLOMAR JAVA SEA was equipped with a distress signal generator which could be activated by lifting a protective plastic cover and depressing a pushbutton. The terminal would then have transmitted a distress signal which would have alerted system operators and which would have been recorded on system records.

In addition to recording distress signals the system generates records of calls, whether completed or only unsuccessful attempts, to and from a user's terminal. Due to billing requirements, the numbers called by the user are recorded along with the system use time associated with each call. For calls originating elsewhere and received by the terminal only the system use time is recorded; the caller's number is not.

In an effort to determine whether or not any distress signal was sent or any calls (other than that at 2348) were made on the evening of 25 October 1983, the Marine Board examined COMSAT's records for the GLOMAR JAVA SEA's account. The Marine Board also contacted INMARSAT and requested that company to review its records. Information received from INMARSAT resulted in contact with and a similar request to Kokusai Denshin Denwa Company, the Japanese counterpart of

COMSAT. In all cases the results were the same: there is no record of any other calls from the drillship on the evening of 25 October. Also, there were no calls made to the drillship on 25 October before the casualty. There were well over one hundred unsuccessful attempts to call the drillship from stations in the United States in the sixteen hours immediately following the casualty.

35. ADDITIONAL INFORMATION SOLICITED

In order to ensure that all significant information about the drillship was made available to the Marine Board, information was solicited from two other sources. With outstanding cooperation and a great deal of assistance from Global Marine, ARCO China, and all of the subcontractors who had personnel on board the drillship, letters were sent to all of the following for whom an address was available:

a. the families of persons on board the drillship on 25 October 1983, and

b. persons (other than those interviewed in person) who had served on board the drillship between 1 August 1983 and 20 October 1983, the date of the last crew change.

The letters requested any information or comments the individual might have on the material condition of the drillship or which the individual felt might be helpful in determining what happened to the drillship and its crew.

A number of responses were received. They indicated that the drillship had experienced some mechanical difficulties with some of the drilling equipment and that some morale problems probably existed on board the drillship. In general, however, the responses provided nothing of note on the circumstances surrounding the casualty.

Recommendations concerning possible improvements in Marine Safety were received from several of the families of crewmembers. Those recommendations were forwarded to the Commandant for evaluation.

36. DRILLSHIP EXPERIENCE IN SEVERE WEATHER

Several Global Marine and ARCO China supervisory personnel and two previous Masters testified that they had, while serving on the GLOMAR JAVA SEA, its sisterships, and other drillships, experienced weather conditions worse than those forecast for and reported by the GLOMAR JAVA SEA. The forecast issued at 1630, 23 October, called for winds of 40 kts with gusts to 50 kts. The forecasts got progressively worse.

At 0730, 25 October, winds of 55 kts with gusts to 65 kts, 16-foot seas, and 21-foot swells were predicted at the storm center. The predicted intensity of the storm continued to worsen on 25 October, with the most severe prediction, at 1800, being 60 kt winds with 75 kt gusts and 15-foot seas with 26-foot swells. Supervisory personnel ashore testified that those forecasts did not cause them any concern.

Wind conditions at the drill site were not as bad as predicted (sea conditions were worse), and, up to at least the evening of 24 October, the storm was still

expected to pass to the north of the drillship. At 0800, 25 October, the GLOMAR JAVA SEA was experiencing 25-30 kt winds, 20-24-foot seas, and 18 to 26-foot swells. Those conditions did not cause any concern on the part of shoreside personnel.

Conditions at the drill site worsened during the day until, at 1600, the drillship reported 45-50 kt winds and 38-foot seas with 30-foot swells. Again this did not cause any concern among shoreside personnel. Further, there is no evidence that persons onboard the drillship voiced any concern about the conditions.

To obtain information on drillship experience in adverse weather, the Marine Board requested specific data from drillship operators. Survey forms were prepared and sent out. Five major drilling companies responded with data from 15 different drillships. Some companies submitted multiple responses for individual drillships. The replies dealt with incidents all around the world, in some cases going back to 1973. The information obtained in the survey is shown in Table 2. Some of the replies were very sketchy and incomplete and are not included in the table.

The data covers a wide range of vessel types, operating conditions, and environmental conditions. Although no one case matches the GLOMAR JAVA SEA exactly the data shows that drillships have routinely survived very heavy weather conditions with little or no serious damage. Of particular note, however, are the two cases where anchor cables or chains parted. In both cases the wind and sea conditions were less severe than those experienced by the GLOMAR JAVA SEA.

PREFACE TO CONCLUSIONS

1. FIXING THE TIME OF THE CASUALTY

The drillship's crew called Global Marine's Houston, TX, office at 2348. The conversation was abruptly terminated, by the Marine Board's estimate, at 2351.

Two of the three clocks recovered from the wreck showed a time of five minutes before the hour of twelve. The third clock showed thirteen minutes before the hour of eleven. The difference cannot be reconciled.

On all three clocks the glass was broken and the hands were crushed back against the face. It is probable that as the drillship sank, hydrostatic pressure acting on the outside of the face or a rapid ingress of water into the compartment crushed the glass into the clock hands and face.

There is no way to tell the status or condition of any of the clocks prior to the casualty. However, it is reasonable to expect that at least the clocks in public spaces, including the messroom and lounge, would be wound regularly. It is also reasonable to expect that since daily activities were logged and reports made at specific times, the clock in the Drilling Supervisor's office would be wound routinely. Further, it is reasonable to expect that all ship's clocks would be set to show approximately the same time, with no more than a few minutes variation at most. It is also reasonable to expect that crushing the hands against the face could cause a clock to stop. Thus it is probable that the recovered clocks were running at the time of the casualty and the two clocks showing the same time stopped as the vessel sank. That would put the time of sinking at about 2355, or approximately 4 minutes after the last call to Houston was terminated. It is not unreasonable to expect an elapsed time of 3 to 4 minutes from the time the drillship began to capsize until it sank to a depth sufficient for the clock faces to be crushed.

For these reasons it appears that the call to Houston was interrupted at 2351 as a result of the drillship capsizing.

2. CAUSE OF THE STARBOARD LIST

The drillship reported a 15° starboard list at 2348, 25 October. The cause of the list was not known.

How the magnitude of the list was determined is not known. The severe motions the drillship reported would have made it difficult to accurately measure any permanent list. Thus, it is possible that the actual list was something other than 15°.

Flooding of the No. 6 and No. 7 starboard wing tanks would, according to calculations performed during the investigation, have resulted in a starboard list of approximately 14°. Several parties have used that datum to infer that such flooding caused the list. However, the available evidence concerning the conditions of those tanks indicates that they were empty when the drillship sank. Thus, the Marine Board examined other possible causes.

A severe list could have been caused by a shift of drill pipe, well casing, marine riser sections, and associated materials which for the most part were stored high on the drillship.

Another possibility is that the drillship had taken on water through hatches or other fittings which had been inadvertently left open or which had been damaged or otherwise breached by the storm. Flooding in such a case may have escaped detection since access to some compartments and several tank sounding points was not possible due to weather and sea conditions.

Still another possible cause was an improper shifting of liquids between tanks. Testimony revealed that the vessel's engineering crew routinely shifted liquids to correct list and trim without the prior knowledge of the Chief Engineer or the Master. It is possible that liquids were transferred to correct a perceived problem that didn't really exist, or that incorrect action was taken to correct what was initially a minor problem. In either case, an undesirable list could have unknowingly been imposed or aggravated.

It appears that the list developed very quickly. There was no mention of it in the conversations between the drillship and the supply vessel or shore bases prior to 2300 and by 2348 the drillship's crew had apparently been working on correcting it for at least a short period of time.

Lacking evidence of hull failure on the surface, any flooding of the drillship while afloat would have been gradual and probably minor. Any list resulting from wrong action by the crew in transferring liquids would also have developed gradually and would have been noticed, and the action terminated, long before the angle of list approached 15°. Thus the Marine Board feels that the most probable cause of the list was the shifting of the drill pipe and other materials stored on board when the drilling operation was halted.

The Marine Board also feels that the action of the drillship's crew in attempting to correct a list, the cause of which was not known, was ill-advised. Testimony on the last communication with the drillship indicates that the crew was in the process of or already had completed dumping of the starboard mud tank or tanks. It is not clear exactly which tank or tanks were involved but that action could have made the vessel's stability condition worse. For example, if the bulk liquid mud tanks at the tank top level were dumped the drillship's vertical center of gravity would have been raised and its stability would have been slightly diminished. While it cannot be shown or stated conclusively that the crew's action contributed to the casualty, the possibility exists.

3. CAUSE AND EFFECTS OF THE ANCHOR CHAIN FAILURES

Anchor chains No. 2, 3, and 4 are known to have broken. Chains No. 3 and 4 failed as the result of overloading in tension. It is probable that No. 2 failed for the same reason. The Marine Board feels that such failures occurred while the drillship was afloat. While afloat the GLOMAR JAVA SEA was exposed to the forces of wind, waves, and swell resulting in severe vessel motions. Once the drillship sank however, those forces would no longer have been acting on it. It is highly improbable that sufficient pull could have been exerted on the chains to part them after the drillship sank, whereas anchor chain failures on moored ships are relatively common in heavy weather. See Table 2.

The directions of wind, waves, and swell were such that anchor chains No. 2, 3, and 4 were subject to the highest environmentally-imposed loadings. Their failure created a situation in which anchor No. 10 and anchor No. 5 were the only anchors capable of preventing the drillship from drifting to the southwest. The relative winds and seas would have caused the drillship's bow to swing to the southwest simultaneously with its drift in that direction. Initially that swing would have been resisted only by anchor No. 10. As the drillship swung further anchor No. 9 would also become a resisting factor. As the drillship swung to the southwest, it presented a larger sail area to the wind while retaining a beam sea aspect. Thus the forces acting to push the drillship to the southwest continued to increase.

Failure of the anchor chains allowed the GLOMAR JAVA SEA to drift to the southwest of its original position and change heading from 339°T to 285°T. The change in heading changed the directions of wind and seas relative to the drillship. That probably changed the loads applied to the remaining anchor chains. Whether or not it had any other effect on the drillship is not known.

Other than the changes in position and heading the anchor chain failures had no significant effect on the GLOMAR JAVA SEA. The anchors originally served only to hold the drillship on station; they did not serve to hold it upright. Because of the locations of the anchor windlasses and fairleads relative to the drillship's centerline and the positions of the anchors relative to the drillship, heeling moments, righting moments, and tripping forces exerted by the anchors were relatively small. Any imbalance or other change in those moments or forces as a result of the failures would also have been relatively small and alone would not have been sufficient to capsize the drillship.

4. THE HULL FRACTURE AT FRAME 91

Of all of the damage -- fractures, buckling, crushing -- found during the wreck surveys, the transverse fracture at frame 91 starboard has received by far the most attention. The fracture extends the full depth of the hull crossing the transverse bulkhead between wing tanks No. 6 and 7, starboard, and extending into both the main deck and bottom shell plating.

The available evidence indicates that the two affected tanks were empty on 25 October 1983. Since flooding of those tanks, as would occur from a fracture, would impart a significant starboard list such as that reported in the call to Houston, it appeared reasonable to pursue the thought that the fracture occurred on the surface and caused the list. Stability calculations showed that such a scenario would have caused a list of approximately 14°. However, hydrodynamic and structural studies performed to determine the drillship's motions in response to environmental conditions and the resultant loads and stresses imposed on the drillship's structure did not support that approach. Those studies show that the forces acting on the hull of the anchored drillship were not of sufficient magnitude to have caused the two cracks which joined to cause the fracture to develop in the manner it did. Another puzzling point was the unusual manner in which the cracks terminated. They simply stopped in mid-plate rather than at any type of crack arrester. In mild steel, such as the drillship's hull plating, that type of termination usually occurs only when the force propagating the fracture is suddenly removed. It is unlikely that that would be the case if the fracture occurred while the drillship was being exposed to winds of 60 to 75 kts and seas in excess of 40 feet. Another point was the lack of contact between opposing fracture surfaces. Examination of the fracture

surfaces in samples cut from the drillship's hull show no sign that the surfaces ever rubbed together. Considering the times of the various reports of the drillship listing, if the fracture had caused the list, the ship would have been afloat for at least 30 to 45 minutes after the fracture occurred. It is reasonable to expect that, if the fracture occurred with the drillship afloat and experiencing severe rolling, pitching and heaving, the hull would be flexing and working to such a degree that some amount of contact would have occurred. Thus, it appears the fracture occurred after the drillship sank.

A broader issue is whether or not the fracture occurred simultaneously with the massive hull buckling in the areas adjacent to the fracture and the extensive damage to bulkhead 91. The metallurgical and structural studies have shown nothing to indicate that the forces acting on the drillship while afloat could have caused such damage. However, the forces exerted by hydrostatic pressure as the drillship sank were on a much higher magnitude. Atmospheric pressure at sea level is 14.7 pounds per square inch (psi) or one atmosphere. Pressure below the sea surface is equal to that one atmosphere plus an additional one atmosphere for each 32.7 feet, approximately, of depth. Since the GLOMAR JAVA SEA sank in 317 feet of water, the hydrostatic forces acting on the hull would have been as great as 157 psi at any given point. If the No. 6 and 7 starboard wing tanks were already breached when the drillship sank, hydrostatic pressure would have had no effect on the shell plating in way of those tanks. However, if, as appears to be the case, those two wing tanks were empty and intact and thus filled with air, the capsizing of the drillship would have trapped that air in the tanks. Then, as the ship sank, the hydrostatic pressure applied to the hull would have been far greater than the atmospheric pressure in the tanks. It is not unreasonable to expect that that great a pressure differential could cause severe bulkling.

It is probable that the combination of stresses imposed on the hull by hydrostatic pressure as the drillship sank and the force of striking the sea floor caused the observed damage, including initiation of the fracture near frame 91. It is also probable that the fracture propagated until the hydrostatic pressures equalized and the drillship came to rest thus neutralizing the forces acting on the hull.

5. WATERTIGHT INTEGRITY DISCIPLINE

The wreck survey showed that many of the weather deck doors were not dogged down as would have been expected for a vessel experiencing severe weather and seas. It could be argued that the water pressure at a depth of over 300 feet could have caused the gaskets on the watertight door to be depressed sufficiently to allow the dogs, with the drillship inverted, to fall to the open position. But that does not explain why in some cases all but one dog were open. The more realistic answer is that it was the practice of personnel on the drillship to use only one or two of the dogs to secure a door. It is probable that the emergency generator room door was hooked open to provide easier access. The shaft alley door would be normally open and was probably not closed, even though the vessel was in a severe storm where good seamanship would dictate that the door be closed.

It would be difficult to conclude that the lack of complete watertight integrity at any one of these doors contributed significantly to the sinking of the GLOMAR JAVA SEA. With the drillship upright and afloat flooding through any one of those doors would have been minor. However, the apparent lack of discipline of

the drillship's personnel in maintaining a watertight envelope raises a concern that such practice may not be unique to the GLOMAR JAVA SEA. There are many persons employed on drillships who are not experienced seafareers and may not appreciate the protection provided by a completely watertight closure of weather doors. It is easy to envision the practice of only casually closing weather doors, especially in environments with mild temperatures. The habits formed during periods of good weather would be difficult to change during the few hours when the vessel depended upon a strict watertight closure for survival.

It is difficult to maintain a high degree of watertight integrity at all times on a ship which is not in a harsh environment. Therefore, when the environment does change for the worse it is incumbent upon the vessel's leaders to ensure that an adequate degree of watertight integrity is established and maintained throughout the hazardous period. It does not appear that such action was taken by the key personnel on board the GLOMAR JAVA SEA the night of October 25, 1983.

6. SUPERVISORY RELATIONSHIPS

A drillship is unique in that it spends the vast majority of its time anchored over a drill site where the skills of navigating and maintaining propulsion control go unused. However, the ship is still subject to the forces of the marine environment and dedication to seamanship and a high degree of seaworthiness is still necessary to ensure that a satisfactory drilling platform is maintained. As a result, traditional maritime concerns become intertwined with drilling concerns.

The supervisory personnel assignments on a drillship are unique in the marine industry. The primary job is drilling, and that is reflected in the drillship's staffing.

The senior Global Marine representative on board was the Drilling Superintendent who was responsible for the actual drilling operation. He reported to the Rig Manager in Zhanjiang. Reporting directly to the Drilling Superintendent were: the Master, in charge of the deck crew and ultimately responsible for the safety of the ship and its crew; the Chief Engineer, in charge of the engineering crew and responsible for power services and keeping the drillship properly trimmed; and, the two Toolpushers, in charge of their respective drilling crews. With this arrangement there was no one designated "second in command".

The supervisory picture was complicated by the presence of the ARCO China Drilling Supervisor who had overall responsibility for the well itself. He held equal stature with the Global Marine Drilling Superintendent with respect to decisions affecting drilling of the well and the drillship's ability to provide a suitable drilling platform.

This was the organization on paper. In actual operations, the toolpushers and assistant engineers carried out the routine operations, the former drilling the well, and the latter maintaining the drillship's trim and providing routine services.

The Master's responsibility for the safety of the drillship put him on an almost equal footing with the senior drilling personnel during normal drilling operations. Formal instructions and guidelines provided by Global Marine in the various operations manuals delegate to the Master the authority to take any appropriate action necessary to safeguard the crew and the ship in a

non-drilling-related emergency. In fact, the Master had unilateral authority to order termination of the drilling operation and moving of the drillship or evacuation of its crew. However, it is highly unlikely that the Master would have exercised that authority unilaterally.

All key shoreside supervisory personnel unanimously testified that the Master at all times had responsibility for the safety of the ship and its crew. They also testified that the Master had the authority to initiate any action he deemed necessary in the interests of safety. The two previous Masters testified that in their opinions they did have the authority and responsibility for stability and safety. However, they both testified that major decisions were made in party with the Drilling Superintendent and the Drilling Supervisor, and to a lesser extent, the Chief Engineer. The shoreside Rig Manager also exercised a certain degree of control. Both the alternate Master and the alternate Chief Engineer testified that they reported to the Drilling Superintendent. Also, the former Master and the alternate crewmembers unanimously indicated that drilling fluids and other stores and supplies were received and liquid loads shifted routinely by both the marine crew and the drilling crew without the specific approval or, often, even the prior knowledge of the Master. All of these facts indicate that, although the Master was in charge on paper, he did not enjoy or exercise the same degree of autonomous control as would the Master on a traditional merchant vessel. Whether or not this was intentional policy or even known and desirable to Global Marine, ARCO China, their management personnel, or anyone else is immaterial. That the drillship's Masters perceived that they did not have full unequivocal authority at all times is the controlling issue.

At the time of the casualty the drillship was, except for the guide wires, disconnected from the well. Thus, full control of the drillship's operation should have been vested in the Master. However, every indication is that any major decision, such as evacuation or moving the drillship, would still have been made by committee. That does not necessarily mean that any action taken or not taken was improper or that a decision "by committee" was of itself improper. The Marine Board found no instance where the lack of total authority during drilling operations encumbered the Master in his conduct of safety inspections, stability checks, fire and boat drills, or, in one instance (during a previous storm), from partially evacuating the drillship. And there is nothing to indicate that any action directed by the Master on 25 October was not carried but because of a division of authority, disagreement among senior personnel, or for any other reason. However, the possibility cannot be ruled out.

The Marine Board considered the possible deficiencies in the division of authority and ultimately leadership. The problem most likely to occur would be a division of loyalty such that the crew as a whole might not immediately respond to or follow the orders of the one leader who is supposed to take charge in an emergency, the Master. It is reasonable to expect that the drilling crew would look to the Drilling Superintendent for direction and the operator's personnel to the Drilling Supervisor. It is not possible to predict to whom the subcontractor personnel and trainees - many of whom probably had little, if any, marine experience - would respond initially. It is reasonable to expect that this situation might cause some degree of confusion initially. However, it is also reasonable to expect that the senior drilling personnel would fully support the Master and ensure that their subordinates did the same. The testimony of management personnel and alternate crewmembers indicates that on 25 October 1983 the Master of the GLOMAR JAVA SEA could have expected the full support of the other senior personnel, and there is nothing to indicate that he did not have

it. However, the possibility that all of the persons on board did not support and immediately obey the orders of the Master cannot be ruled out.

The Marine Board also considered possible problems from not having a "second in command". The Master was the only licensed deck officer on board the drillship. If he became incapacitated, there was no one else on board qualified to take command of the drillship. The ability to get underway or, if underway, to continue to navigate, would have been impaired. At anchor the ability to assess potential dangers and respond to emergencies affecting the seaworthiness of the drillship would have been greatly diminished if not lost entirely. Even anchored as it was on 25 October 1983, the drillship's ability to survive in a marine environment might have been severely impaired. The next issue is who would take charge. With no one individual designated or clearly better suited to the task, it is reasonable to expect that decisions would be made by the senior drilling personnel "in committee" with the most experienced marine personnel on board, the Chief Engineer and possibly the Bosun. However, without clearly established authority, there is a possibility of divided loyalties and a resultant failure to follow the best qualified of the potential leaders.

There is no reason to believe that on 25 October 1983, the Master of the GLOMAR JAVA SEA was not in control of his ship and receiving the support of everyone on board. But it does not necessarily follow that such would always be the case on a drillship. There exists a very real possibility that divisions of authority and loyalty could result in a lack of quick, proper response to actions directed by the Master in an emergency, resulting in increased risk of injury to the crew or loss of the ship. Loss of the Master could make the problem even worse. The Marine Board feels that the issue of command authority should be carefully and thoroughly examined by both drillship operators and the Coast Guard.

7. MANNING STANDARDS

The required manning level and the total number of persons allowed to be onboard the GLOMAR JAVA SEA depended on the drillship's status with respect to navigation. Those levels were identified on the drillship's Certificate of Inspection and are shown in Table 3.

Information provided by the Commandant confirmed that the personnel on board the drillship on 25 October 1983 held the following Coast Guard licenses or Merchant Mariners Documents:

Master	1
Radio Officer	1
Able Bodied Seaman	3
Ordinary Seaman	8
Chief Engineer	2
2nd Asst Engineer	1
Oiler	2
Lifeboatman	11

The number of licensed personnel on board the drillship exceeded the requirements of the Certificate of Inspection. The Master, the Radio Officer, and one Chief Engineer served in those capacities. The other two licensed Engineers served as engineers in charge of the watch.

The number of certificated personnel on board also exceeded the requirements of the Certificate of Inspection. That was due to the fact that some of the drilling crew held Merchant Mariners Documents. The two Oilers and two of the Able Bodied Seamen (one designated as "Bosun") were serving in those capacities. However, none of the Ordinary Seamen were serving in that capacity. Instead, Chinese personnel were used in that position.

Normal practice was that the Able Bodied Seaman served as "night seaman," and two Chinese "ordinary seamen" worked the day shift. Those three persons were supervised by the Bosun.

With the exception of a Chief Mate, there were enough licensed and certificated personnel physically on board to satisfy the requirements for rig moves of not more than 16 hours duration. However, the third of the three known Able Bodied Seamen on board was the ARCO China Drilling Supervisor. (There is reason to believe that the Global Marine Drilling Superintendent may also have held an Able Bodied Seaman's document.) And, there is nothing to indicate that he (or the Drilling Superintendent, if actually certificated) or any of the Ordinary Seamen in the drilling crew did serve or would have served as a watchstander on moves between drilling sites, including the move to the final drill site.

There was no Chief Mate onboard nor immediately available to the drillship while on location. During the last rig move, both the off-going Master and the relieving Master were onboard. Thus, technically, the requirement of the Certificate of Inspection to have both a Master and Chief Mate onboard was satisfied.

There were no other rig moves scheduled in the immediate future, and no Chief Mate was immediately available to the drillship. In an emergency, the Master could have taken whatever action he deemed necessary, including getting underway without the full crew required by the Certificate of Inspection. However, the Master was the only person on board licensed to navigate the drillship, and that fact could have influenced his apparent decision to remain anchored at the drillsite rather than get underway.

The Marine Board feels that required manning levels for drillships not in navigation should be reevaluated in light of the possibility of having to get underway in an emergency. Increased manning levels appear to be desirable since drillships frequently operate in remote areas where additional properly qualified marine personnel are not readily available on extremely short notice.

Further, the Marine Board feels that the practice of counting certificated members of the drilling crew toward the totals required by the Certificate of Inspection should be discouraged if not prohibited. It is highly unlikely that such persons actually perform the duties of the station. Thus, the numbers of actual watchstanders prescribed by law and regulation are not maintained.

8. LIFEBOAT DRILLS

The two previous Masters called as witnesses testified that they conducted fire and boat drills on a weekly basis. During those drills the boats were lowered to the embarkation deck, and the crewmembers participating (those not on duty or "on tower") were given instructions in boarding, lowering and releasing the lifeboats. Generally the engines were started, and the emergency lifeboat radio was tested. The Chinese personnel were given additional instructions with an

interpreter present so they would be familiar with the lifeboats and abandon ship procedures.

Generally, the lifeboats were lowered only to the embarkation deck during drills. On occasion, in good weather, they were lowered to the water. However, they were rarely released and exercised in the water. The reason for this practice was the difficulty in reconnecting the boat falls and the risk of injury to personnel under all but the most ideal of sea conditions.

The lifeboats had small hatches in the deck fore and aft. The falls passed through those hatches and connected to hooks inside the lifeboat. Releasing the falls was easily accomplished from inside the lifeboat. And, once the falls were released, the hatches could be closed. However, reconnecting required personnel to be out on the deck of the lifeboat. The small deck areas at the bow and stern gave the persons reconnecting little space to work. The footing was described as "precarious." The persons reconnecting had to cope with all the usual problems of capturing the block and overhauling the falls and, in addition, had to fit the blocks down through the hatches and into the hooks. The Bosun from the alternate crew testified that he had injured his hands doing just that during a drill.

Both of the Masters testified that the danger of injury to personnel overrode their concern about regulatory requirements to hold lifeboat drills. Thus the lifeboats were released only when weather and sea conditions were ideal.

The Marine Board feels that the practice of not releasing the lifeboats during drills is probably widespread. Difficulty in reconnecting and fear of injuries are probably factors in many cases. Since weather and sea conditions will frequently preclude launching the lifeboats during drills when ships are underway, the Marine Board feels that greater emphasis should be placed on conducting drills when those conditions are not factors. In some cases it could be done in port; however, most ships are in port for only a few hours at a time and crew changes and other ship's business would result in deferral of the drills altogether or crews rushing through superficial attempts just to satisfy the requirement. The Marine Board feels that a suitable alternative to shipboard drills is needed. Schools or training programs should be established to train lifeboatmen. They could be formal schools or company training programs approved by the Coast Guard. Before being certified as a lifeboatman an individual would have to complete the course of training. Periodic requalification would be required to maintain the certification and training on each type of lifeboat and liferaft would be necessary.

Further, greater emphasis should be put on ensuring that all crewmembers, not just lifeboatmen, are intimately familiar with their abandon ship duties and the procedures for boarding, lowering, and releasing lifeboats. It appears that the drills and instructions conducted by the previous Masters of the GLOMAR JAVA SEA were adequate for that purpose.

9. CONDITION OF LIFEBOATS AND LIFERAFTS

Although they were not routinely placed in the water and exercised afloat, there is nothing in the available evidence to indicate that the drillship's lifeboats were anything less than fully serviceable. The lifeboats had been stripped and thoroughly examined by the previous Master approximately 3 weeks prior to the casualty. They were also inspected by a Coast Guard Marine Inspector

approximately 1 week prior to the casualty. The lifeboats were also checked during the weekly drills.

Information provided by the Commandant shows that the lifeboats were designed to be self-righting when intact and easily righted by persons in the water when partially flooded and capsized. If completely flooded and capsized the lifeboats could not be righted by persons in the water. The lifeboats were designed to remain afloat even if damaged, flooded, and capsized.

There is evidence that the hydraulic releases for two of the three inflatable liferafts had not been serviced within the past 12 months as required by current Federal regulations - one was three years overdue. The liferafts themselves had all been serviced within the eleven months preceding the casualty and thus at the time of the inspection the requirement for annual servicing was satisfied.

Only one of the three inflatable liferafts was found after the casualty. When examined, it was found to be ripped and the inflation cylinder, provisions, and equipment were all missing. Due to the circumstances of its recovery and delivery to Global Marine, there is no way of knowing if the damage was done before or after recovery. It is noted, however, that that raft appears to have been the one that was equipped with the one hydraulic release which had been recently serviced.

There is nothing to indicate that the two hydraulic releases which had not been recently serviced were not fully operable. However, under the circumstances, that possibility cannot be ruled out.

The Marine Board feels that, while most marine personnel know about the annual servicing requirements for inflatable liferafts, many probably do not realize that a similar requirement applies to hydraulic releases. The Marine Board feels that that requirement should be made more visible. One way to accomplish that is to make the hydraulic release a required part of the liferaft equipment which stays with the liferaft at all times including when the liferaft is removed from the vessel for servicing.

10. LIFEBOAT CAPACITY

The GLOMAR JAVA SEA was equipped with two motor-propelled enclosed lifeboats, each with a capacity of 64 persons. One lifeboat was installed on each side of the drillship. In addition, the drillship was equipped with inflatable liferafts with a total capacity of 55 persons.

The Coast Guard and SOLAS regulations in effect at the time the GLOMAR JAVA SEA was built and still in effect today require that all cargo and miscellaneous vessels (drillships were included in that category) be equipped with lifeboats on each side of the vessel to accommodate 100 percent of the persons onboard; a total of 200 percent capacity. In addition, each vessel was required to have sufficient liferafts to accommodate 50 percent of the persons onboard. Since the lifeboat on each side held 64 persons, the total number of persons allowed was limited to that figure. These figures were listed on both the Coast Guard Certificate of Inspection and the SOLAS Cargo Ship Safety Equipment Certificate and applied while the drillship was underway.

When the drillship was moored at a drilling site, however, the same criteria were not applied. At least ten years prior to the construction of the GLOMAR

JAVA SEA, the Coast Guard had ruled that, when in the moored position for drilling operations, a drillship was not on an international voyage and was, therefore, exempt from the SOLAS regulations. At such times a drillship was required to provide lifeboatage for only 100 percent of the persons on board rather than 200 percent. The requirement to provide life rafts for 50 percent of the total persons remained applicable. These rulings remained in effect at the time the GLOMAR JAVA SEA was built and, at least for drillships built prior to 1976, remain in effect today.

Under those rulings, the GLOMAR JAVA SEA could accommodate 124 persons on the basis of 100 percent lifeboat capacity, but only 110 persons on the basis of 50 percent liferaft capacity. As a result, the drillship's Certificate of Inspection authorized an increase in total persons allowed from 64 when the drillship was underway to 110 when it was moored at the drill site. Since the drillship did not have berthing accommodations, the Certificate of Inspection carried the provision "persons in excess of the number of berths will be on board on a daily visit basis and not quartered on board." The GLOMAR JAVA SEA had berthing facilities for approximately 85 persons.

At one time the Coast Guard issued SOLAS Exemption Certificates to explain why 200 percent lifeboatage was not required while the drillship was moored on location. By 1972, however, the Coast Guard had determined that the issuance of Exemption Certificates was no longer appropriate in such cases. Thus, no SOLAS Exemption Certificate was issued for the GLOMAR JAVA SEA.

The Marine Board has not attempted to conduct a historical review of or analyze the reasoning behind those decisions. The Marine Board did, however, compare the lifesaving equipment requirements for the GLOMAR JAVA SEA to those currently in effect for mobile offshore drilling units (MODU's). Such a comparison was deemed appropriate since a drillship moored on location and thus not in navigation is essentially the same as a semi-submersible MODU. The current regulations for MODU's require that lifeboats and liferafts combined must provide for at least 200 percent capacity with the lifeboats alone providing at least 100 percent capacity. The lifesaving equipment on board the GLOMAR JAVA SEA satisfied those requirements.

11. PROBABILITY THAT A LIFEBOAT WAS LAUNCHED

The Marine Board feels that the available evidence supports the probability that some of the persons on the GLOMAR JAVA SEA boarded and launched one of the two enclosed lifeboats.

From the damage to the pelican hooks for the gripes and the condition of the davit arms and fall cables on the port side, it appears probable that the port lifeboat was forcibly ripped from its normal stowage position. The equipment on the starboard side was undamaged. Also, the power switch for the winch motor was in the "on" position (it is normal practice to put power to the winch during launching even though it is not needed to actually launch the lifeboat). Further, comparison of the cable on the winch drum to that on the GLOMAR CORAL SEA indicates that the starboard lifeboat was intentionally and properly lowered to the boat deck. It is reasonable to expect that it was lowered for the purpose of preparing it for launching and that the falls were released with no more than normal tension being applied.

On the afternoon of 27 October 1983, during the active search, a merchant vessel reported receiving a distress signal on 500 kHz, the marine distress frequency on which the emergency lifeboat radio transmitted. The transmission reportedly included the GLOMAR JAVA SEA's call sign and a latitude and longitude to the northwest of the drill site. Those could only have been transmitted manually.

Although the merchant vessel's distance from the drill site far exceeded the expected range of the lifeboat radio and the reported position only approximately matched the drillship's last position, there is no reason to doubt the accuracy of the report with respect to receipt of the signal. Also, it is not an uncommon occurrence to have radio signals of limited power "skip" long distances because of unusual weather conditions.

On the morning of 28 October 1983 a Chinese helicopter reported a "capsized lifeboat" with the propeller sticking out of the water at a position northwest of the drill site. Although it was not located by any of the search ships, there is no reason to doubt the report. And, since there was no report of a lifeboat being lost from any other ship, it is probable that it came from the drillship.

Only thirty-six bodies were found in the drillship even though almost all of the accommodations areas were searched. Only a few of the other forty-five persons, i.e.: watchstanders, would have had cause to be elsewhere on the drillship during the storm. That they were not found supports the possibility that at least some of them had left the drillship.

The Bosun's body was found in the lounge. There has been some speculation that that indicates a lifeboat was not launched, supposedly because after the Master, the Bosun was the best qualified person to take charge of a lifeboat. That logic is not supportable. There were at least 11 certificated Lifeboatmen on board the GLOMAR JAVA SEA. Included in that group were the following persons whose bodies have not been found: a licensed Assistant Engineer, a Toolpusher, the Drilling Supervisor, a Driller, the Able Seaman, and the Master. Any or all of them could have taken charge of a lifeboat, and most were senior to the Bosun in the drillship's hierarchy. It is more probable that the Bosun had helped to prepare and launch the starboard lifeboat, then returned to the lounge.

The body of one of the Oilers was found near the lifeboat installation tangled in a line that apparently came from the drillship's line throwing gun. The Marine Board could find nothing to indicate why he was on the weather deck. However, among other things, it is possible that he was trying to reach a lifeboat or had helped to launch the starboard lifeboat.

The only significant argument against a lifeboat having been launched is that none has been found. That is not conclusive evidence. The lifeboat could have broken up - only the foam bouyancy cells were inherently buoyant. Although unlikely, a combination of unusual conditions could have caused it to sink. It could have washed up on some extremely remote shore. All are possible.

The Marine Board feels that the preponderance of evidence supports the probability that the emergency lifeboat radio was placed in the starboard lifeboat, that an undetermined number of persons boarded and launched that lifeboat, and subsequently used the emergency lifeboat radio to send one or more distress signals. The lifeboat and the persons aboard it are presumed lost at sea.

12. LIFEBOAT RADIO DEFICIENCY

The ITT Mackay 401a was one of three radio sets approved by the Federal Communications Commission (FCC) for use in lifeboats. However, information provided by the Commandant (G-MVI-3) and the FCC's Aviation and Marine Branch indicate that the 401A's approval for use in enclosed lifeboats was, in effect, withdrawn by the publication in the 11 October 1979 Federal Register of new standards for lifeboat radios for use in enclosed lifeboats. The deadline date for compliance with the new standards was 1 June 1980. The most significant change to the equipment requirements was with respect to the antenna. With the 401A radio a person had to climb onto the roof of the lifeboat to set up the antenna. The new standards provided for an antenna that could be set up completely from inside the lifeboat. The information provided by the Commandant and FCC indicate that the effective range of the 401A radio was unknown. The antenna installation had a major impact on the range, but there is no actual test data to show the operating range of the 401A in an enclosed lifeboat under different environmental conditions. It appears that under ideal conditions the radio's range may have been as little as 50 miles. Under the weather conditions the GLOMAR JAVA SEA experienced on the night of its loss, the radio's range was probably significantly less than 50 miles.

Another factor which affected the 401A radio's operation was grounding. The ground wire had to either be connected to a hull grounding plate or through-hull metal fixture or be deployed overboard.

In addition to their possible effects on the radio's range, deployment of the antenna and ground wire could have had significant effects on the seaworthiness of an enclosed lifeboat in that doors or hatches may have been opened. Neither the alternate Master, alternate Radio Officer, nor the other former Master had seen the radio deployed or the antenna rigged.

The lifeboat radio currently approved for use in enclosed lifeboats is the ITT Mackay Marine Type 403A. It was designed to allow erection of the antenna from inside the lifeboat. It appears that deployment of the ground wire may still have necessitated the opening of a door or hatch. And, its capabilities far surpass those of the 401A - in addition to radiotelegraph capabilities on 500 kHz and 8364 kHz, the 403A is capable of two-way radiotelephone (voice) communications and transmission of the two-tone radiotelephone alarm signal on 2182 kHz.

The fact that the GLOMAR JAVA SEA was not equipped with the proper portable emergency lifeboat radio was apparently unknown to or overlooked by everyone involved with the vessel, including the Federal Communications Commission. The drillship's station license issued by the FCC on 12 August 1982 and valid until 12 August 1985 lists the characteristics of the 401A rather than those of the 403A. The Coast Guard Marine Inspector who recertificated the drillship on 17 October apparently did not know of the change in the radio requirements. It is probable that few other maritime or regulatory personnel know that lifeboat radios other than the 403A are not suitable for use with enclosed lifeboats. The Marine Board feels that the current regulatory requirements for lifeboat radios should be made highly visible. The Marine Board also feels that significant emphasis should be placed on ensuring that marine personnel are thoroughly familiar with the procedures for and the problems and dangers inherent to setting up a lifeboat radio in an enclosed lifeboat.

13. LANGUAGE DIFFICULTIES

Thirty-eight of the eighty-one persons on board the GLOMAR JAVA SEA on 25 October 1983 were from countries where the primary language is other than English. Three of those persons -- one from the Phillipines and two from Singapore -- were subcontractor personnel. The other thirty-five were Chinese (drilling crew, service personnel, and trainees).

The testimony of alternate crew members indicates that while the language differences did pose some problems in communicating with the Chinese personnel, the problems were generally minor. There is nothing in the available evidence to indicate that any significant problems arose during normal operations as a result of the language differences. However, it is possible that under other circumstances, such as in an emergency when people might be excited or afraid the language differences could result in confusion and lead to improper or untimely action; especially if the number of interpreters is limited or the interpreters are not immediately available to relay directions and orders from key supervisory personnel.

14. TROPICAL STORM VERSUS TYPHOON

The fact that tropical storm "Lex" was not a "typhoon" received a great deal of attention during the testimony taken during the investigation. The weather forecasts provided to the drillship forecast maximum sustained winds of 60 kts with gusts to 75 kts. A "typhoon" is defined as having sustained winds of 64 kts or greater. Since "Lex" was not predicted to reach that stage it was classed as a severe tropical storm.

From the afternoon of 24 October through the evening of 25 October the drillship was experiencing wind conditions slightly less severe than those forecast. However, the wind velocities had continued to increase throughout that period and were still increasing during the evening of 25 October. In the 2348 telephone call to Houston persons on board the drillship reported winds of 75 kts. It is reasonable to assume that that reported wind velocity was either relatively constant or was at least an average velocity over a period of time rather than the velocity noted for isolated gusts.

It is evident that at some time prior to 2348, 25 October, the winds at the drill site exceeded typhoon strength, 64 kts, and by 2348 had increased to approximately 75 kts.

The continually increasing wind velocities throughout the day, especially when considered in light of the worse than forecast sea conditions, should have been an indication to persons on the drillship that the storm could well exceed the predicted strength, easily reaching typhoon strength. Yet there is no indication that anyone associated with the drillship took any action on the basis of that possibility.

CONCLUSIONS

The Casualty

1. At about 2351 local time on 25 October 1983, the drillship GLOMAR JAVA SEA capsized and, within minutes, sank in 317 feet of water. The drillship was approximately 100 yards southwest of its original anchored position when it capsized.

2. The proximate cause of the casualty cannot be determined. The most probable cause is capsizing due to severe environmental conditions: the impact of one or more unusually large waves, the passage of one or more unusually large swells, unusual wave or swell periods or sequences, or a combination of any or all of those factors, aggravated by the effects of typhoon-strength winds.

3. Contributing to the casualty was the significant starboard list which had been imposed on the drillship approximately 30 to 45 minutes before the 2348 telephone call to Global Marine's Houston, Texas, offices. The list had an adverse effect on the drillship's stability by shifting the center of gravity and the center of buoyancy and decreasing the range of positive stability to starboard. The list was most probably the result of the shifting of the drillship's cargo of drilling pipe, well casing, riser sections, and related materials.

4. Many of the weather deck accesses were not securely closed and dogged. It is possible that breaches in the watertight integrity because of improperly closed fittings or storm damage resulted in minor flooding which aggravated the starboard list and the resultant loss of stability by introducing both additional unbalanced loads and uncontrolled free surface effects.

5. The drillship's stability condition may have been adversely affected by attempts to correct the starboard list when the cause of that list was not known. Although required as a condition of the Coast Guard approval of the operating manual, Global Marine had not provided instructions to the Master cautioning against any attempt to correct any unusual list or trim when the cause was not known. That failure evidences a violation of 46 CFR 170.110 and has been referred to the Commander, Fourteenth Coast Guard District for further investigation.

6. The drillship capsized to starboard.

7. Of the eighty-one persons on board the GLOMAR JAVA SEA on 25 October 1983, the bodies of thirty-one were recovered and identified. The bodies of five others are in the wreck but could not be recovered for identification. The other forty-five persons are missing and presumed dead.

8. There is no evidence that a structural or material failure caused or contributed to the casualty.

9. There is no evidence that any act of misconduct, inattention to duty, negligence, incompetence, or willful violation of any law or regulation on the part of licensed or certificated personnel contributed to the casualty.

10. There is no evidence that any personnel of the Coast Guard or other government agency or any other person contributed to the casualty.

Weather

11. On 24 and 25 October 1983 the GLOMAR JAVA SEA was feeling the effects of tropical storm "Lex." At about 2400 on 25 October 1983, the eye of the storm passed almost directly over the drillship's position.

12. The actual path of tropical storm "Lex" consistently tracked to the south of the predicted path. On 24 and 25 October the actual path was almost directly toward the drill site.

13. By 0800, 25 October, sea conditions at the drill site were in excess of those forecast. The sea conditions continued to worsen throughout the day and were consistently worse than predicted. By late afternoon, the drillship was experiencing waves of 38 feet (more than twice the height predicted) and a swell of 30 feet; those conditions did not moderate throughout the evening.

14. Wind conditions at the drill site at 0800, 25 October, were just slightly less severe than forecast. The winds continued to worsen throughout the day. As the storm center neared the drill site, winds of at least 60 kts with gusts to 75 kts should have been anticipated. Judging from the actual versus forecast sea conditions, the Master of the GLOMAR JAVA SEA should have, by late that afternoon, foreseen the possibility that wind conditions significantly worse than those forecast might be experienced at the drill site that night.

15. At some time late in the evening of 25 October, the winds at the drill site reached typhoon proportions. By 2348 the sustained wind speed had climbed to 75 kts.

Evacuation

16. Neither Global Marine nor ARCO China had established definitions or guidelines for determining who on board the GLOMAR JAVA SEA would be considered "non-essential" personnel in the event evacuation was considered necessary. The Coast Guard had no requirement to establish such definitions or guidelines.

17. Evacuation of any part of the drillship's crew was not initiated because, on the basis of forecast weather conditions alone, neither the key personnel on board the drillship nor supervisory personnel ashore considered it necessary. If any personnel had been evacuated, the loss of life could have been reduced.

18. By the time the well was secured on 23 October, evacuation of nonessential personnel by helicopter was not feasible. The only evacuation sites were Sanya on Hainan Island and Vietnam. Neither of those sites was acceptable. Sanya was an unprotected harbor which lay in the predicted path of tropical storm Lex. Vietnam was unacceptable for political reasons.

19. By 1000, 24 October, the wind and sea conditions were such that evacuation by supply vessel could not have been accomplished safely. From that time on, evacuation could be accomplished only by using the drillship's lifesaving equipment.

Move Off Well Site

20. The GLOMAR JAVA SEA was not moved off the well site. How and when the decision to stay anchored was made and who made it are not known.

21. On the basis of the forecast weather conditions alone, the Master would not have deduced a need to get the drillship underway. Before 1330, 25 October, tropical storm "Lex" was predicted to pass well north of the drill site. Forecasts at 1330, 1630, and 1800 indicated "Lex" would pass within 30 miles of the drillship but would not strengthen above 60 kts. The 2230 forecast called for the storm to begin weakening. The drillship had in the past survived storm conditions worse than those predicted. And, even though the actual environmental conditions were worse than those forecast and the actual path of the storm was more directly toward the drill site, that knowledge would have minimized any concerns the Master may have had about remaining at anchor.

22. Had the GLOMAR JAVA SEA gotten underway, the effects of the storm may have been reduced. Considering the path of the storm, which could be approximated from the weather reports, and the proximity of Hainan Island to the north, Vietnam to the southwest, and shoal waters to the south, there were only two directions to sail to gain relief from the storm. The drillship could have moved to the northwest, into the lee of Hainan Island, an option which had been discussed between Captain Swanson and Captain Lester whom he had relieved. However, that track entailed the risk of sailing ahead of the storm and perhaps being overtaken by the storm in shallow open water. The other option was to run to the southeast. The swells were coming from 050°T all day on 25 October. The winds and waves, at least from 1600 on, were from about 335°T. The drillship could have put its stern to the wind and run at slow speed away from the storm track, into the "navigable semicircle" of the storm, that side of the storm track on which the winds and seas are less severe. This latter course of action would have been in line with procedures recommended by such authoritative texts as the American Practical Navigator (Bowditch), U.S. Navy Hydrographic Office Publication No. 9. In either case, maneuvering to find the best heading and speed would have been possible, and it is possible that the casualty may have been prevented.

Anchors and Chains

23. Anchor chains No. 2, 3, and 4 broke prior to the drillship capsizing.

24. Anchor chains No. 2, 3, and 4 each failed as the result of overloads in tension. The overloads were the direct result of the impact of one or more unusually large waves on the drillship or the passage of unusually large swells, unusual wave or swell sequences, or a combination of any or all of those factors.

25. Other than allowing the drillship to drift to the southwest, the failure of the anchor chains did not contribute to the capsizing. The anchors and chains served only to hold the drillship over the well site, not to hold it

upright. Thus the failure did not cause the loss of any righting force. Also, the locations of windlasses and fairleads were such that after the failures, the remaining chains did not impose any significant heeling or tripping loads on the hull.

26. The GLOMAR JAVA SEA had normal ship's electrical power available at the time of the casualty. The drillship thus had the capability to release the anchor chains from the master control panel on the navigation deck (04) level as well as from the forward and aft anchor windlass control stations. The anchor chains could have been released individually or simultaneously in a matter of seconds. None of the anchor chains was released.

27. The anchor pattern used at the drill site allowed the drillship's heading to be changed by as much as 30° to either side by taking in chain from some anchors and letting it out on others. Since normal power was available, such a change was possible. There is no evidence that the Master attempted to change the drill ship's heading to reduce the effects of the storm.

Manning

28. The Master was the only licensed deck officer on board the drillship. There were no other licensed deck officers available to the drillship on short notice, and even if available, there was no way to get such persons to the drillship after the weather began to deteriorate. If the drillship had had to get underway, the ability to navigate safely for more than a short period of time was severely impaired. Considering the severity of the weather and the drillship's motions, exhaustion would have become a significant factor in a very short period of time.

Language Differences

29. There is no evidence that the language difference and the resultant difficulty of communication between Chinese- and English-speaking crew members gave rise to any significant problems during the drillship's normal operations or in any way contributed to the cause or the severity of the casualty.

Material Condition

30. The GLOMAR JAVA SEA was designed and built in accordance with the Coast Guard regulations and the American Bureau of Shipping rules applicable to drillships at that time.

31. Structurally, the drillship's section modulus exceeded that required by the American Bureau of Shipping rules in effect, and adopted by the Coast Guard, at the time it was built.

32. The GLOMAR JAVA SEA satisfied the Coast Guard intact stability criteria and the American Bureau of Shipping intact and damage stability criteria in effect at the time it was built. (The Coast Guard did not have damage stability criteria for drillships at that time.)

33. With respect to design, GLOMAR JAVA SEA was structurally adequate to survive the sea conditions it experienced on 25 October 1983. The loads imposed on the drillship were only approximately one-half of the yield strength of the hull materials. Ships of similar design had survived worse conditions with, in general, little or no damage to equipment, only occasional anchor chain failure, and, infrequently, minor hull damage.

34. There were no significant material defects or deficiencies in the GLOMAR JAVA SEA's structure which affected the drillship's seaworthiness. All required inspections and surveys had been conducted within the prescribed time periods.

35. Wing tanks No. 6 and No. 7 starboard were empty at the time of the casualty.

Hull Damage

36. The hull damage noted during the wreck surveys was the result of the forces imposed on the drillship's structure by hydrostatic pressure as it sank and the impact when the drillship struck the sea floor.

37. The major structural deformations and fractures in the vicinity of frame 91 starboard occurred as the drillship was sinking rather than on the ocean surface. The yield strength of the hull plating was exceeded due to stresses imposed by the increasing hydrostatic pressure. As the drillship passed the 98-foot depth, the hull plating began to buckle because wing tanks No. 6 and 7 were empty. Watertight bulkhead No. 91 acted as a fulcrum as the bulkling plate wrapped around this stiffened bulkhead. The plating was stressed beyond its tensile limit in two weldment areas, and cracks initiated in those areas. The two cracks may not have occurred simultaneously. The cracks started as brittle fractures and developed into ductile fractures as they propagated. The cracks continued to run until the stresses diminished sufficiently to arrest them; this most likely occurred when the drillship rested on the ocean floor.

Lifesaving Equipment

38. All required lifesaving equipment was on board the drillship, and, with the exception of the hydraulic releases for two of the inflatable liferafts, all equipment had been inspected or had the required annual servicing performed within prescribed time frames.

39. There is evidence of violation of the vessel inspection regulations, 46 CFR 91.25-15(a)(8), regarding annual servicing of the hydraulic releases for the inflatable liferafts, on the part of the owner, operator, and Master of the GLOMAR JAVA SEA. This matter has been referred to the Commander, Fourteenth Coast Guard District, for further investigation.

40. One of the drillship's three inflatable liferafts was recovered. It was severely damaged, and all equipment and supplies were missing. How the damage and losses were sustained cannot be determined. Neither of the other liferafts nor the lifeboats have been found.

41. The damage to the components of the port lifeboat installation is attributed to the lifeboat being forcibly ripped from its stowed position. The nature of the damage indicates that it probably occurred as the result of massive overloading. If the boat had not been griped in, there would have been no way to impose a high load on those components. Whether the boat was torn free as the result of boarding seas before the drillship sank or as the result of the buoyant effect of the lifeboat as the drillship sank cannot be positively determined. The lack of damage to the components of the starboard

lifeboat installation indicates that that lifeboat was not forcibly ripped from its cradle.

42. The starboard lifeboat was deliberately released from its stowed position, boarded by an unknown number of persons who brought with them the portable emergency lifeboat radio, and was launched. The emergency radio was used to transmit at least one distress signal which, probably as the result of freak environmental conditions, was picked up by the merchant vessel WILLINE TOYO several hundred miles away. The lifeboat and those aboard it were subsequently lost at sea.

43. The lifeboats on board the GLOMAR JAVA SEA were designed to be self-righting when intact and to remain afloat even if damaged, flooded, and capsized. Thus, the capsized lifeboat spotted during the search was undoubtedly flooded. It may have been damaged as well. A potential source of flooding was the hatches at either end through which the falls passed. Also, it is possible that one or more openings into the lifeboat were opened to deploy the emergency radio antenna or ground wire. Flooding could also have resulted from damage. In any event, persons in the lifeboat would not have been able to right it. In the capsized condition, its value as a survival tool would have been minimal.

44. The portable emergency lifeboat radio on board the GLOMAR JAVA SEA was an ITT/Mackay Type 401A which was not approved by the Federal Communications Commission for use with enclosed lifeboats. The requirement for a different radio became effective more than three years before the casualty. This deficiency was overlooked during the most recent Federal Communications Commission inspection. It appears that the Coast Guard Marine Inspector who attended the drillship in October 1983 had not been informed of the change in the requirements.

45. There is evidence of violation of 47 CFR 83.472 with regard to portable emergency lifeboat radios, on the part of the owner and operator of the GLOMAR JAVA SEA. This matter has been referred to the Commandant (G-M) for referral to the Federal Communications Commission.

46. The effectiveness of the ITT/MACKAY Type 401A radio when deployed in the GLOMAR JAVA SEA's lifeboat cannot be determined. However, since a distress signal was picked up a considerable distance away, it must be concluded that having the wrong radio on board had no significant effect on the outcome of the casualty.

47. The EPIRB recovered during the search came from the GLOMAR JAVA SEA. It was fully operable when deployed. A signal transmitted by that EPIRB was picked up by two commercial airliners, but the position of the signal's source was not determined.

48. If the lifeboats and/or liferafts had been equipped with EPIRB's, the probability of locating them would have been improved.

49. The lifeboats were not properly exercised every three months as required by 46 CFR 109.217. The primary reason for failing to conduct these drills on schedule was the high risk of injury to personnel attempting to reconnect the lifeboat to the falls.

Communications

50. The communications center at ARCO China's Zhanjiang office was unmanned from 2300 to 2330 on 25 October 1983. The drillship attempted to contact Zhanjiang at 2300 presumably to report a problem. Because the station was unmanned, the report of a possible problem did not get to Zhanjiang until 2335 and was not passed to ARCO China personnel until an hour later. If that station had been manned, ARCO China personnel may have learned of the problem more than an hour earlier.

51. There were no formal communications schedules for the drillship. The drillship had been instructed by ARCO China to conduct hourly checks with the shore bases and the supply vessel during the storm, but no such checks were being made. The lack of a formal schedule had no impact on the casualty. Persons on the drillship made contact with the shore bases and the attending supply vessel at least six times between 2210 and 2315, and in none of those communications was any problem reported.

52. The loss of life might have been reduced if the NANHAI 205 had maintained a radio watch on the single side band (SSB) radio on 25 October 1983. The supply vessel crew routinely turned off the SSB radio at night and when just standing by the drillship. And, although they could communicate with the drillship via the VHF radio, they could not receive communications from either Zhanjiang or TianDu. Further, there were no regular communications schedules for the vessels or shore bases. As a result, there were more than seven hours lost between the time TianDu lost contact with the GLOMAR JAVA SEA and the time the NANHAI 205 was finally contacted. During that time, the supply vessel was sailing away from the drill site, and the distance back was much greater than it might otherwise have been. If constant radio contact had been maintained, the NANHAI 205 could have been sent to the scene shortly after radio contact with the drillship was lost. It might not have been able to rescue personnel leaving the drillship, but at least it could have sounded the alarm to alert the shore stations that a problem existed, thus setting the search and rescue operations in motion much sooner.

53. There were no established procedures for action to be taken at Zhanjiang, TianDu, or Houston if communications with the drillship were lost. The radio operator at TianDu began trying to contact his superior to report the problem just eight minutes after losing contact. Since he could not reach Zhanjiang, he did little else. The radio operator at Zhanjiang learned of the problem at 2335, but ARCO China officials were not informed until about one hour later. Once notified, they tried to contact the drillship but did nothing else. Global Marine personnel were in contact with the drillship when communications were cut off. They tried for four hours to reestablish contact, then reported the problem to the Coast Guard in San Francisco. With the time it took to get the necessary information to WESTPAC RCC and actually get SAR forces to the drill site, that four-hour delay probably made no difference in the outcome of the casualty. However, if persons at TianDu or Zhanjiang had notified Chinese authorities directly and promptly, it may have been possible to get local forces to the drill site sooner and, possibly, reduce the loss of life.

54. The GLOMAR JAVA SEA contacted Global Marine's offices in Houston, Texas, via satellite telephone link at 2348, 25 October 1983. The Marine Board estimates that the conversation lasted only 2 to 3 minutes before being abruptly cut off. The most probable cause of the loss was a sudden change in

the drillship's heading or attitude which caused the MARISAT antenna to lose track of the satellite. It is probable that contact with the satellite was lost as the drillship began to capsize.

55. One distress signal transmitted by the drillship's EPIRB was received by two commercial aircraft. One distress signal transmitted by persons using the portable emergency lifeboat radio was received by a merchant vessel. No other distress signals were received. It is unlikely that any distress signal was transmitted from the drillship itself.

Search and Rescue

56. The search and rescue (SAR) activities were hampered by the language and communications equipment differences among the various SAR forces, as well as by environmental conditions. However, the overall search efforts were handled such that the adverse effects of those factors were minimized and the probability of detection of survivors was at least 90%.

57. The crews of the U.S. Navy and U.S. Air Force planes, Chinese Navy ships, and the helicopters and ships of CNOOC, British Petroleum, and other companies that participated in the search risked their lives in that undertaking. The severity of weather conditions not only made the search more difficult but resulted in damage to some of the vessels. The efforts of those persons, in particular, and everyone else involved in the search effort were as complete and thorough as possible and are admirable.

RECOMMENDATIONS

It is recommended that:

1. The Coast Guard reexamine the minimum manning scales for drillships while moored and working to ensure that enough qualified personnel are available to allow the ship to get underway in an emergency. This issue is of particular concern for drillships operating in remote areas where additional qualified personnel are not immediately available under all conditions. The Marine Board feels that at least two qualified deck watch officers should be on board, since, as with the GLOMAR JAVA SEA, it may not be possible to bring other personnel to the ship even if they are available ashore. A vessel's ability to get underway for more than a few hours is severely limited if only one deck watch officer is on board.

2. The Coast Guard look into the apparent practice of some marine drilling companies counting members of the drilling crew who hold Merchant Mariner's Documents toward the complement of certificated seamen required by the Certificate of Inspection. Persons serving or employed in any capacity other than as a member of the marine crew or for any reason not available full-time for watch-standing duties should not be credited toward required manning levels, with the exception of lifeboatmen.

3. The Coast Guard reemphasize to the maritime community the need for routine communications checks on a regular basis for vessels operating in remote areas and during adverse weather. Support vessels operating in or near the same area and shoreside support stations should be included in the checks. Vessel operators should be encouraged to develop formal guidelines for actions to be taken by shoreside personnel and support vessels in the event an emergency arises or communications are suddenly lost.

4. The Coast Guard reexamine current regulatory requirements for lifeboat drills and lifeboatman certification. It appears that environmental conditions may often preclude conducting full drills at sea. Further, it is safe to assume that all lifeboat equipment, such as emergency lifeboat radios and antenna, is not routinely deployed and checked in service. The ideal place to conduct such drills is in port. However, on modern vessels, port calls are generally of very short duration and often hectic with crew changes and ship's business. Also, many vessels such as drillships and other drilling units may only rarely enter port. Thus, some other solution is needed. Another concern is the wide range of lifeboat and liferaft types and designs on modern vessels. An experienced seaman can easily find himself confronted with lifesaving equipment he has never seen before.

The Marine Board feels that the solution to these problems may be the development of formal training standards for lifeboatmen. Training could be through a program similar to that now available for Radar Observer endorsements on deck officers' licenses or through certified company-run training programs. It would include "hands on" training, possibly a formal examination, certification by the Coast Guard, and periodic requalification. The certification would describe the type of equipment the individual is qualified to handle. This would ensure that at least one or two individuals on a vessel would have seen the equipment in operation. Requirements for

periodic drills would remain along with requirements for operational tests of emergency equipment. The overall effect would be to enhance the crewmembers' abilities to survive in an abandon ship situation without adversely affecting vessel schedules or causing delays while drills are conducted in port.

5. That current regulatory requirements for the annual servicing of hydraulic releases for inflatable liferafts be revised. The current requirement is not nearly as visible as the servicing requirement for the liferafts themselves; thus it is probably overlooked more often than would be expected. This is especially true when rafts are serviced overseas. The Marine Board feels that a potential solution is to make the hydraulic release a required part of the equipment for any inflatable liferaft. The release could be permanently or at least securely affixed to the raft or its container. When the raft is removed from the vessel for servicing, the hydraulic release would go with it. Servicing and inspection would be accomplished on the liferaft and release simultaneously and would eliminate deficiencies such as that noted on the GLOMAR JAVA SEA.

6. Requirements for outfitting primary lifesaving equipment with EPIRB's be implemented as soon as practicable. The Marine Board is aware that current lifesaving equipment requirements of both SOLAS and Coast Guard regulations are undergoing major revision and that requirements for additional EPIRB's will be included in the new regulations. Consideration should be given to making those requirements applicable retroactively to existing vessels. The possible benefits accruing from such a requirement were recognized by the families of several members of the GLOMAR JAVA SEA's crew, and recommendations to that effect were submitted to the Marine Board. Those recommendations were forwarded to the Commandant for consideration.

7. The Coast Guard and lifeboat manufacturers investigate the possibility that personnel attempting to reconnect the falls on covered or enclosed lifeboats are exposed to significant risk of personal injury. If such risk exists, design changes for new boats or modifications for existing boats may be necessary or desirable.

8. The Coast Guard and the Federal Communications Commission make the current requirements for emergency lifeboat radios and the differences between the requirements for open lifeboats and enclosed lifeboats more visible for both vessel inspection personnel and the marine community. To the knowledge of the Marine Board, there are only three lifeboat radios currently approved, and only one of those is approved for enclosed lifeboats. However, it is apparent that even that basic information is not well known in either government or industry sectors and cannot be readily determined from current FCC regulations. Further, since radio equipment inspections on U.S.-flag vessels may be conducted by foreign governments acting on behalf of the United States, the FCC should ensure than any other agency which might act on its behalf is fully apprised of the current equipment requirements.

9. The Coast Guard initiate whatever action is necessary to effect a complete review by both regulatory bodies and equipment manufacturers of current requirements and standards for both enclosed lifeboats and emergency lifeboat radios. The purpose of such a review would be to consider possible changes to lifeboat design and/or radio equipment which would eliminate the need for any hatches or doors to be open to accommodate the falls, radio antennas, ground wires, or any other equipment. The lifeboat should be capable of being made

watertight immediately upon boarding and maintained in that condition after launching.

10. The Coast Guard amend the current regulations pertaining to operating manuals for mobile offshore drilling units to include:

a. a definition of "non-essential personnel", and

b. requirements for

(1) identifying those persons who can be considered "non-essential" during each stage of the preparations for passage of a severe storm,

(2) developing, for each drilling locale, specific guidelines, keyed to prevailing weather and storm patterns, for determining whether or not partial or complete evacuation is necessary or desirable,

(3) direct evacuation when environmental conditions approach the design limits for the unit, and

(4) specific procedures for actually conducting a partial or complete evacuation during each stage of storm preparations.

11. In the absence of specific Federal regulations, all mobile offshore drilling unit operators:

a. examine, and revise as necessary, the severe weather preparations sections of unit operating manuals to ensure that they provide adequate guidance for unit personnel to -

(1) identify and designate, for each stage of storm preparations, "non-essential personnel",

(2) determine, for the current work site, on the basis of forecast weather conditions and prevailing storm patterns, the likelihood that evacuation may be desirable or necessary or unit design limits approached, and

(3) actually conduct a full or partial evacuation at any stage of storm preparations,

b. recognize that current Federal regulations require that unit operating manuals address preparations for the passage of any severe storm, not just one that has actually reached hurricane or typhoon status, and

c. ensure that all marine crew, drilling crew, and supervisory personnel understand that storm plans and prescribed preparatory actions apply to all potentially severe storms whether or not they actually have or are forecast to reach hurricane or typhoon strength.

12. All drillship operators examine the command structure on all drillships to ensure that one individual is clearly identified as the absolute authority on board. The very character of a drillship demands, for all matters other than well control, that that individual must be the Master. All written directives -- operting manuals, procedure manuals, etc. -- should reflect that

assignment of authority. And, more importantly, all operating personnel must understand and accept it.

13. The Coast Guard amend the regulations in 46 CFR 109.107 to require that on all self-propelled mobile offshore drilling units, and particularly drillships, the licensed Master required by the Certificate of Inspection be the individual designated as "person in charge".

14. This investigation be closed.

[redacted]

W. W. McDOUGALL
Captain
U.S. Coast Guard
Chairman

[redacted]

D. H. WHITTEN
Captain
U.S. Coast Guard
Member

[redacted]

T. B. RODINO
Lieutenant Commander
U.S. Coast Guard
Member and Recorder

TABLE 1: LOCATIONS OF BODIES

Body	ID #	Name (Nationality)	Position	Location
1	1	Edward L. Ganzinotti (USA)	Floorman	Poop Deck Lounge
2	2	Tyronne Higgins (USA)	Oiler	Boat Deck at Lifeboat Area
3	3	Donald J. Ouellet (USA)	Oiler	Poop Deck Lounge
4	4	Kenneth B. Rogers (USA)	Bosun	Poop Deck Lounge
5	5	Zhou Jie Fang (PRC)	Roustabout	Poop Deck Lounge
6	6	Xu Hui (PRC)	Roughneck	Poop Deck Lounge
7	7	Zhou Shu Rong (PRC)	Roughneck	Poop Deck Lounge
8	8	Jacob Chong Kim Joo (Sing.)	Cementer	Poop Deck Lounge
9	9	Terrence C. Green (G.Br.)	Mud Logger	Poop Deck Lounge
10	10	Russell E.J. Reynolds (USA)	Asst. Engineer	Poop Deck Lounge
11	11	Feng Shao Jian (PRC)	Roustabout	Boat Deck Passageway
12	12	Jerry L. Manfrida (USA)	Geologist	Boat Deck Passageway
13	13	Edgor Saplad Lim (Phil.)	Cementer	Boat Deck SR 20
14	14	Chen Wei (PRC)	Trainee Welder	Boat Deck SR 20
15	15	Timothy Jarvis (G.Br.)	Mud Logger	Boat Deck SR 20
16	16	Xia Jing Sheng (PRC)	Ordinary Seaman	Boat Deck SR 17
17	17	Henry Marion Gittings (USA)	Steward	Boat Deck SR 17
18	18	Zhang Xing Zhen (PRC)	Asst. Derrickman	Boat Deck SR 17
19	19	Michael W. Thomas (USA)	Crane Operator	Boat Deck SR 20
20	20	John W. Jennings, Jr. (USA)	Storekeeper	Boat Deck SR 19
21	21	Raymond D. Miller (USA)	Diving Supvsr.	Boat Deck SR 19
22	22	Guan Jun Tian (PRC)	Interpreter	Boat Deck SR 19
23	23	James C. Sleeman (G.Br.)	Mud Logger	Boat Deck SR 17
24	24	Kevin C. Swanson (USA)	Floorman	Boat Deck SR 16
25	25	---	---	Boat Deck SR 16
26	26	Mo Tian Jie (PRC)	Cook	Boat Deck SR 14
27	27	Gerald T. Batiste (USA)	Electrician	Boat Deck SR 14
28	X1	Albert G. Gilmore (USA)	Medic	Superstructure Deck SR 13
29	X2	David P. Clifton (USA)	Tool Pusher	Superstructure Deck SR 10
30	X3	David Higgins, Jr. (USA)	Cook	Superstructure Deck SR 12/13
31	X4	Robert M. McCurry (USA)	Asst. Derrickman	Superstructure Deck SR 12
32	X5	Li Xuan Qiu (PRC)	Cook	Main Deck Steward's Stores

TABLE 2: DRILLSHIP EXPERIENCE IN SEVERE WEATHER

Drillship	Date (Mo/Yr)	Length (Feet)	Beam (Ft)	Draft (Ft)	Water Depth (Feet)	Wind (Kts)	Waves (Ft)	Swell (Ft)	Riser Connected	Continued Drilling	Number of Anchors Out	Dynamic Positioning	Underway	Damage
OCEAN TEMPEST	7/79	379'6"	70'	19'	90'	55-65	25-30'	-	No	No	4	No	No	Minimal; due solely to drill collars breaking loose
BEN OCEAN LANCER	9/78	504'10"	77'10"	26'	1,804'	85	30'	24'	Yes	No	-	Yes	No	None
OCEAN CYCLONE	8/83	360'	70'	17'10"	312'	45-65	12'	25-30'	Yes	Yes	8	No	No	Riser tensioner system damaged; 2 anchor fairleads lost; 4 anchor cables parted
J. W. BATES	1/73	639'	77'	35'	501'	60	20'	-	Yes	Yes	7	No	No	1 anchor chain parted
PACHORSE 1	12/80	502'	75'	26'	470'	82	38'	-	No	No	-	Yes	No	Minimal damage to exposed equipment
" "	1/81	502'	75'	26'	470'	78	30'	-	No	No	-	Yes	No	None
NEDDRILL 2	7/83	540'9"	89'9"	29'	1,485'	65	7-10'	18-20'	No	No	-	Yes	No	None
NEDDRILL 1	3/84	495'	89'9"	27'6"	237'	100	10'	14'	No	No	8	No	No	Minimal damage to exposed equipment
DISCOVERER 511	12/81	488'	70'	26'	1,750'	46	20-25'	25-30'	Yes	Yes	8	No	No	None
INTEROCEAN DISCOVERER	8/83	380'	70'	18'	390'	55	24'	28'	No	No	8	No	No	None
DISCOVERER III	5/76	380'	70'	18'10"	450'	55-70'	15-20'	-	No	No	8	No	No	None
DISCOVERER 534	2/79	486'	80'	24'9"	-	50-70	50'	-	No	No	-	No	Yes	Minor damage to exposed equipment
DISCOVERER SEVEN SEAS	1/83	534'	80'	24'	4,090'	65	14'	15'	Yes	Yes	-	Yes	No	Negligible
" " "	9/80	534'	80'	24'	4,508'	70	30'	35'	No	No	-	Yes	No	Minor hull cracks at bow thruster; damage to exposed equipment
" " "	1/81	534'	80'	24'	2,714'	72	14'	16'	Yes	Yes	-	Yes	No	Lost riser below slip joint
" " "	11/82	534'	80'	24'	5,624'	50	15'	12'	No	No	-	Yes	Yes	None
" " "	12/83	534'	80'	24'	6,448'	50	15'	16'	Yes	Yes	-	Yes	No	Negligible

TABLE 3: MANNING REQUIREMENTS

Required Crew	Underway in Normal Navigation	Navigating Not Over 16 Hours Between Drill Sites	On Location Not Navigating
Master	1	1	1
Chief Mate	1	1	-
2nd Mate	1	-	-
3rd Mate	1	-	-
Radio Officer	1	1	-
Able Bodied Seamen	4	3	2
Ordinary Seamen	2	1	1
Chief Engineer	1	1	1
1st Asst Engineer	1	1	-
2nd Asst Engineer	1	-	-
3rd Asst Engineer	1	-	-
Oilers	3	2	2
Optional Manning			
Other Persons in the Crew	10	10	10
Industrial Personnel	36	43	93
Total Persons Allowed	64	64	110
Lifeboatmen Required to be included in Total	7	7	7

APPENDIX A: Crewmember Data

1. Name: [redacted]

   a. Nationality: U.S.A.
   b. Position: Derrickman
   c. Employer: Global Marine Drilling Company
   d. Date of Birth: [redacted]
   e. SSAN: [redacted]
   f. MMD: None
   g. License: None
   h. Status: Missing

2. Name: Gerald T. Battiste

   a. Nationality: U.S.A.
   b. Position: Electrician
   c. Employer: Global Marine Drilling Company
   d. Date of Birth: [redacted]
   e. SSAN: [redacted]
   f. MMD: None
   g. License: None
   h. Status: Deceased

3. Name: [redacted]

   a. Nationality: U.S.A.
   b. Position: Toolpusher
   c. Employer: Global Marine Drilling Company
   d. Date of Birth: [redacted]
   e. SSAN: [redacted]
   f. MMD: Ordinary Seaman; Wiper; Lifeboatman
   g. License: None
   h. Status: Missing

4. Name: [redacted]

   a. Nationality: U.S.A.
   b. Position: Sub-Sea Engineer
   c. Employer: Global Marine Drilling Company
   d. Date of Birth: [redacted]
   e. SSAN: [redacted]
   f. MMD: Any Unlicensed Rating in the Engine Department; Lifeboatman
   g. License: None
   h. Status: Missing

5. Name: David P. Clifton

   a. Nationality: U.S.A.
   b. Position: Toolpusher
   c. Employer: Global Marine Drilling Company
   d. Date of Birth: [redacted]
   e. SSAN: [redacted]
   f. MMD: Ordinary Seaman; Wiper; Lifeboatman
   g. License: None
   h. Status: Deceased

6. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Crane Operator
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Ordinary Seaman; Wiper; Steward's Department; Food Handler
g. License: None
h. Status: Missing

7. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Assistant Diving Supervisior
c. Employer: SubSea International, Inc.
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Missing

8. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Radio Officer
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Radio Officer
g. License: Radio Telegraph Operator
(Also FCC Certificate as First Class Radio Telegraph Operator)
h. Status: Missing

9. Name: Edward L. Ganzinotti

a. Nationality: U.S.A.
b. Position: Floorman
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Ordinary Seaman; Wiper; Steward's Department; Food Handler
g. License: None
h. Status: Deceased

10. Name: Albert G. Gilmore

a. Nationality: U.S.A.
b. Position: Medic
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Deceased

11. Name: Henry Marion Gittings

a. Nationality: U.S.A.
b. Position: Steward
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Ordinary Seaman; Wiper; Steward's Department; Food Handler; Lifeboatman
g. License: None
h. Status: Deceased

12. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Able Bodied Seaman
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Able Seaman (Special); Wiper; Steward's Department; Lifeboatman
g. License: None
h. Status: Missing

13. Name: David Higgins, Jr.

a. Nationality: U.S.A.
b. Position: Cook
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Deceased

14. Name: Tyronne Higgins

a. Nationality: U.S.A.
b. Position: Oiler
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Ordinary Seaman; Oiler (Diesel Only)
g. License: None
h. Status: Deceased

15. Name: John W. Jennings, Jr.

a. Nationality: U.S.A.
b. Position: Storekeeper
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Deceased

16. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Assistant Engineer
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Any Unlicensed Rating in the Engine Department; Lifeboatman
g. License: Second Assistant Engineer of Motor Vessels of Any Horsepower; Third Assistant Engineer of Steam Vessels of Any Horsepower
h. Status: Missing

17. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Assistant Rig Manger, Zhanjiang, China Office
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Missing

18. Name: Jerry L. Manfrida

a. Nationality: U.S.A.
b. Position: Geologist
c. Employer: ARCO China Inc.
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Deceased

19. Name: Robert M. McCurry

a. Nationality: U.S.A.
b. Position: Assistant Derrickman
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Deceased

20. Name: Raymond D. Miller

a. Nationality: U.S.A.
b. Position: Diving Supervisor
c. Employer: SubSea International
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Deceased

21. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Derrickman
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Missing

22. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Sales Engineer (Drilling Mud)
c. Employer: Dresser Industries, Inc.
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Missing

23. Name: Donald J. Ouellet

a. Nationality: U.S.A.
b. Position: Oiler
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Ordinary Seaman; Wiper; Steward's Department; Food Handler; Oiler
g. License: None
h. Status: Deceased

24. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Assistant Derrickman
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Missing

25. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Chief Engineer
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Any Unlicensed Rating in the Engine Department
g. License: Chief Engineer of Motor Vessels of Any Horsepower
h. Status: Missing

26. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Drilling Supervisor
c. Employer: ARCO China Inc.
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Able Seaman; Any Unlicensed Rating in Deck Department of Column Stabilized or Self-elevating Motor Drilling Vessels; Lifeboatman
g. License: Master of Column Stabilized or Self-elevated Motor Drilling Vessels of Any Gross Tons Upon Oceans Under Tow or Engaged in M & O Exploration; Radar Observer (Expired 9/21/81)
h. Status: Missing

27. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Driller
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Ordinary Seaman; Wiper; Lifeboatman
g. License: None
h. Status: Missing

28. Name: Russel E.J. Reynolds

a. Nationality: U.S.A.
b. Position: Assistant Engineer
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Any Unlicensed Rating in the Engine Department; Lifeboatman
g. License: Chief Engineer of Motor Vessels of Any Horsepower
h. Status: Deceased

29. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Electronic Technician
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Missing

30. Name: Kenneth B. Rogers

a. Nationality: U.S.A.
b. Position: Bosun
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Able Seaman; Wiper
g. License: None
h. Status: Deceased

31. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Driller
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Ordinary Seaman; Wiper; Steward's Department; Food Handler
g. License: None
h. Status: Missing

32. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Rig Mechanic
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Ordinary Seaman; Wiper
g. License: None
h. Status: Missing

33. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Diver
c. Employer: SubSea International, Inc.
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Missing

34. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Drilling Superintendent
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Missing

35. Name: [redacted]

a. Nationality: U.S.A.
b. Position: Master
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: Any Unlicensed Rating in the Deck Department;
Unlimited Able Seaman, Any Waters
g. License: Master of Ocean Steam and Motor Vessels of Any Gross Tons
with Radar Observer endorsement
h. Status: Missing

36. Name: Kevin C. Swanson

a. Nationality: U.S.A.
b. Position: Floorman
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Deceased

37. Name: Michael W. Thomas

a. Nationality: U.S.A.
b. Position: Crane Operator
c. Employer: Global Marine Drilling Company
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. MMD: None
g. License: None
h. Status: Deceased

38. Name: [redacted]

a. Nationality: Australia
b. Position: Senior Field Engineer (Well Logging)
c. Employer: China Offshore Services, S.A.
d. Date of Birth: [redacted]
e. Passport: Western Australia [redacted]
f. Status: Missing

39. Name: [redacted]

a. Nationality: Canadian
b. Position: Drilling Engineer
c. Employer: ARCO China Inc.
d. Date of Birth: [redacted]
e. SSAN: [redacted]
f. Status: Missing

40. Name: Edgar Saplad Lim

a. Nationality: Philippines
b. Position: Cementer
c. Employer: Halliburton Services
d. Date of Birth: [redacted]
e. Passport: Philippines [redacted]
f. Status: Deceased

41. Name: Jacob Chong Kim Joo

a. Nationality: Singapore
b. Position: Cementer
c. Employer: Halliburton Services
d. Date of Birth: [redacted]
e. Passport: Singapore [redacted]
f. Status: Deceased

42. Name: [redacted]

a. Nationality: Singapore
b. Position: Diver
c. Employer: SubSea International, Inc.
d. Date of Birth: [redacted]
e. Passport: Singapore [redacted]
f. Status: Missing

43. Name: [redacted]

a. Nationality: United Kingdom (Great Britain)
b. Position: Mud Logging Service
c. Employer: The Analysts Overseas Services, S.A.
d. Date of Birth: [redacted]
e. Passport: United Kingdom [redacted]
f. Status: Missing

44. Name: Terence C. Green

a. Nationality: United Kingdom (Great Britain)
b. Position: Mud Logging Service
c. Employer: The Analysts Overseas Services, S.A.
d. Date of Birth: [redacted]
e. Passport: United Kingdom [redacted]
f. Status: Deceased

45. Name: Timothy Jarvis

a. Nationality: United Kingdom (Great Britain)
b. Position: Mud Logging Service
c. Employer: The Analysts Overseas Services, S.A.
d. Date of Birth: [redacted]
e. Passport: United Kingdom [redacted]
f. Status: Deceased

46. Name: James C. Sleeman

a. Nationality: United Kingdom (Great Britain)
b. Position: Mud Logging Service
c. Employer: The Analysts Overseas Services, S.A.
d. Date of Birth: [redacted]
e. Passport: United Kingdom [redacted]
f. Status: Deceased

47. Name: Chen Wei

a. Nationality: Peoples Republic of China
b. Position: Trainee Welder
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Deceased

48. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Utilityman
c. Employer: China Nanhai Oil Joint Service Co. (CNOJS)
d. Status: Missing

49. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Utilityman
c. Employer: China Nanhai Oil Joint Service Co. (CNOJS)
d. Status: Missing

50. Name: Feng Shao Jian

a. Nationality: Peoples Republic of China
b. Position: Roustabout
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Deceased

51. Name: Guan Jun Tian

a. Nationality: Peoples Republic of China
b. Position: Interpreter
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Deceased

52. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Roughneck
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

53. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Utilityman
c. Employer: China Nanhai Oil Joint Service Co. (CNOJS)
d. Status: Missing

54. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Diver
c. Employer: China Ocean Engineering
d. Status: Missing

55. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Roustabout
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

56. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Diver
c. Employer: China Ocean Engineering
d. Status: Missing

57. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Drilling Engineer (Assigned to ARCO)
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

58. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Roustabout
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

59. Name: Li Xuan Qiu

a. Nationality: Peoples Republic of China
b. Position: Cook
c. Employer: China Nanhai Oil Joint Service Co. (CNOJS)
d. Status: Deceased

60. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Cementer
c. Employer: Nan Hai West Cementing Co.
d. Status: Missing

61. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Geologist (Assigned to ARCO)
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

62. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Roustabout
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

63. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Utilityman
c. Employer: China Nanhai Oil Joint Service Co. (CNOJS)
d. Status: Missing

64. Name: Mo Tian Jie

a. Nationality: Peoples Republic of China
b. Position: Cook
c. Employer: China Nanhai Oil Joint Service Co. (CNOJS)
d. Status: Deceased

65. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Interpreter
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

66. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Roustabout
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

67. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Radio Operator
c. Employer: China Nanhai Oil Joint Service Co. (CNOJS)
d. Status: Missing

68. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Radio Operator
c. Employer: China Nanhai Oil Joint Service Co. (CNOJS)
d. Status: Missing

69. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Oiler
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

70. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Roughneck
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

71. Name: Xia Jing Sheng

a. Nationality: Peoples Republic of China
b. Position: Ordinary Seaman
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Deceased

72. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Utilityman
c. Employer: China Nanhai Oil Joint Service Co. (CNOJS)
d. Status: Missing

73. Name: Xu Hui

a. Nationality: Peoples Republic of China
b. Position: Roughneck
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Deceased

74. Name: Xu Ming Rui

a. Nationality: Peoples Republic of China
b. Position: Mud Logging Services
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

75. Name: Zhang Xing Zhen

a. Nationality: Peoples Republic of China
b. Position: Assistant Derrickman
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Deceased

76. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Ordinary Seaman
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

77. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Roustabout
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

78. Name: Zhou Jie Fang

a. Nationality: Peoples Republic of China
b. Position: Roustabout
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Deceased

79. Name: Zhou Shu Rong

a. Nationality: Peoples Republic of China
b. Position: Roughneck
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Deceased

80. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Roustabout
c. Employer: Nan Hai West Oil Co. (NHWOC)
d. Status: Missing

81. Name: [redacted]

a. Nationality: Peoples Republic of China
b. Position: Diver
c. Employer: China Ocean Engineering
d. Status: Missing

APPENDIX B: Witness Data

[redacted], Alternate Chief Engineer, GLOMAR JAVA SEA

Mr. [redacted] was [redacted] years old. He held a license as Chief Engineer of Steam and Motor Vessels of Any Horsepower. He had been employed by Global Marine, in the capacity of Chief Engineer, for seven years. He was last onboard the drillship for the 4-week period ending 20 October 1983 and participated in the Coast Guard inspection and ABS surveys conducted 13-17 October.

[redacted], Logistics Superintendent, ARCO China Inc., Zhanjiang

Mr. [redacted] was the ARCO liaison representative dealing with the Chinese companies that operated the work boats and the helicopters. He was a party to conversations with Chinese and ARCO China officials about the approaching storm and its possible effect on the drillship.

[redacted], Rig Manager, Global Marine Drilling Company, Zhanjiang

Mr. [redacted] was the shore-based rig manager for the GLOMAR JAVA SEA. As such, he was responsible for the operation of the vessel. His office was located in Zhanjiang on the Chinese mainland north of Hainan Island. He supervised an assistant rig manager, a materials man, an accountant, and a clerical staff, and reported directly to the drilling group vice-president.

Mr. [redacted] started working offshore, on a drilling platform, in 1969. He stayed on that job until joining Global Marine in 1972. He started as a crane operator, then assistant derrickman, and worked his way up through drilling superintendent. He was promoted to rig manager and assigned to the GLOMAR JAVA SEA in May, 1982. He had been in Zhanjiang since January, 1983. All of his experience with Global Marine had been on drillships. Mr. [redacted] was not in his office on 25 October 1983. He left Zhanjiang on 22 October to return to the United States for medical treatment. He returned to Zhanjiang soon after the casualty but played no significant part in the search and rescue activities.

[redacted], Vice-President of Engineering and Construction,
Global Marine Drilling Company, Houston

Mr. [redacted] was one of the Global Marine representatives onboard the survey vessel during the wreck survey in March, 1984. He coordinated the cutting of coupons (plate samples) from the hull of the drillship. He also supervised the preparation of a chart showing the final location of the drillship, its anchors, and debris from the drillship.

[redacted], Operations Manager, ARCO China Inc., Zhanjiang

Mr. [redacted] was responsible for directing the actual drilling operation, purchasing and handling of materials, and logistics in general. After the casualty he helped to arrange and coordinate the search activities particularly with respect to resources available to ARCO (workboats and helicopters).

[redacted], Project Manager, Global Marine Drilling Company, Houston

Mr. [redacted] was [redacted] years old. He graduated from the U.S. Naval Academy in [redacted]. He spent 31 years in the Navy, mostly in engineering jobs. He held Masters degrees in naval architecture and marine engineering. He had been employed with Global Marine for 10 years, the last 3 1/2 as project manager on the drillship GLOMAR CHALLENGER. Using data collected during the investigation he reconstructed the loading and stability conditions for the GLOMAR JAVA SEA on 25 October 1983; those were used as a base for further studies.

[redacted] Chief Geophysicist, ARCO China Inc., Zhanjiang

Mr. [redacted] was responsible for locating the exact spot where wells were to be drilled, well site surveys, seismic work, rig location, and navigation matters. After the casualty he helped to coordinate communications, set up fathometer and side scan sonar surveys of the ocean bottom at the drill site, and set up plans for the search. He maintained records and plots of search patterns, debris recovered, and all significant developments/reports associated with the search activities.

LT [redacted] Falkenstein, U.S. Coast Guard

Lt [redacted] was commissioned in [redacted]. From 1978 to 1982 he was assigned to the Marine Inspection Office in New Orleans, LA. He was reassigned to the Marine Safety Office in San Francisco, CA in August, 1982. He spent approximately a year conducting inspections on drilling vessels offshore and a little over a year on other types of inspections. He conducted the last drydock examination on the GLOMAR JAVA SEA in November 1982.

[redacted], Drilling Superintendent, ARCO China Inc., Zhanjiang

Mr. [redacted] was based at Zhanjiang. He was responsible for supervising the actual drilling operation on behalf of ARCO China Inc. The ARCO drilling supervisor and drilling engineer onboard the GLOMAR JAVA SEA reported to him. He had had extensive experience with offshore drilling operations. He was a party to conversations with Chinese officials about typhoon Lex and its possible effect on the drillship. After the casualty he helped to coordinate and direct the movement of the Chinese workboats and helicopters involved in the search.

[redacted] Marine Project Superintendent,
Global Marine Drilling Company, Houston

Mr. [redacted] was [redacted] years old. He was a mechanical engineer who held a license as Third Assistant Engineer of Steam Vessels. He had served in the Navy, sailed under his license, and worked as an ABS Surveyor. His duties with Global Marine included preparation of repair specifications and drydocking plans and attending vessels during shipyard periods. He attended the GLOMAR JAVA SEA during its last drydocking in November 1982. He participated in the surveys of the wreck site and the wreck in November, 1983 and March, 1984.

[redacted] Senior Drilling Supervisor, ARCO China Inc., Zhanjiang

Mr. [redacted] was the alternate drilling supervisor for the GLOMAR JAVA SEA. He had worked on the vessel periodically since 1976. He was in the United States, off duty, when the drillship sank. After the casualty he participated in the initial survey of the wreck site.

[redacted] Manager of Safety and Training
Global Marine Drilling Company, Houston

Mr. [redacted] was the head of the Safety and Training Department. He was responsible for developing and maintaining Global Marine's internal school program and on-the-job training program. He was also responsible for maintaining the company's safety program.

[redacted] American Bureau of Shipping Surveyor, Hong Kong

Mr. [redacted], a citizen of Hong Kong, was an ABS exclusive surveyor. From 1969 to 1976 he worked in a number of engineering positions for shipbuilding companies. Then he returned to school and received a degree as a naval architect. From 1979 to 1981 he was employed as a shipyard manager. In 1981 he joined ABS. His experience with ABS was on new construction of drill rigs.

Mr. [redacted] conducted annual surveys and damage surveys onboard the GLOMAR JAVA SEA 13 - 17 October 1983.

[redacted] Alternate Assistant Engineer, GLOMAR JAVA SEA

Mr. [redacted] was [redacted] years old. He held a license as Chief Engineer of Motor Vessels of Any Horsepower and had been serving on the GLOMAR JAVA SEA as First Assistant Engineer for 5 years. He was last onboard the drillship during the 4-week period which ended 20 October1983.

[redacted] Vice-President Operations Support,
Global Marine Drilling Company, Houston

Mr. [redacted] was responsible for providing staff support to the company's operations, including preventative maintenance, rig inspections, trouble shooting, drydock planning, and inspections. He had held that position for approximately 4 years. He had previously held a license as First Assistant Engineer but had allowed it to expire. He was responsible for the management of Global Marine's preventative maintenance program which included the GLOMAR JAVA SEA. He was also responsible for Global Marine's in-house inspection program.

[redacted] American Bureau of Shipping Surveyor, San Francisco

Mr. [redacted] had been an ABS Surveyor for approximately 2 1/2 years. Prior to that he spent 1 1/2 years in the Quality Assurance Branch of a major shipyard. Prior to that he had spent 20 years in the Coast Guard including 8 years

experience in the marine inspection field. He conducted the last drydock survey on the GLOMAR JAVA SEA In November 1982.

LT [redacted], U.S. Coast Guard

LT [redacted] was a shipboard electrician for 5 1/2 years before attending Officer Candidate School in 1974. He spent the next 3 years as assistant industrial manager at Base Honolulu. He was assigned to the Marine Inspection Office in New Orleans, LA for the next 4 years, and had been at the Marine Safety Office in Buffalo, NY since 1981. He was augmenting the Marine Safety Office in Honolulu, which has responsibility for vessel inspections in the Pacific, when he conducted an inspection for certification (biennial inspection) on the drillship between 13 and 17 October 1983.

[redacted], Former Master, GLOMAR JAVA SEA

Captain [redacted] was [redacted] years old. He was licensed by the Coast Guard as Master of Seagoing Vessels of Any Gross Tonnage. He had been self-employed since 1981 as a marine consultant and surveyor. From May to October 1983 he was employed by Global Marine as an alternate Master of the GLOMAR JAVA SEA. Before that he had an extensive marine career. He started as an ordinary seaman in 1942 and worked up to Master by 1956. From 1956 to 1981 he served in the Coast Guard, primarily in marine inspection duties. He worked for 7 months in Saudi Arabia setting up a port safety program and a very large crude oil carrier (VLCC) docking facility. He then served as Master of the drillship WESTERN OFFSHORE IX off the coast of Venezuala for approximately one year before joining Global Marine.

Captain [redacted] had served two 4-week hitches on the GLOMAR JAVA SEA. He was last onboard in August 1983 and left the drillship on 31 August immediately upon completion of the move to the final drill site.

[redacted], Drilling Group Vice-President
Global Marine Drilling Company, Houston

Mr. [redacted] was in charge of the operation of one of Global Marine's four groups of drilling vessels. He was [redacted] years old, was a graduate of the California Maritime Academy, and held a Masters license. He had been involved with drilling vessels in both marine and drilling capacities since 1957. He had been with Global Marine since 1962.

After the casualty he coordinated the information coming in from China on the search. He maintained a chronological listing and a chart of all sightings, reports, and materials recovered. He also handled contract arrangements for the vessel that conducted the initial wreck survey in November 1983.

[redacted], Alternate Master, GLOMAR JAVA SEA

Captain [redacted] was [redacted] years old. Born in New Zealand and a naturalized citizen of the United States, he held licenses issued by the British government as well as by the Coast Guard. He had been going to sea for approximately 30 years,

starting as a midshipman. He first assumed command of a seagoing vessel in 1970 and had previous experience on drilling vessels.

Captain [redacted] was last onboard the GLOMAR JAVA SEA from 31 August through 28 September 1983. He completed the deployment of the anchors at the last drilling site on 31 August. He was relieved by Captain [redacted] on 28 September 1983. His tour of duty overlapped those of many of the personnel who were onboard when the drillship sank.

Captain [redacted] was one of the Global Marine representatives on the wreck surveys.

[redacted] Research Engineer, American Bureau of Shipping, New York

Dr. [redacted] was a research engineer who had been with ABS for 18 years. He holds a BS degree in nautical science from the U.S. Merchant Marine Academy, BS and MS degrees in naval architecture and naval engineering from MIT, and a Ph.D degree in mechanical engineering from the University of Arizona. His primary experience is in research and analysis of ship structures, including development of computer programs for advanced analysis of ship structures. He performed analytical calculations and a full evaluation of the loads and stresses imposed on the GLOMAR JAVA SEA due to sea action.

[redacted], Staff Assistant to Drilling Group Vice-President
Global Marine Drilling Company, Houston

Mr. [redacted] was Mr. [redacted] administrative assistant. He was with Mr. [redacted] at the time of the last known communication with the drillship and heard both sides of the conversation.

LCDR John F. McGowan, U.S. Coast Guard

LCDR McGowan was Chief of the Stability and Subdivision Section, Naval Architecture Branch of the Coast Guard's Marine Technical Division at Washington, DC. He was responsible for the interpretation and application of Coast Guard stability standards for merchant vessels. His office conducted post-casualty intact and damage stability calculations for the GLOMAR JAVA SEA.

LCDR Alphons Richard Melis, U.S. Coast Guard

LCDR Melis was Administrative Assistant to the Marine Board of Investigation. He was the Board's representative on the diving expedition and wreck survey conducted in March, 1984.

[redacted] Materialsman, Global Marine Drilling Company, Zhanjiang

Mr. [redacted] handled all of the purchasing and supply activity for the GLOMAR JAVA SEA. The storekeeper on the drillship reported to him. After the casualty he remained in Zhanjiang and helped with communications. All of the debris recovered during the search was delivered into his custody.

[redacted] Rig Inspection Supervisor,
Global Marine Drilling Company, Houston

Mr. [redacted] was [redacted] years old. He held a license as Second Assistant Engineer of Motor Vessels and Third Assistant Engineer of Steam Vessels of Any Horsepower. He graduated from the U.S. Merchant Marine Academy in 1975. He worked on a semi-submersible drilling unit in the North Sea for 2 years and sailed on tankships for 3 years. He joined Global Marine in 1981 and was assigned as rig inspection supervisor in 1982. He was responsible for setting up in-house inspection programs on Global Marine vessels, scheduling and conducting inspections, and following up on deficiencies. He was present onboard the GLOMAR JAVA SEA for a full inspection in August 1983.

[redacted] Marine Project Superintendent
Global Marine Drilling Company, Houston

Mr. [redacted] job entailed operations support such as technical assistance and troubleshooting and special projects such as vessel construction, repairs, drydockings and inspections. He graduated from the U.S. Merchant Marine Academy in 1976. He worked for 4 1/2 years as a staff engineer (maintenance, inspections, troubleshooting) for Ashland Oil, Inc. before joining Global Marine. He accompanied the Coast Guard Marine Inspector and ABS Surveyor who attended the vessel 13 - 17 October 1983 and prepared an independent report of the inspection.

[redacted] Alternate Radio Officer, GLOMAR JAVA SEA

Mr. [redacted] was [redacted] years old. He held a Coast Guard license as Radio Officer as well as a FCC Radio Operator's license. He first went to sea as Radio Officer in 1939, sailed until 1950, and then went ashore. He went back to sea in 1977 in the employ of Global Marine. He had served as the alternate Radio Officer on the GLOMAR JAVA SEA since November, 1982. He was last onboard for the 4-week period ending 20 October 1983.

[redacted] Alternate Bosun, GLOMAR JAVA SEA

Mr. [redacted] was [redacted] years old. He held a Merchant Mariner's Document as Able Seaman and was a certified lifeboatman. He had been sailing for 41 years. He had sailed as "bosun" for the last 20 years, most of that time on tankships, and for the last 4 years on the GLOMAR JAVA SEA. His duties included maintenance of the lifeboats and other safety equipment. He was last onboard during the 4-week period ending 6 October 1983.

[redacted] Alternate Assistant Engineer, GLOMAR JAVA SEA

Mr. [redacted] was [redacted] years old. He graduated from the U.S. Merchant Marine Academy in 1979 and held a license as First Assistant Engineer of Motor Vessels / Third Assistant Engineer of Steam Vessels of Any Horsepower. He had been employed in that capacity on the GLOMAR JAVA SEA for 4 years. He was last onboard the drillship during the 4-week period which ended 6 October 1983.

[redacted], Drilling Group Vice-President,
Global Marine Drilling Company, Houston

The Operations Department of Global Marine was headed by a Senior Vice-President. Under that person were four Drilling Group Vice-Presidents each of whom was responsible for specific vessels. Mr. [redacted] was Vice-President of the Drilling Group which included the GLOMAR JAVA SEA. The shore-based rig manager reported to him.

Mr. [redacted] had been involved with offshore drilling vessels for nearly 22 years. He was employed by Global Marine in 1962 as a roughneck and worked his way up, reaching the position of toolpusher in 1965. He served in that capacity onboard the drillship GLOMAR III until 1967 when he was promoted to drilling superintendent. He served in that capacity aboard the GLOMAR GRAND ISLE, in the North Sea and Morroco, until 1972. He was assigned as shorebased rig manager for the GLOMAR NORTH SEA, operating in the North Sea, from 1972 until 1975. From 1975 until 1977 he served as shoreside area manager in California. He left Global Marine in 1977 and was employed as an advisor to a Norwegian drilling company working in the North Sea. He returned to Global Marine in 1982 as a rig manager and was promoted to drilling group vice-president 3 months later. He was in his office in Houston on 25 October 1983 and was a party to the last known communication with the GLOMAR JAVA SEA.

In March, 1984 he was the senior Global Marine representative for the diving expedition which surveyed the wreck, recovered bodies, and obtained steel samples from the hull of the GLOMAR JAVA SEA.

[redacted], Chief Surveyor, Hull Technical Department
American Bureau of Shipping, New York

Mr. [redacted] verified the applicability to the GLOMAR JAVA SEA of the 1973 ABS Rules and the associated damage stability criteria. He provided technical data from the construction files on the drillship.

[redacted], Drilling Superintendent
Global Marine Drilling Company, Houston

Mr. [redacted] was [redacted] years old. He had been employed with Global Marine for 15 1/2 years, working his way up from derrickman to rig manager. For the last 10 years he was employed as a drilling superintendent, in charge of all routine operations when the vessel was in the drilling mode. He had served on the GLOMAR JAVA SEA for 28 days and left the drillship on 29 September 1983.

[redacted] Metallurgist, Failure Analysis Associates, Houston

Dr. [redacted], a citizen of Great Britain, was a metallurgist who conducted examinations, tests, and evaluations of steel samples cut from the hull of the GLOMAR JAVA SEA. He holds Bachelor's, Master's and Doctor's degrees in metallurgy from the University of Cambridge, England. He had more than 12 years of experience in metallurgical engineering and failure analysis work.

[redacted], Operations Manager, Hydrographic Survey Division, Brown & Root, Inc., Houston

Mr. [redacted] was a hydrographic survey engineer with approximately 10 years experience in hydrographic survey work. He was responsible for all of the Brown & Root, Inc. work in this field. He supervised the analysis of the data obtained from a side scan sonar survey of the wreck site. He also supervised preparation of the reports of the survey including a composite mosaic of the magnetic tapes of the side scan sonar data which provides a map of the wreck site.

[redacted], Safety and Training Coordinator, Global Marine Drilling Company, Houston

Mr. [redacted] was responsible for general oversight of Global Marine's rig safety and personnel training programs in the drilling group that included the GLOMAR JAVA SEA. He had been aboard the drillship from 25 July to 5 August 1983 for a safety and training inspection.

[redacted], Vice-President and General Manager, ARCO China Inc., Zhanjiang

Mr. [redacted] was the principal ARCO representative in China. He was responsible for carrying out the terms of ARCO's contract for oil exploration and exploitation in the South China Sea. After the casualty he coordinated communications between the various agencies and offices involved in the search activities.

[redacted], Deputy General Manager, Nanhai West Oil Company

The principal Chinese operating company supporting the drillship and its operations was the Nanhai West Oil Company. The Supply vessels, most of the Chinese crewmembers and other support personnel, as well as most other support and liasion services were provided by that company.

[redacted], Master, M/V NANHAI 205
[redacted], Master, M/V NANHAI 209

The GLOMAR JAVA SEA was supported by two supply vessels, the NANHAI 205 and the NANHAI 209, operated by Nan Hai West Oil Company. Those vessels transported supplies to the drillship, assisted in anchor handling and rig moves, and were generally available to assist the drillship as needed. In general, they operated such that while one was in Zhanjiang loading/discharging cargo the other was standing by at the drill site. The vessels were 62 meters in length and had Chinese crews. The NANHAI 205 was attending the drillship on 25 October 1983.

[redacted] Radio Operator, Zhanjiang
[redacted], Radio Operator, TianDu

The drillship was also supported by two communications centers. One, at Zhanjiang, was referred to as "ARCO Zhanjiang Radio". It was located in the ARCO China Inc. offfices at Zhanjiang and was intended to be continuously manned. It was manned by three Chinese radio operators on a rotating basis. They had single sideband (VHF, voice) radio, telex, and facsimile capabilities. The other communications center was at TianDu, near Sanya, and was referred to as "Arco TianDu Radio". It was manned continuously by four Chinese radio operators on a rotating basis, and three administrative personnel. TianDu was a military base and military and civilian airfield. The helicopters servicing the GLOMAR JAVA SEA operated from that base and were also supported by the communications center. The center was equipped with single sideband (VHF, voice) radio.