

UNITED STATES DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE
GULF OF MEXICO REGION

ACCIDENT INVESTIGATION REPORT

1. OCCURRED

DATE: 23-SEP-2005 TIME: 0600 HOURS

2. OPERATOR: Chevron U.S.A. Inc.

REPRESENTATIVE: Sandy Fury
TELEPHONE: (504) 592-6095

CONTRACTOR:
REPRESENTATIVE:
TELEPHONE:

- STRUCTURAL DAMAGE
- CRANE
- OTHER LIFTING DEVICE
- DAMAGED/DISABLED SAFETY SYS.
- INCIDENT >\$25K
- H2S/15MIN./20PPM
- REQUIRED MUSTER
- SHUTDOWN FROM GAS RELEASE
- OTHER **Capsized - Mooring Failure**

3. OPERATOR/CONTRACTOR REPRESENTATIVE/SUPERVISOR
ON SITE AT TIME OF INCIDENT:

6. OPERATION:

4. LEASE: G15563
AREA: GC LATITUDE:
BLOCK: 237 LONGITUDE:

- PRODUCTION
- DRILLING
- WORKOVER
- COMPLETION
- HELICOPTER
- MOTOR VESSEL
- PIPELINE SEGMENT NO.
- OTHER

5. PLATFORM: A-Typhoon TLP
RIG NAME:

6. ACTIVITY: EXPLORATION (POE)
 DEVELOPMENT/PRODUCTION
(DOCD/POD)

8. CAUSE:

7. TYPE:
 HISTORIC INJURY
 REQUIRED EVACUATION
 LTA (1-3 days)
 LTA (>3 days)
 RW/JT (1-3 days)
 RW/JT (>3 days)
 Other Injury

- EQUIPMENT FAILURE
- HUMAN ERROR
- EXTERNAL DAMAGE
- SLIP/TRIP/FALL
- WEATHER RELATED
- LEAK
- UPSET H2O TREATING
- OVERBOARD DRILLING FLUID
- OTHER **Hurricane Rita**

FATALITY 0
 POLLUTION
 FIRE
 EXPLOSION

9. WATER DEPTH: 2107 FT.

LWC HISTORIC BLOWOUT
 UNDERGROUND
 SURFACE
 DEVERTER
 SURFACE EQUIPMENT FAILURE OR PROCEDURES

10. DISTANCE FROM SHORE: 92 MI.

11. WIND DIRECTION: E
SPEED: 83 M.P.H.

12. CURRENT DIRECTION: SSE
SPEED: 3 M.P.H.

COLLISION HISTORIC >\$25K <=\$25K 13. SEA STATE: 43 FT.

17. INVESTIGATION FINDINGS:

In preparation for Hurricane Rita, the Typhoon TLP was evacuated on 09/20/2005. All operations were secured and all wells were shut-in. Following the passage of Hurricane Rita, the Typhoon TLP was found floating upside down, grounded in Eugene Island block 271.

The path of Rita was a southeast to northwest direction passing to the south of the Typhoon TLP. This path placed the TLP at approximately 46 miles from the center of the eye of Hurricane Rita at the closest point. At 0602 hrs CDT on 09/23/05, the Emergency Position Indicating Radio Beacon (EPIRB), located inside lifeboat #2 began broadcasting. At 0627 hrs CDT on 09/23/05, the EPIRB inside lifeboat #1 began broadcasting. These broadcasts indicated the approximate time of capsizing.

TLP Orientation

The TLP was oriented in the GC 237 block with the #2 pontoon at the 12 o'clock position (12 o'clock position has a heading of 0 degrees), the #3 pontoon at the 8 o'clock position and the #1 pontoon at the 4 o'clock position. The tendons are numbered 1-6 starting on pontoon #1 and progressing counterclockwise. Therefore, tendons 1 & 2 are on pontoon #1, tendons 3 & 4 are on pontoon #2, and tendons 5 & 6 are on pontoon #3. The flare boom and #2 lifeboat are located on the northwest side of the structure between pontoons 2 & 3. The quarters and heliport are located on the southeast side of the structure directly over pontoon #1.

Metocean hindcast data indicates the following probable metocean conditions at the Typhoon TLP location at the time of capsizing:

- 1 Hour Wind = 83 mph towards 266 degrees heading
- Significant Waves = 43.5 feet towards 288 degrees heading
- Peak Wave Period - 14.4 seconds
- Inertial Current - 2.97 knots towards 349 degrees heading

Rig Movement Data indicates:

- GPS data analysis indicates that the Mobile Offshore Drilling Unit (MODU) Diamond "Ocean Star" begins drifting at approximately 23:00 hrs CDT on 09/22/05.
- GPS data analysis indicates that the MODU Noble "Therald Martin" begins drifting at approximately 02:30 hrs CDT on 09/23/05.
- GPS data analysis indicates that the MODU Noble "Max Smith" begins drifting at approximately 03:00 hrs CDT on 09/23/05.
- The MODU Transocean "Marianas" begins drifting at an unknown time. There is no GPS data available for analysis.
- Based on original positions of the rigs and the GPS tracks, none of the rig contacted the TLP. Also, based on time, speed, and distance analysis of the Transocean "Marianas", the "Marianas" was still approximately 25-30 miles to the southeast of the TLP at the time of capsizing.

An inspection of the TLP hull was conducted along with inspections of the the suspect MODUs. No impact marks on the TLP pontoons or hull were found. The TLP platform decks have limited damage. The flare boom side of the TLP shows visible damage, however, the damage does not match up to any deck or column damage on the MODUs.

High resolution sidescan sonar and ROV surveys were conducted at Green Canyon 237. All drag marks not associated with the "Therald Martin" or "Max Smith" were old features and did not occur during Hurricane Rita. There is no evidence of snagging of the steel cantenary risers (SCRs), risers, flowlines, or umbilicals.

Inspection of the tendon porches, hull upper structure, pontoons, central shaft, and ballast tanks revealed the following:

- Major damage on tendon porches 3, 4, 5, and 6.
- Little damage on tendon porches 1 & 2.

Post incident hull and pontoon inspections revealed:

- Pontoons 1A and 1B revealed no water.
- Pontoons 2A and 2B revealed no water.

- pontoons 3A and 3B revealed no water.
- Only central shaft had evidence of water in TLP prior to capsizing.

ROV surveys of the bottom connectors at the GC 237 location revealed:

- Tendons 3, 4, & 6 bottom connectors were still located inside the piles.
- Tendons 1, 2, & 5 bottom connectors were located outside the piles and buried approximately 40-80' into the mud.
- Recovered bottom connectors 1, 2, & 5, all had separated bodies; and all lock rings were missing.
- Recovered shrouds from piles 1 & 5 have identical damage features.
- Shroud from bottom connector 2 (inside pile 2) was not recovered. It appeared to be relatively undamaged.

3D Photogrammetry was conducted inside the bottom piles. Markings were matched up on the bottom connectors and inside the piles. The 3D Photogrammetry revealed that the damage and markings inside drive heads and receptacles of piles 1 & 5 were similar. The #2 pile drive head and receptacle indicated very little damage & markings. The 3D Photogrammetry also revealed similar damage on the load shoulder locations (associated with the lock ring "gap" and 180 degrees from the lock ring "gap") on piles 1, 2, 4, & 5.

Finite Element Analysis (FEA) of the Lock Ring

- FEA of the lock ring indicates non-uniform load transfer associated with the lock ring "gap" when subjected to 100 thousand pounds (kips) of tension and 122 thousand foot pounds bending force. However, the FEA does not show applied load is sufficient to cause failure. The FEA was conducted with 3250 kips of tension and no bending. This analysis also revealed non-uniform load transfer with the lock ring "gap".
- Lock ring material by design is stronger than the load shoulder inside the receptacle.
 - Lock rings were not found on the location.

Testing of the flex joint portion of the #1 bottom connector confirmed that the flex joint had rotational stiffness properties as per the basis of design.

Evidence Summary of Downward Motion or "Short Stroke"

- Short strokes were observed on all tendons during installation. Some short strokes were approximately 10".
- Evidence indicates downward motion in pile 5. Capsizing rotation strokes bottom connector down. This stroke downward is as much as 8' at 20 degrees list. At this point tendons 4 and 5 go slack immediately. Tendons 3 and 6 go to peak tension.
- There is little evidence of downward motion in pile 1. Marks in pile 1 appear to be old. Marine growth is on top of the marks. Identified white marks (footprints) from work boots are easy to make.
- There is little evidence of downward motion in pile 2. Marks in pile 2 appear to be old. Marine growth is on top of marks.

Tendon Tension

- Model testing of the TLP and tendons indicate that large waves can generate simultaneous minimum tensions on all tendons. This phenomenon is called "ringing" of the tendons. (Note: Actual ringing was measured during Hurricane Lili.)
- The model testing indicates that extremely low tensions (<500 kips) is only seen from wave impact on the production deck.
- No physical evidence of wave impact on the TLP production deck.

18. LIST THE PROBABLE CAUSE(S) OF ACCIDENT:

The key findings of this investigation indicate that the most probable cause of the capsizing of the Typhoon TLP facility was the loss of integrity of the mooring systems on pontoon 1; specifically the bottom connector system at piles 1 & 2. This is supported by evidence of loss of integrity in the load shoulder in piles 1 & 2. This damage is evident in piles 1, 2, 4, & 5. Further metallurgical analysis of recovered material from inside the shrouds (1 & 5) which is believed to be from the load shoulder reveals evidence of shear ductile overload, plastic deformation, and deformed surfaces.

The failure of the mooring system on pontoon 1 would cause a capsizing rotation around a center axis located from the center-line tip of pontoon 3 and the center-line tip of pontoon 2. This is first supported by the extensive damage to the flare boom and #2 lifeboat. These components were located on the side of the structure that would impact the water first. This is also supported by the evidence of major damage to the tendon porches for tendons 3, 4, 5, & 6.

19. LIST THE CONTRIBUTING CAUSE(S) OF ACCIDENT:

There are several potential causes that have been determined to be unlikely. The first is the loss of tension due to a down stroke. This has been ruled out due to no indication of wave impact on the TLP production deck and visual observations inside of pile 1 & 2 receptacle do not provide clear evidence to support.

Failure of the lock ring has been ruled unlikely because the lock ring material by design is stronger than load shoulder material and the lock rings have not been located.

There is no evidence of direct collision. There are no impact marks on the hull, pontoons, or topside. No MODU paths coincide with Typhoon TLP at time of capsizing. The MODU damage does not support collision with the TLP. Also, there is no evidence of snagging of risers, umbilicals, SCR's or tendons. There are no drag marks to support this. The observed "failed" state of equipment is consistent with recoil or dropping after parting from the TLP after capsizing.

Other contributing causes that have been ruled unlikely are that metocean conditions exceeded the survival design and/or the TLP motions differed from expected response in storm conditions. There is no evidence of large wave striking the production deck. Maximum conditions during Rita were below the 1000 year storm criteria ($H_s = 49'$). Further, the TLP motion responses predicted from original design and Morpeth model tests were consistent with DNV computer simulation and Marin model tests conducted as part of the RCA investigation.

20. LIST THE ADDITIONAL INFORMATION:

21. PROPERTY DAMAGED:

NATURE OF DAMAGE:

22. ~~RECOMMENDATIONS TO PREVENT RECURRENCE NARRATIVE:~~
MMS recommends that a study of the mooring system be done for the purposes of:
1. Determining if there are possible "quick fixes" for those existing tension-leg-platform facilities that have this type of mooring system.
2. Determining if this mooring system is still an acceptable mooring system for floating offshore installations.

23. POSSIBLE OCS VIOLATIONS RELATED TO ACCIDENT: **NO**

24. SPECIFY VIOLATIONS DIRECTLY OR INDIRECTLY CONTRIBUTING. NARRATIVE:

N/A

25. DATE OF ONSITE INVESTIGATION:

26. ONSITE TEAM MEMBERS:
Andy Sheffield - USCG / David Dykes
/

29. ACCIDENT INVESTIGATION
PANEL FORMED: **NO**

OCS REPORT:

30. DISTRICT SUPERVISOR:
J. David Dykes

APPROVED
DATE: **01-JAN-2007**

