OCS Report
MMS 87-0075

Investigation of October 27-28, 1985, Structural Failures:

Ocean Drilling & Exploration Company Platforms: Outer Continental Shelf Lease 0605, South Timbalier Block 86 & Outer Continental Shelf Lease 0073, South Pelto Block 19

Gulf of Mexico, off the Louisiana Coast

U.S. Department of the Interior
Minerals Management Service
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F. Dyhrkopp
G. Schonekas
M. Stewart

U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Regional Office

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I. Investigation and Report

A. Authority

A series of structural failures occurred on Ocean Drilling and Exploration Company's (ODECO) Platform A, South Timbalier Block 86, Lease OCS 0605, and ODECO-Burmah-Murphy (OBM) Header Platform and three-pile, single-well protector, South Pelto Block 19, Lease OCS 0073, in the Gulf of Mexico (GOM), offshore the State of Louisiana, during the period October 27-28, 1985. Pursuant to Section 208, Subsection 22(d), (e), and (f), of the Outer Continental Shelf (OCS) Lands Act Amendments of 1978, and to Department of the Interior Regulations 30 CFR Part 250, the Minerals Management Service (MMS) is required to investigate and prepare a public report of this accident. By memorandum dated November 4, 1985, the following MMS personnel were named to the investigative panel:

Felix Dyhrkopp, New Orleans, Louisiana
Gerard Schonekas, New Orleans, Louisiana
Maurice Stewart, New Orleans, Louisiana

B. Procedures

Members of the investigative panel met with Messrs. Les Vincent, Herb Price, and Terry Petty of ODECO on December 4, 1985. During this meeting, the MMS panel informally questioned these ODECO personnel to obtain information concerning the structural failures of the subject platforms during Hurricane Juan. The panel was presented with (1) design drawings of both platforms as well as postmortem calculation results for the platform in South Pelto Block 19 and (2) a sketch prepared from an underwater survey of the failed platform in South Timbalier Block 86. Additionally, the panel was allowed to review two reports of underwater surveys conducted by Sub Sea

International, Inc. (reports dated November 1982 and July 1985). At the panel's request, ODECO subsequently submitted copies of these reports to MMS.

On December 11, 1985, the panel inspected and photographed the South Pelto wreckage at Teledyne Movible's yard in Morgan City, Louisiana.

The investigative panel convened on March 6, 1986, to formally question personnel knowledgeable about the platform failures. The meeting was held at the MMS Gulf of Mexico Regional Office in Metairie, Louisiana. The following personnel gave testimony:

Jackie Owen Anthony, ODECO
Ciro Anthony Cuchinelli, ODECO
Joe Edward Gilbert, Jr., ODECO

The investigative panel convened again on August 21, 1986, to formally question additional personnel knowledgeable about the platform failures. The meeting was held at the MMS Gulf of Mexico Regional Office in Jefferson, Louisiana. The following personnel gave testimony:

Thomas J. Davidson, ODECO
Robert D. House, ODECO

II. Introduction

A. Background

Lease OCS 0605 covers approximately 2,500 acres of the north half of Block 86, South Timbalier Area, Gulf of Mexico, off the Louisiana coast. (For lease location, see appendix, attachment 1.) The lease was issued effective September 1, 1955, for a cash bonus of $3,670,000 with a 1/6 fixed royalty rate. The original lessee was Sinclair Oil and Gas Company.

ODECO was designated as operator of the lease on July 26, 1971. At present, the lessees are as follows:

ODECO Oil and Gas Company — 71.92 percent
Furth Oil Company — 1.29 percent
Enstar Corporation — 9.2 percent
Minatome Corporation — 15 percent
Joe D. Price (individual) — 2.59 percent

Lease OCS 0073 covers approximately 2,500 acres of the west half of Block 19, South Pelto Area, Gulf of Mexico, off the Louisiana coast. (For lease location, see appendix, attachment 2.) The lease was issued effective September 12, 1946, with a 1/8 fixed royalty rate. The original lessees were as follows:

Magnolia Petroleum Company — 33.33 percent
Continental Oil Company — 33.33 percent
Newmont Oil Company — 33.34 percent

ODECO was designated as operator of the lease on February 12, 1975. At present, the lessees are as follows:

Phillips Petroleum Company — 15 percent
Murphy Oil U.S.A., Inc. — 25 percent
ODECO Oil and Gas Company — 25 percent
Sun Operating Limited Partnership — 35 percent

The last annual MMS inspection of operations of Platform A was completed June 26, 1985. The result of the inspection determined that production operations were in compliance with MMS regulatory requirements.

The last annual MMS inspection of operations of the OBM Header Platform and the three-pile, single-well protector was completed on August 8, 1985. The result of the inspection determined that production operations were in compliance with MMS regulations.

These inspections were directed at oil and gas production operations conducted at each platform and did not include inspection of their structural integrity.

B. Description of Incident

On October 27, 1985, ODECO's Platform A, South Timbalier Block 86, Lease OCS 0605, experienced structural failure and subsequently collapsed into the water due to the presence of Hurricane Juan in the Gulf of Mexico. Five ODECO personnel were washed overboard and were subsequently rescued by the U.S. Coast Guard. The incident did not produce any pollution.

The OBM Header Platform and the three-pile, single-well protector located in South Pelto Block 19, Lease OCS 0073, are located only 29 miles northwest of the South Timbalier Block 86 Platform A and presumably encountered similar weather conditions during Hurricane Juan. Both unmanned platforms experienced structural failures and subsequently collapsed.

III. Findings

A. South Timbalier Block 86, Platform A

1. Design of Platform 86A

Platform 86A was designed in 1955 and constructed in 1956 by J. Ray McDermott and Company, Inc., as a sixteen-pile structure located in approximately 95 feet of water. The platform legs were typically 33 inches in diameter, braced with typically 12-inch-diameter pipe braces. On January 6, 1977, McDermott informed the present owner that the platform was originally designed using a storm recurrence interval of approximately 25 years (yielding a 45-foot-high wave) and was constructed of A7 steel and API pipe. McDermott further informed the owner that, given the advances made in predicting wave heights and improvements in steel qualities since 1955, Platform A "would be lucky to meet today's 10-year [recurrence interval] storm criteria."

2. Underwater Visual Survey, November 1-11, 1982

During this period, Sub Sea International, Inc., an underwater contractor, performed an underwater visual inspection of the jacket, primarily using a remotely controlled vehicle (RCV) equipped with a black-and-white camera system.

The survey was carried out as part of an ongoing training program of Sub Sea International's RCV operators. Three exterior bents of the jacket structure were inspected using the RCV. These bents constituted 50 percent of the six vertical bents of the jacket. Additionally, 50 percent of the horizontally oriented braces located at elevations -15 feet, -41 feet, and -66 feet were inspected using a diver-held color camera. The lowest horizontal level, elevation -92 feet, was not inspected. The inspection technique consisted of "swimming" the cameras past the jacket structure to determine visually whether or not any gross structural or corrosion damage existed.

The inspection report prepared by the contractor contained the following information:

(a) All underwater structural members were covered with moderate barnacle and seaweed growth. (Such growth precludes the visual detection of all but gross damage, particularly when using cameras and CRT monitoring screens.) There is no mention that removal of marine growth was performed on any part of the structure. The condition of the sacrificial anodes of the platform's cathodic protection system at the aforementioned horizontal levels was visually checked and noted, but anodes on the vertically oriented structure were not inspected.

(b) Five of the original vertical diagonal braces were missing from the jacket, but four of the five had been replaced. The reported existence of moderate marine growth on the replaced members indicates they had not been recently installed at the time of inspection. Three of the members were located near the base of the jacket, whereas the other two were located at or near the water surface. The member which had not yet been replaced was located between elevations -15 and -41 feet in Row 1 exterior face. (A later inspection report confirms that this brace was subsequently replaced.)

(c) Corrosion holes were found in three members, two located near the leg joints and one located at the brace midpoint joint where other braces intersected. At one brace-to-leg connection, a mechanical clamp had been previously installed in an attempt to strengthen the connection.

Additional damage consisted of two missing vertical diagonals located in the area of the waterline and a through-thickness crack encompassing 50 percent of the end connection weld of an underwater vertical diagonal.

The above information was presented in either pictorial or photographic form. Additionally, a written report summary stated that "No one area of confinement was noted. In addition to the holes, there appears to be heavy overall thinning and wastage occurring on this platform. Several of these holes are in or directly adjacent to leg/joint welds and members intersections. . . . A visual inspection of the sacrificial anode system showed that it is basically nonexistent. The only remains found were that of the [anode] clamps and [anode] center cross ribs. Some areas did not even have complete clamps or ribs remaining. . . . This platform has a high degree of debris on the bottom and suspended from the lower level. Other levels have typical debris in the form of chains, wire rope and small sections of steel; however, there are two areas with broken [off] members wedged in place between members and legs."

(b) The location of 24 underwater members that had been replaced was identified. Of these, 13 were horizontal braces and 11 were vertical braces. All 24 members had been replaced using wet-welding techniques. Four of the replaced vertical braces had been noted in the limited 1982 survey discussed in section 2(b) above.

(c) Thirty locations throughout the underwater structure where mechanical clamps had been used to repair brace joints that were badly cracked or corroded were identified. Of these, 13 were located on horizontal braces and 17 were located on vertical braces. Some of these clamps were reported in the limited 1982 survey discussed in section 2 above. It is inferred these clamps were installed before the installation of the wet-welded replacement members, that is, sometime before 1982. For an example of such a clamp, see appendix, attachment 7.

4. Crew Awareness of Platform Structural Condition

Production personnel aboard Platform 86A were of the impression that the structure was badly deteriorated. Most stated that on calm weather days broken and missing members could be seen beneath the water. Some had spoken with the divers who had performed the underwater inspection on July 20, 1985, and others had seen their reports, but none were aware of any repairs having been made subsequent to that inspection.

5. Failure of Platform 86A

On Sunday morning, October 27, 1985, the production personnel of Platform 86A were operating in a Stage 2 Alert condition and the platform had been secured. At approximately 3 p.m. that same day the crew was informed via radio that a Stage 3 Alert was in effect and that they were to be evacuated. At approximately 3:30 p.m. the wells were shut in and the crew awaited the evacuation. However, they received no further communication from the shore base.

At approximately 6:30 p.m. one or more casing supports on one well casing failed, allowing the casing to undergo horizontal deflections due to wave action. As the casing was forced into large excursions, it began to destroy the deck structure on the well deck.

The production personnel descended from the main to the well deck in an attempt to secure the loose well casing to the other well casings. However, just as they began working, a wave that is estimated from the crew's description to have approached 70 feet in height (trough to crest) hit the platform and was followed shortly by another wave slightly smaller in size. The crest of the first wave was observed approximately midway between the main and well decks and actually washed one crew member overboard. At the passing of the second wave the entire platform shifted horizontally and collapsed into the water.

The five crewmen were wearing lifejackets and were all rescued the following day by the U.S. Coast Guard after they spent hours in the water — up to 21 hours in one case. The crew members were taken to area hospitals where they were treated for exposure and exhaustion and later released. One crew member sustained a hip injury.

B. South Pelto Block 19 OBM Header Platform and Three-Pile, Single-Well Protector

1. OBM Header Platform

The OBM Header Platform was designed and constructed in 1961. It was a four-pile jacket structure and was unmanned. The structure consisted of legs 24 inches in diameter by 0.5 inch thick, whose centers were located at the corners of a 26-foot square. The braces were 10.75-inches in diameter by 0.5 inch thick. The piles in each leg were 20 inches in diameter by 0.5 inch thick and penetrated the seafloor 100 feet below the mudline.

Although the original design criteria were not available, an owner-supplied, post-failure analysis of the structure (as originally constructed) revealed that it would have approached failure in the presence of 100-mph winds, a 1.5-knot surface current, and a wave height of approximately 20-25 feet.

After collapsing, this platform was removed by divers and brought to shore to be scrapped. A post-failure inspection revealed a structure which had severely deteriorated before its collapse.

At several locations mechanical brackets, such as that shown in appendix attachment 7, had been installed at broken brace-to-leg connections. In many cases, the original welded joint had completely cracked, or a plug had been pulled out of the leg can. In some instances the plugs had pulled away from the leg a distance sufficient to allow barnacles to enter and attach themselves to the inside of the plug walls. The gaps in the cracked leg walls allowed sufficient light to enter to sustain barnacle growth, their presence indicating that joint damage had existed for some time.

There were no anodes on this structure. In fact, not even the remains of anode attachments could be found. From all appearances, a cathodic protection system had not existed on this platform for some time.

The piles appeared to have failed in a bending mode since they were flattened near the mudline, much as a flagpole might fail due to lateral overload. This fact, coupled with the evidence that several brace-to-leg connections had completely pulled apart, suggests that the bracing system probably began failing first and continued to do so until the piles simply failed in bending at the mudline.

2. Three-Pile, Single-Well Protector

This small well jacket was installed adjacent to the South Pelto Block 19 platform and was connected to it by an access bridge. The date of design and construction of this structure is unknown.

Although this structure was not cathodically protected, it appeared to be in very good structural condition. There was no evidence of any previous repairs having been made. Further, the structure failed as a unit with all structural members intact. From all indications, the piles failed at the mudline, probably from gross overload.

IV. Conclusions

A. South Timbalier Block 86, Platform A

1. Probable Causes of Platform Failure

Platform A collapsed into Gulf of Mexico waters as a result of the deteriorated structure being impacted by excessive environmental forces during Hurricane Juan. Although wind and current velocities were unknown at the time of the accident, a wave whose height is estimated at 70 feet (crest to trough) passed through the jacket structure. This wave height corresponds to the theoretical breaking wave height for the site during Juan, and it greatly exceeds the 45-foot-high wave assumed in the platform design. Undoubtedly, it caused the failure of several underwater structural members, which led to the platform's collapse a few minutes later during the passing of a slightly smaller wave.

Both the environmental forces *and* the poor structural condition of the platform are believed to have jointly caused its collapse. Although the assumed design wave was greatly exceeded during this storm, it is possible that the platform would have remained standing had it been maintained in good structural condition. In fact, although Platform A was in poor structural condition before Hurricane Juan, it did manage to sustain several hours of heavy seas and remained standing after the passing of a 70-foot wave.

2. Probable Contributing Cause of Platform Failure

The use of numerous mechanical clamps to repair cracked, corroded, or otherwise parted member connections is a probable contributing cause of platform failure. Analysis of the inspection report data indicates that at some point in time the owner recognized the undesirability of using clamps, for repairs made after the early 1980's were carried out by replacing and rewelding members. Those repairs more appropriately restored the structure to its original design condition in that drastically altered load paths, reduced joint stiffnesses, increased bending moments, and additional stress concentrations were not introduced at the rewelded connections. More importantly, replacement removed the entire member that had been subject to years of corrosion attack, whereas clamps were installed on partially deteriorated members. However, there is no evidence suggesting that an attempt was also made to remove and replace the existing clamped members.

3. Probable Causes of Platform Deterioration

The probable causes of the structural deterioration were a failure to maintain the cathodic protection system and, after 1985, to repair mechanical and corrosion damage as it occurred. After both the 1982 and 1985 surveys, ODECO was made aware of the virtually complete lack of corrosion protection and resulting deterioration of the underwater structure. Whereas it appears that structural members and connections were repaired over a period of several years, no attempt was made to replace the cathodic protection system. After the 1985 survey, there is no evidence to suggest that attempts were made to repair damage of any kind even though the structure had seriously deteriorated.

4. Probable Cause of Injury

In general, the probable cause of injuries was prolonged exposure to the environmental elements. In one case, a worker sustained a hip injury when he was pinned down by structural members that had fallen on him during the passing of a 70-foot-high wave.

B. South Pelto Block 19 OBM Header Platform

1. Probable Causes of Platform Failure

The unmanned South Pelto Block 19 OBM Header Platform presumably encountered weather conditions similar to those that affected the South Timbalier Block 86 Platform 86A; it was also in an advanced state of deterioration. Therefore, the probable causes of failure are presumed to be structural deterioration and excessive environmental forces.

2. Probable Contributing Cause of Platform Failure

The probable contributing cause of failure is the use of mechanical clamps for repairing broken joints.

3. Probable Cause of Platform Deterioration

The probable cause of platform deterioration is failure to maintain properly the structure and its cathodic protection system.

C. Three-Pile, Single-Well Protector Adjacent to South Pelto Block 19 OBM Header Platform: Probable Cause of Failure

The probable cause of failure of the unmanned, three-pile, single-well protector adjacent to the South Pelto Block 19 OBM Header Platform structure was gross overload by environmental forces. All structural members appeared to be intact and in good condition.

V. Recommendations

A. Platforms Installed Before 1966

In general, platforms installed before 1966 were designed using the 25-year-storm criteria thought to be adequate at that time. With the passing of Hurricane Betsy through the Gulf of Mexico in September 1965, the failure of several platforms led to the general use of the more conservative 100-year-storm criteria used today. Because a large number of pre-1966 platforms are still in operation, the following are recommended:

1. Manned Platforms

a) Operators should be required by MMS to submit a report providing the date of the last inspection of each of these platforms, the type of inspection performed, areas inspected, and the condition of the structure and cathodic protection system.

b) Operators should be required to submit a plan for evacuation of personnel during the approach of storms anticipated to produce conditions comparable to the prescribed design storm conditions for these platforms.

2. Unmanned Platforms with Flowing Oil and Gas Wells

Operators should be required to submit a report on the condition of the structure and cathodic protection system of these platforms.

B. Platforms Designed After 1966

For platforms designed after 1966, the following recommendations are made:

1. Manned Platforms

Operators should be required by MMS to submit a report providing the date of the last inspection of each of these platforms, the type of inspection performed, areas inspected, and the condition of the structure and cathodic protection system.

2. Unmanned Platforms with Flowing Oil and Gas Wells

Operators should be required to submit a report on the condition of the structure and cathodic protection system of these platforms.

C. Development of Structural Requirements for Existing Platforms

1. Publish Regulations

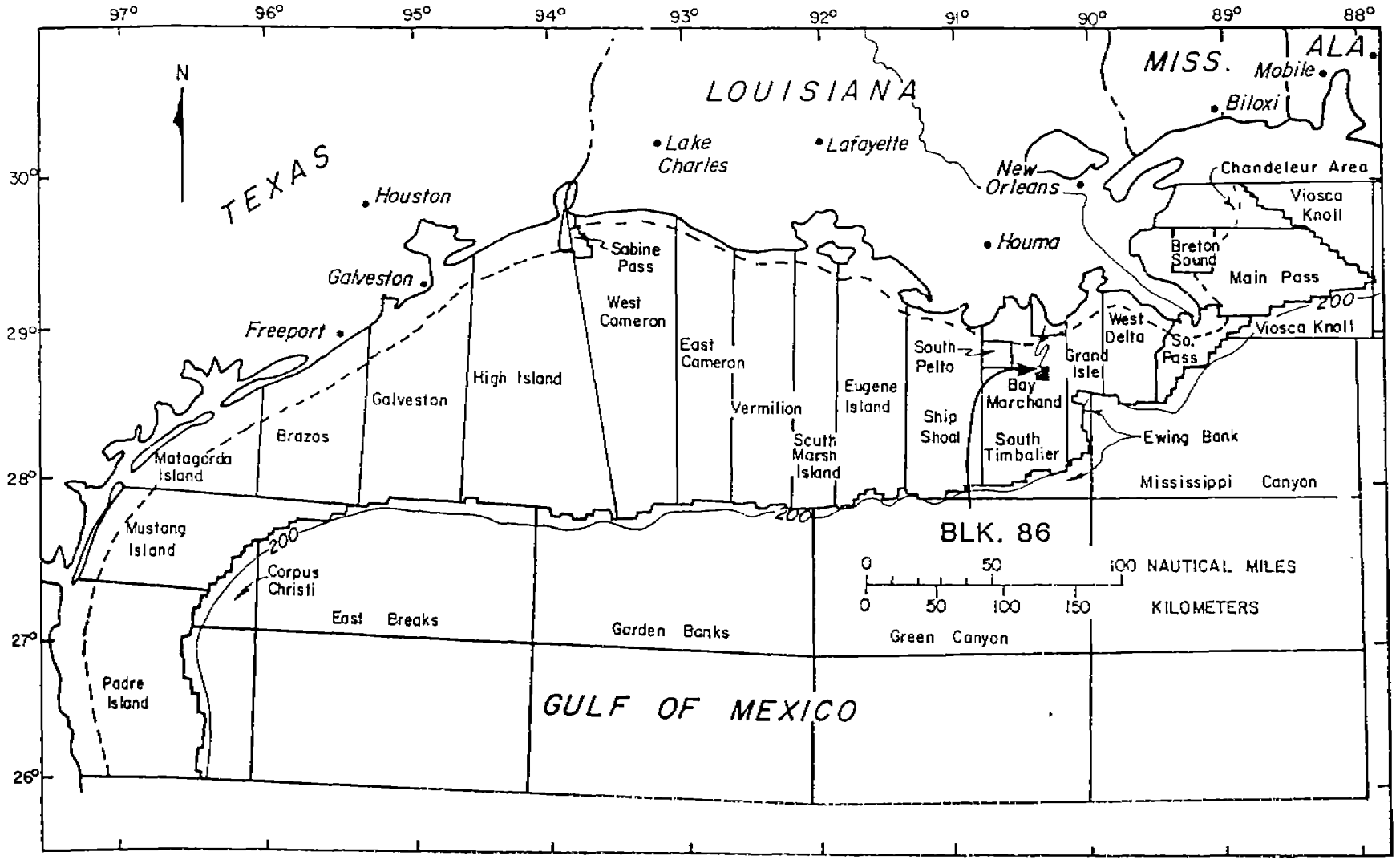
The MMS should publish regulations regarding periodic platform inspection and maintenance as proposed in the *Federal Register* Notice dated March 18, 1986, page 9405 (§250.142).

2. Perform Studies

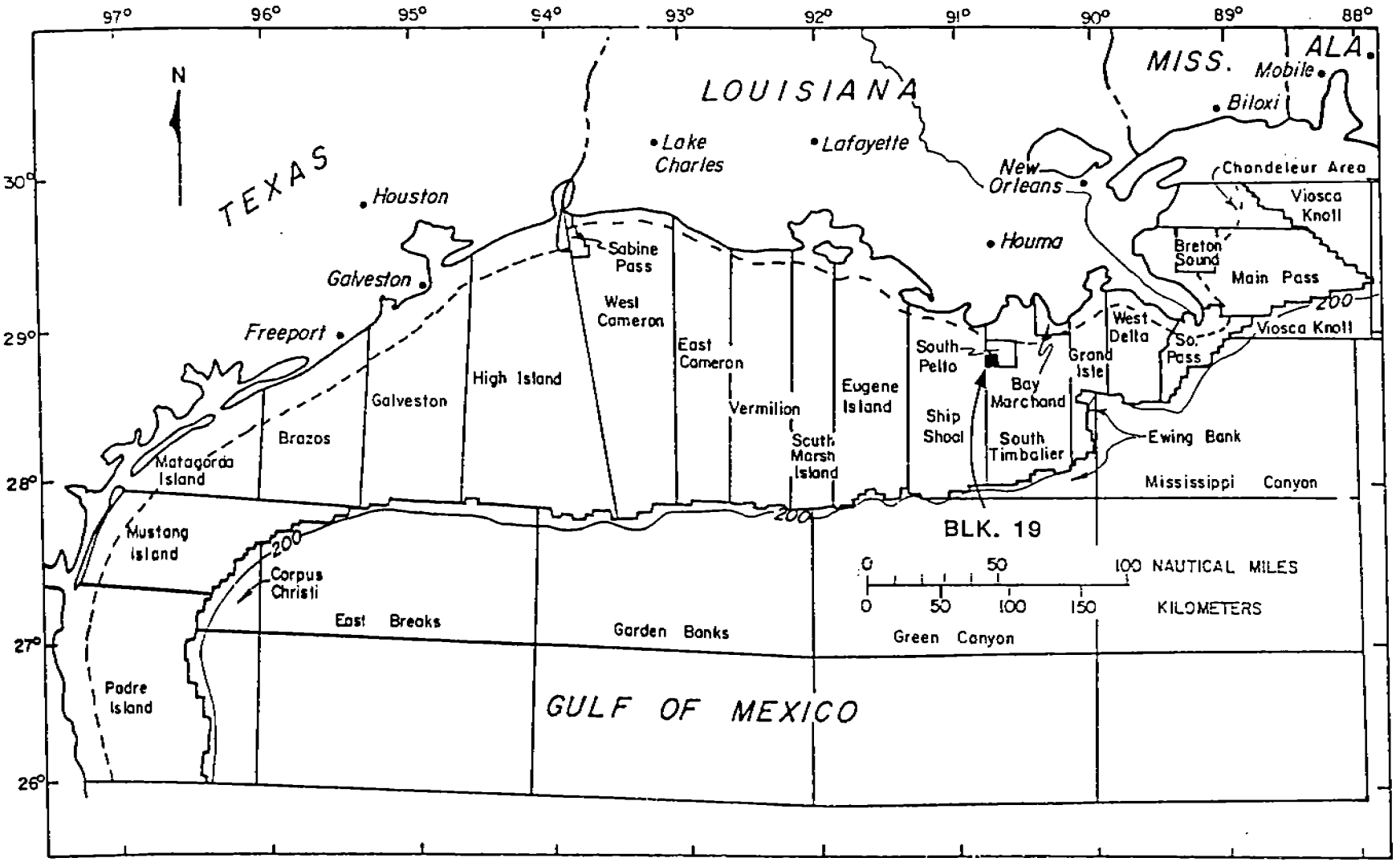
Within a period of 5 years, MMS should, using data gathered under A, B, and C.1 above, ascertain the structural condition of *all* platforms in the Gulf of Mexico.

3. Formulate Policy

The MMS should develop an inspection, maintenance, and repair policy that takes into account the various classes of platforms in the Gulf of Mexico. That policy should allow for consideration of such factors as the age of a platform; its original design criteria; whether it is manned or unmanned; whether its wells are naturally pressured or require gas lift; its present structural condition; the remaining field life; and the impact of platform failure on human life, pollution of the environment, or loss of natural resources. For example, 25-year-old platforms being used to produce marginally economic fields may require a different approach regarding repair than would more recent structures installed in new oil or gas fields. Whereas it may not be economically feasible to completely repair some old structures, perhaps some combination of partial repair, manning restrictions, platform derating, and/or additional subsurface safety systems could allow for their continued use in lieu of abandonment and resulting loss of production.

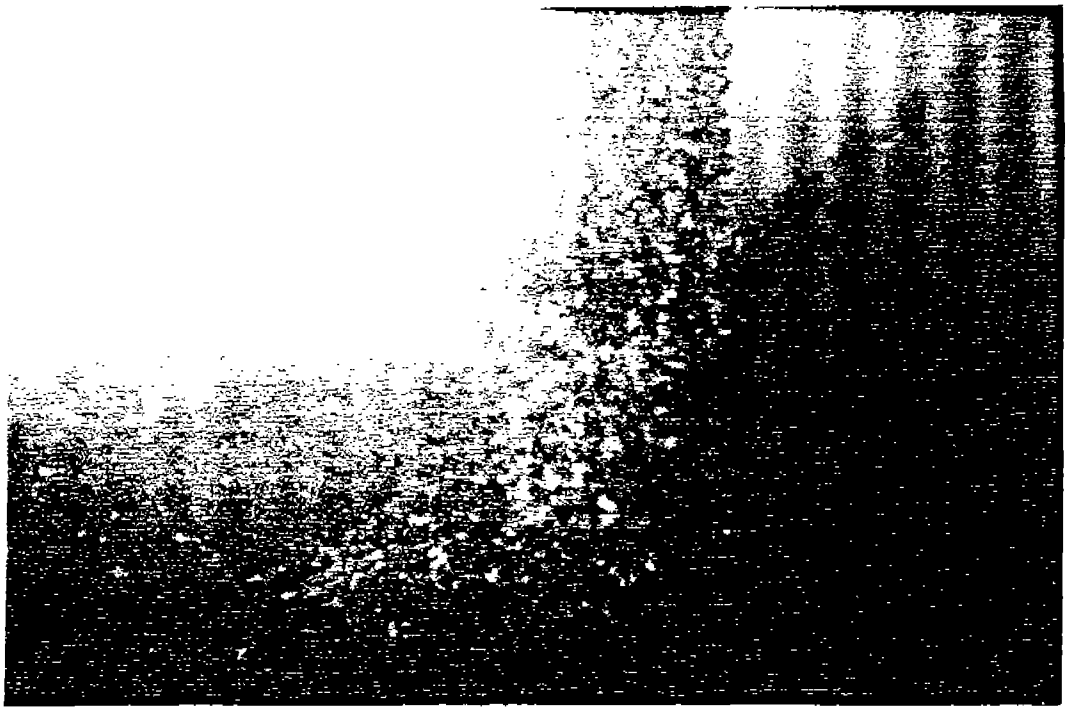


Location of Lease OCS 0605, South Timbalier Block 86, Gulf of Mexico. Dashed lines indicate boundary between State and Federal waters; solid line indicates 200-meter water depth.

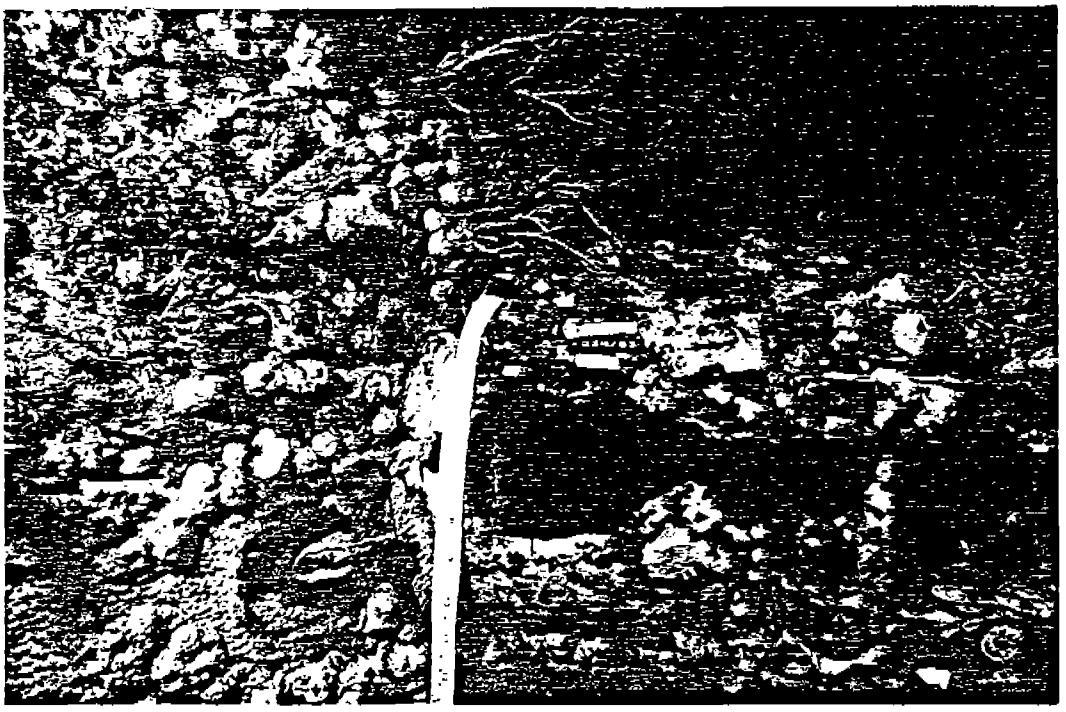


Location of Lease OCS 0073, South Pelto Block 19, Gulf of Mexico. Dashed lines indicate boundary between State and Federal waters; solid line indicates 200-meter water depth.

Photographs Illustrating Platform Damage

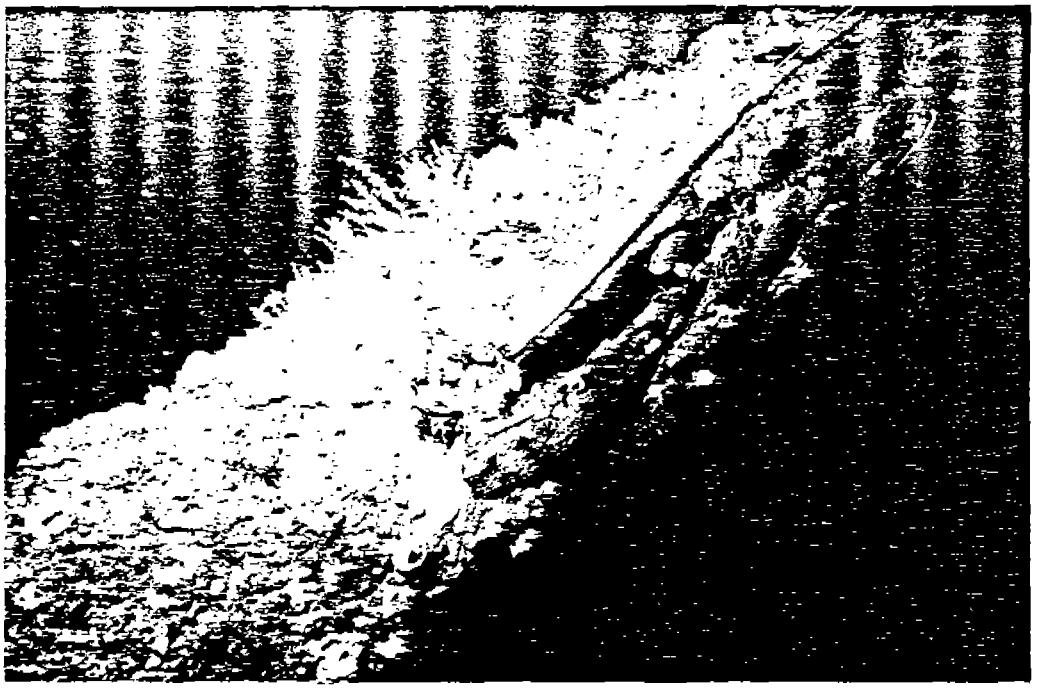


View showing vertical diagonal brace stub remaining from broken member



Corrosion in brace. Portion of mechanical clamp visible.

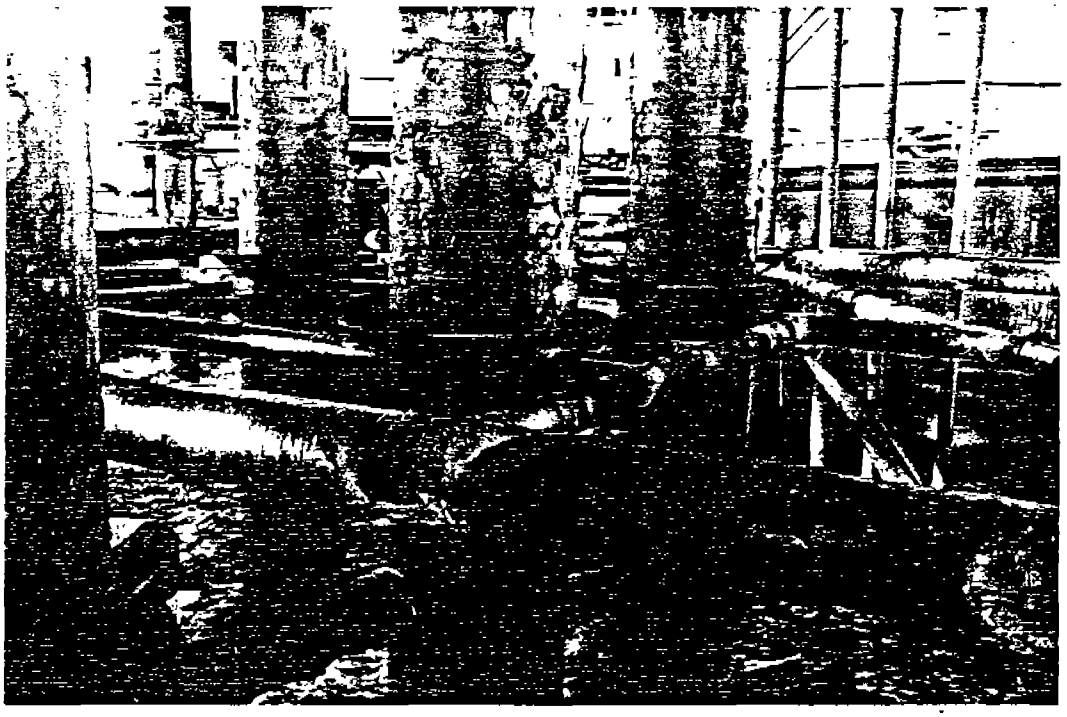
Photographs Illustrating Platform Damage



Corrosion of vertical diagonal brace

Corrosion in brace

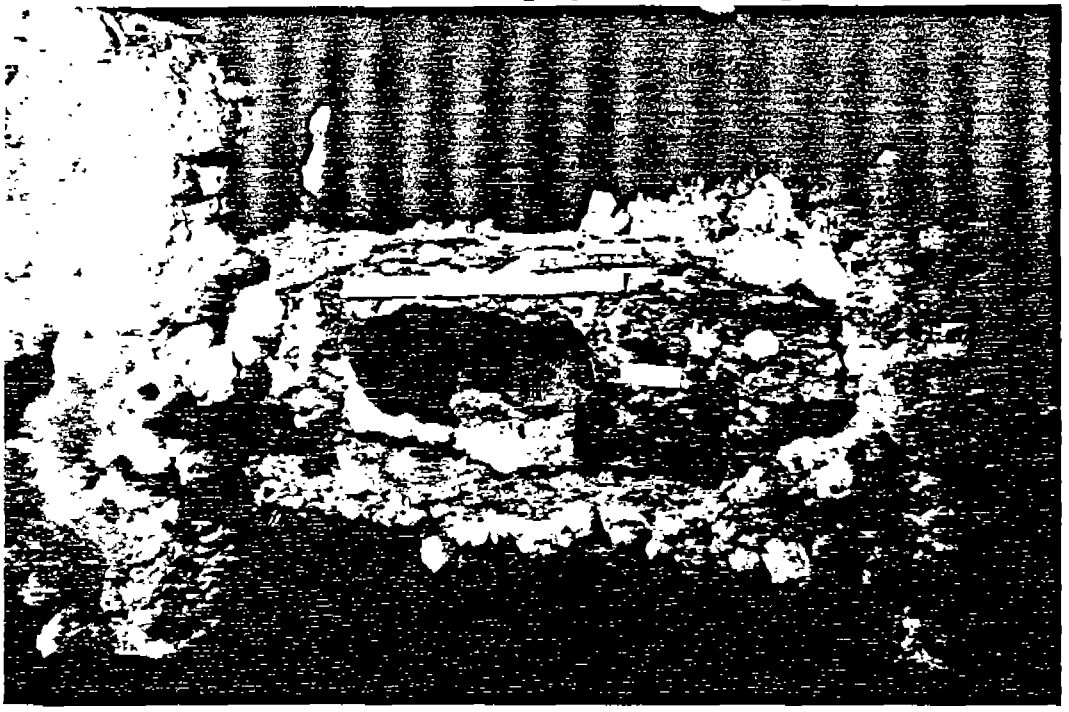
Photographs Illustrating Platform Damage



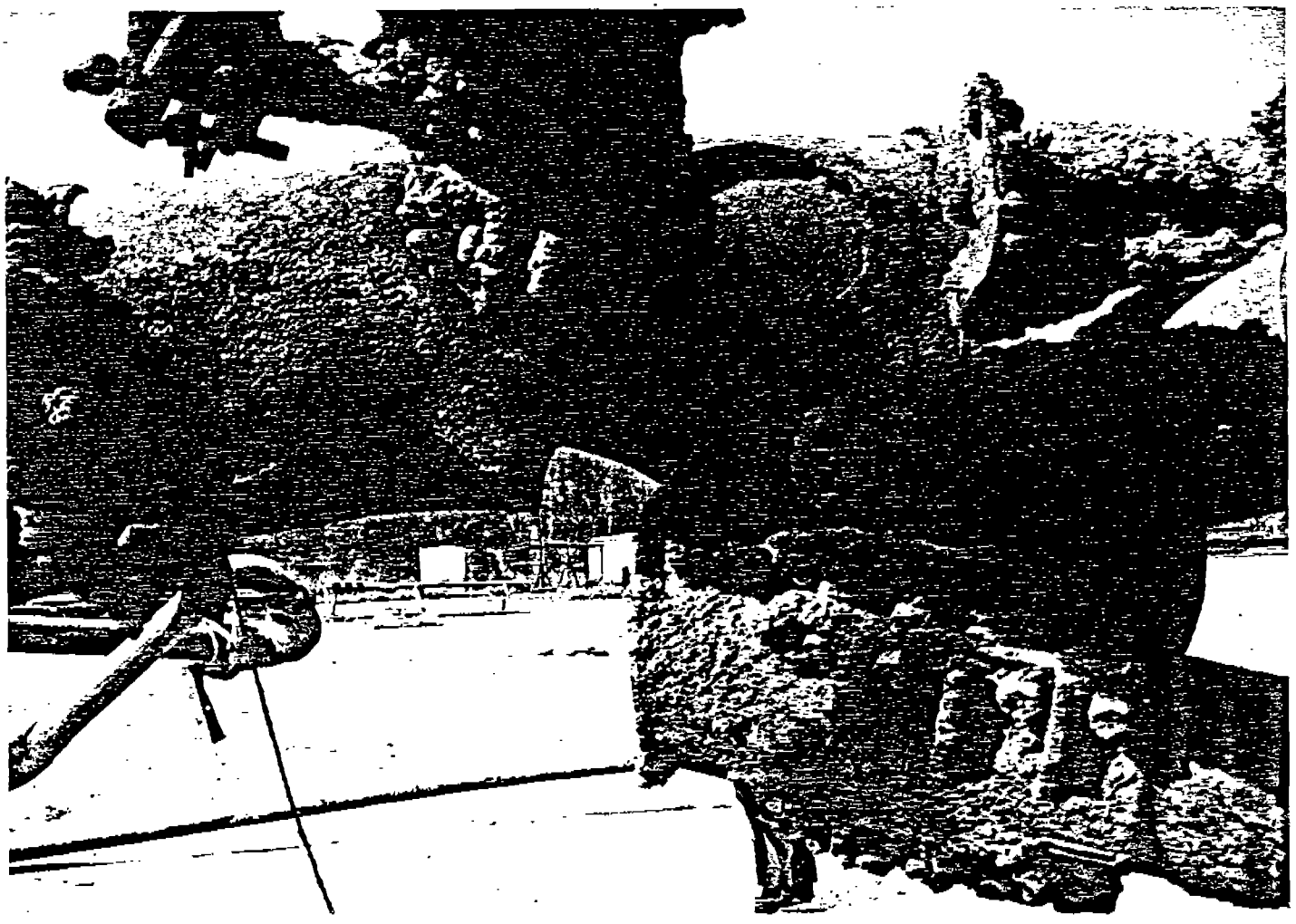
Deterioration of above-water structure

Corrosion of horizontal brace at connection to leg.
Portion of mechanical clamp visible.

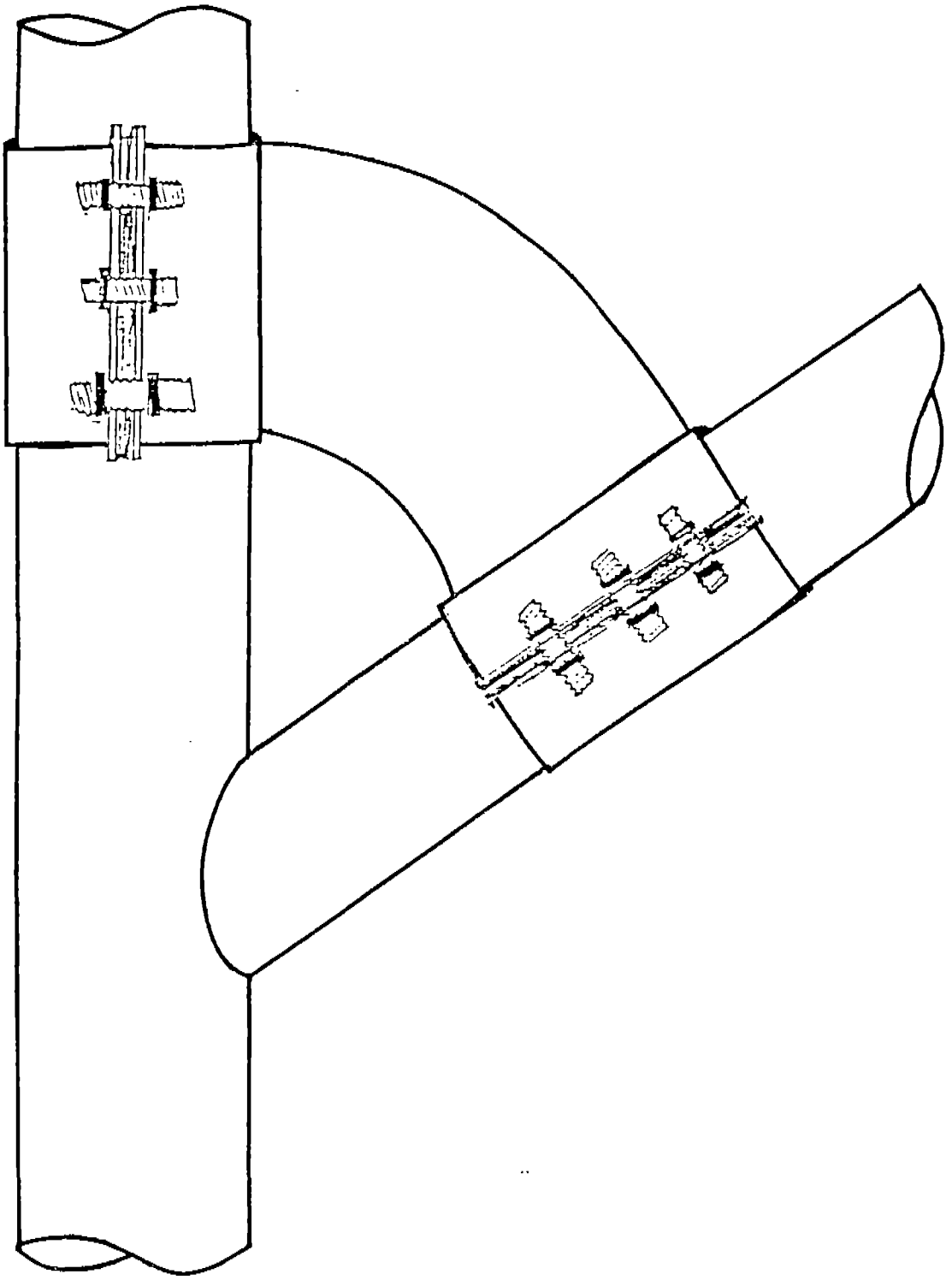
Photographs Illustrating Platform Damage



Corrosion in brace



Damage to South Pelto Block 19 Header **Platform showing "plugs" pulled out** of leg well. Mechanical **clamp visible.**



Mechanical clamp

Glossary

Casing — Steel pipe used in wells to seal off fluids from the borehole and to prevent the walls of the well from sloughing off or caving. There may be several strings of casing in a well, one inside the other. The casing extends from well below the seafloor, through the water column, and terminates at some point on the platform deck.

Cathodic protection system — A system to reduce or eliminate corrosion of an underwater steel structure by the use of an impressed current system or by the use of sacrificial anodes.

CRT monitoring screen — Cathode-ray tube in which cathode rays, usually in the form of a slender beam, are projected on a fluorescent screen and produce a luminous spot (similar to a television screen).

Header platform — A platform that serves as a gathering point for multiple sources of remotely produced hydrocarbons, but does not itself contain producing wells.

Horizontal brace — A horizontal structural support connecting two upright members.

Jacket — The trusswork portion of a platform, which exists between the seafloor and the deck.

Leg can — A short length of pipe that makes up part of a jacket leg at its intersection with brace members and is usually of thicker steel material than the portion of the leg immediately above and below it.

Row 1 exterior face — One of the four exterior sides of a jacket structure as seen in an elevation view of a structural drawing.

Sacrificial anode — An ingot of a metal connected to the underwater steel jacket in such a manner that the current generated by the presence of the jacket in seawater travels from the steel, through the anode, and into the seawater, thus sacrificing the anode rather than the steel structure to the seawater.

16-Pile platform — A platform which is supported by 16 pilings driven into the seafloor and connected to the jacket structure.

Stage 2 Alert — A condition wherein predescribed preliminary preparations are made on a platform as a hurricane approaches the Gulf of Mexico; for example, all loose equipment and material are secured and operations are curtailed, but production is not interrupted.

Stage 3 Alert — A condition wherein producing wells are shut in and personnel are evacuated from the platform due to the imminent approach of a hurricane in the vicinity of the platform.

Vertical diagonal brace — A structural support connecting two upright members. Two vertical diagonal braces crossing at their midpoints would form an upright "X" figure.

Wet-welding techniques — Welding performed underwater where the welding electrode and part being welded are exposed to the marine environment.