
BOEMRE

U.S. Department of the Interior
Bureau of Ocean Energy Management,
Regulation and Enforcement
Gulf of Mexico OCS Region

**Safety
Alert**

Safety Alert No. 296
12 May 2011

Contact: Russell Hoshman
(504) 736-2627

Catastrophic Failures in Mooring Systems Possibly Put Floating Structures at Risk

In early 2011, a single point mooring system for a deepwater Gulf of Mexico (GOM) project failed at the tether chain for a free-standing hybrid riser, allowing the buoyancy air can and the free-standing flowline riser to separate. The 440-ton buoyancy air can rose suddenly to the surface while the free standing riser collapsed. Based on the investigation of this event and a review of historical events, BOEMRE is revising and re-issuing Safety Alert #259.



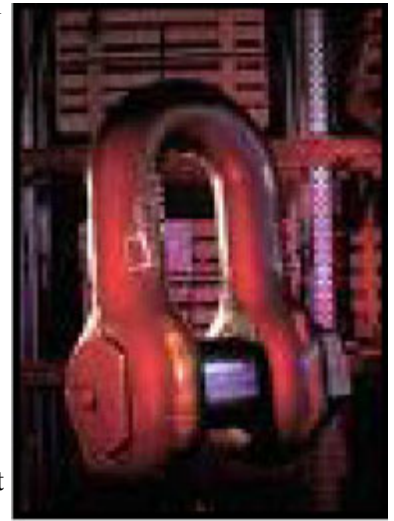
Failed Chain Link

The investigation determined that a 6 3/4-inch diameter, 862-pound chain link in the tether chain had fractured and separated near its butt weld. Analysis of the fracture indicated that the chain link had a weld repair and the fracture initiated in the middle of the weld. Three links of the 24-link tether chain were found to have weld repairs. After the chain had been heat treated, the non-US based manufacturer had made weld repairs to the chain by grinding defects and filling the void with weld material. The chain was being built in accordance with Det Norske Veritas (DNV) Offshore Mooring Chain standard. Post heat treat weld repairs are disallowed per DNV's Offshore Mooring Chain standard. The post heat treat weld repairs made the chain susceptible to hydrogen induced stress cracking due to the extreme hardness

of the weld material and the residual stress within the weld.

As indicated in Safety Alert #259, issued January 16, 2008, catastrophic failure occurred in a portion of an anchoring system in two other separate incidents. One component failed on a system in the GOM. The other was found during installation to be defective after a similar component failed overseas.

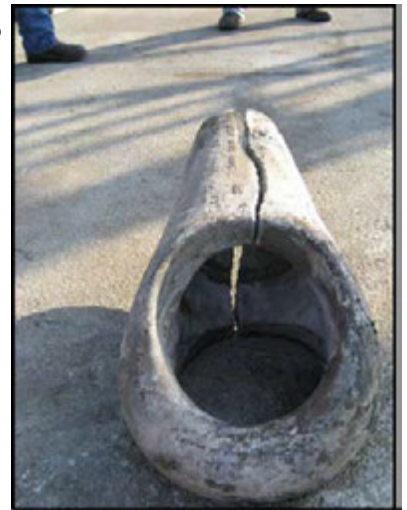
Incident No. 1: A one-ton, 8+ inch-diameter shackle connecting a mooring system to anchoring pilings failed on an overseas floating production facility. Subsequently, an identical shackle scheduled to be used in a deepwater GOM production facility also failed catastrophically under test loads below specifications. Operator reviews of the manufacturing and testing procedure and additional material testing indicated that all of the shackles were possibly defective.



Example: Mooring Shackle

Because anchor pilings with shackles attached had already been driven, the GOM test failure required new shackles to be manufactured, new pilings installed and the replacement of portions of the mooring systems that could not be recovered. Production start-up of the facility has been delayed by at least one year.

Incident No. 2: Two sockets in a mooring system for a MODU failed under moderate loading. Testing of the remaining sockets found that others were also defective and a number of them failed catastrophically at less than specification loading.



Failed Mooring Socket

The BOEMRE and the USCG 8th District concluded the following:

- In both cases the manufacturing procedures are thought to have been defective. Heat treating after casting apparently resulted in a metal unable to meet “Charpy” standards for material “toughness.”
- In both cases, the Operator’s and/or manufacturer’s specifications for the items were either out of date or inadequate.
- In both cases the Operator’s material testing requirements were either not followed, or were not adequate to insure specifications were met.
- Material handling during installation may have exposed the equipment to potential critical damage.

The BOEMRE recommends the following:

- **Operators** should review their specifications requirements to insure testing and manufacturing produces a product that will meet the usage demands.
- **Operators** should include sufficient *Charpy testing requirements* in the specifications to insure the materials and manufacturing process will produce a product of sufficient toughness.
- **Operators** should review their requirements for both destructive and non-destructive testing of critical elements. Operators should insure their test coupons are properly representative.
- **Operators** should review their requirements for equipment inspection and handling to insure no damaging techniques are employed in transportation or installation.

Subsequent to the 2011 incident, the following recommendations are added:

- **Operators** should monitor and inspect critical mooring components 100% of the time during the manufacturing process.
- **Operators** should ensure that the personnel and companies contracted to perform inspections and quality assurance of critical mooring components are qualified to do so.
- **Operators** should treat the area above a buoyancy air can for a free-standing hybrid riser as potentially hazardous. No floating production facility or support vessel should be allowed to pass over a free-standing hybrid riser.

--BOEMRE--GOMR--
www.gomr.boemre.gov

A **Safety Alert** is a tool used by BOEMRE to inform the offshore oil and gas industry of the circumstances surrounding an accident or a near miss. It also contains recommendations that should help prevent the recurrence of such an incident on the Outer Continental Shelf.