ROTARY DRILLING

VESSEL INSPECTION AND MAINTENANCE

Unit V • Lesson 6

PETEX

ROTARY DRILLING SERIES

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(Photo: U.S. Coast Guard, Eighth Coast Guard District)

CHAPTER I
REGULATION OF MOBILE OFFSHORE DRILLING UNITS

All mobile offshore drilling units (MODUs) are subject, in one way or another, to material and operating regulations of either the flag of registry, the nation on whose outer continental shelf they may be operating, or both. This chapter explains the nature, scope, and applicability of various rules, regulations, and standards that provide guidelines for safety and, as a byproduct, efficient operation.

Some of these regulations are based on accepted standards of classification, which provide for a hull design that meets the stress, loading, stability, and damage survival criteria under anticipated wind and sea conditions that would be experienced in various locations of the world. The classification societies that develop standards include the American Bureau of Shipping, Lloyd's Register of Shipping, Det Norske Veritas, Bureau Veritas, Germanischer Lloyd, Registro Italiano, and Japanese Maritime Corporation.

INTERNATIONAL REGULATION

The Safety of Life at Sea (SOLAS) and other international conventions provide minimum standards that signatory nations agree to follow. For example, self-propelled semisubmersible and ship-shaped units, over 500 gross tons on an international voyage, carry convention certificates issued under the authority of their home government, which verify compliance with the SOLAS, 1960 regulations. Figure 1 is an example of the SOLAS Cargo Ship Safety Equipment Certificate.

The degree of regulation of mobile offshore drilling units depends on the government of registry. Most maritime nations have their own vessel requirements that incorporate the international conventions as well as the standards for classification. In addition, specific requirements pertaining to safety equipment, operations, and machinery are implemented with an inspection program.

Each coastal nation also regulates, to various degrees, oil exploration and exploitation activities on its outer continental shelf. Vessel operations are encompassed within frameworks of regulatory control that vary widely from one jurisdiction to another.

International standards for mobile offshore drilling units are being developed through the United Nations Intergovernmental Maritime Consultative Organization (IMCO). Representatives of many maritime nations, including the United States, are meeting to draft a mutually acceptable code for the construction and equipment of drilling units. Units that are built to conform to the code would not be subject to any additional or conflicting vessel requirements when operating in foreign outer continental shelf waters.

UNITED STATES REGULATIONS

United States mobile offshore drilling units come under a framework of safety regulations from the time construction begins to the end of their service life. The United States Coast Guard has principal jurisdiction, with requirements that provide for the safety of the vessel and its personnel, as well as considerations for the environment. Each U.S. agency and its authority over drilling units is listed in table 1.

CHAPTER II
PREVENTIVE MAINTENANCE

The key to a successful preventive maintenance program lies in the fact that the inspections and maintenance are carried out on a regular schedule with accurate records kept for each piece of equipment in the program. Although preventive maintenance involves some paperwork, the bulk of it falls on management in setting up and evaluating the program. On the rig, it is a simple matter of checking appropriate boxes on a form and logging a brief description of problems and corrective action to maintain the program.

There are many approaches to setting up a preventive maintenance program. The program used as an example in this chapter has proved to be effective, involves a minimum amount of record keeping, and is easily adaptable to specific operating requirements. A well-planned preventive maintenance program should be flexible so it can be modified to meet the specific requirements of a particular rig. For example, a jackup rig will have different equipment and, therefore, different maintenance requirements than a semisubmersible rig.

ADVANTAGES

Of the two kinds of maintenance possible, breakdown maintenance and preventive maintenance, the only feasible option for economic and safe operation is the latter. A well-executed preventive maintenance program can assure management and personnel that the rig and its equipment are safe and in optimum condition for continuing operation.

Because the preventive maintenance program will most likely involve drilling and marine personnel as well as the maintenance mechanic and electrician, one of the immediate benefits of such a program is that all personnel on the rig become "equipment conscious" – they become more aware of equipment operation. The primary long-term advantages are reduced operating expense, safer operations, improved pollution control, and compliance with government regulations.

Figure 7 is a graph showing the effectiveness of one preventive maintenance program during its first 12 months of operation. Failures and lesser malfunctions were reduced by 40 percent over this period, and this reduction can be attributed largely to the specified observation and care called for by the program. The graph represents the results of an actual study carried out by a large oil company for the purpose of evaluating its maintenance program.

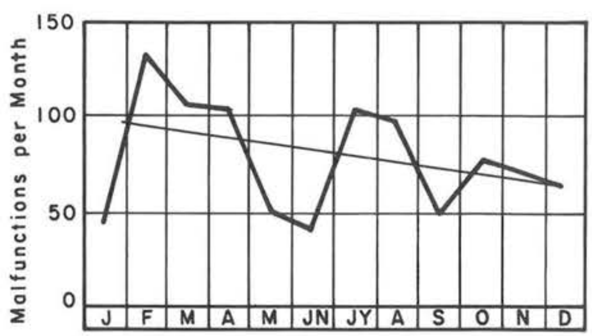

Figure 7. Monthly Malfunction Summary During a Year's Preventive Maintenance Program

CHAPTER III

CORROSION AND CATHODIC PROTECTION SYSTEMS

The reddish rust that appears on a piece of steel is powdery iron oxide, a combination of iron and oxygen. Because iron and oxygen are naturally active toward each other, most iron ores found in nature are oxides, or combinations of iron and oxygen. These iron ores are converted into iron and steel by exposing the ores to reactions that involve the input of large quantities of energy. However, the resulting materials are not stable, and there is the ever-present tendency for them to recombine with oxygen to form a stable oxide once again. This recombination is called corrosion, a chemical change accompanied by the production of electric current.

THE CORROSION PROCESS

Rapid rusting of iron requires three elements in the surrounding environment: oxygen, water, and a source of ions (positively or negatively charged atoms). All of these materials are usually available in abundance. Oxygen is present in the atmosphere, and with the exception of desert areas, the atmosphere is also laden with moisture at all times. In addition to periodic rains, most steel surfaces are exposed to dew at night and water vapor during daylight hours. Industrial fumes, smog, soot, salt spray, and other contaminants provide an ample source of ions, which dissolve in the available moisture. The ions dissolved in water provide the electrolyte to conduct the external current.

Corrosion Cells

Figure 13 shows what is, in effect, a tiny corrosion cell that produces rust. What is shown is a greatly magnified portion of an iron surface. Adjacent areas, so small they are not visible to the naked eye, act as anode and cathode. The anode is the area in which corrosion occurs and in which the current leaves the metal; the cathode is the area in which practically no corrosion occurs and in which current enters the metal. Anodes and cathodes can form on a single piece of metal because of local differences in the environment or in the metal itself; both iron and steel contain impurities that have various solution potentials or various tendencies to dissolve in an electrolyte.

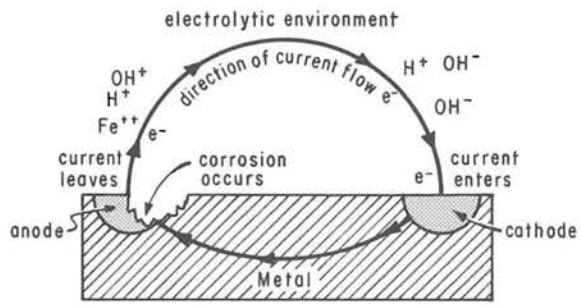

Figure 13. Corrosion Cell

On and immediately above the surface of the metal, there is moisture that contains ions to act as the electrolyte to conduct the external circuit; the internal circuit is provided by the metal, which is highly conductive. The result is a tiny battery cell. At the anode, iron goes into the solution as iron ions (Fe^{++}); these are positive particles that combine with

CHAPTER IV
PROTECTIVE COATINGS

The oldest and most common method of arresting or preventing corrosion consists of breaking the external circuit by using an insulating barrier or coating that adheres to the metal surface. To be totally effective, a protective coating must completely prevent transmission of oxygen, moisture, and ions, not only initially, but during service. It must also display perfect adhesion to the metal over a period of time and be unaffected by surface contaminants or byproducts of the corrosion reaction.

Unfortunately, no coating displays all of these properties, so it is necessary to select the coating or coatings that come closest to matching these ideals. No coating is completely impermeable, but some retard the penetration of oxygen, moisture, or ions better than do others. In addition to inhibiting primers, the protective coatings most frequently used are either oil type or plastic coatings. Table 3 outlines the relative merits of these two types of coatings.

Table 3. Comparison of Oil Type and Plastic Coatings

Property	Oil Type Coatings	Plastic Coatings		
		Vinyl	Epoxy	Chlorinated Rubber
water resistance	poor	excellent	good	excellent
chemical resistance	poor	excellent	excellent	excellent
solvent resistance	poor	resists alcohols, aliphatic, and aromatic hydrocarbons	excellent	same as for vinyl, but dissolves in aromatics
caustic resistance	film destroyed	undercuts, film not affected	excellent	same as for vinyl
sensitivity to surface contaminants	not sensitive	sensitive	sensitive	sensitive
adhesion	excellent	good, but critical	excellent	good, but critical with wash primer
physical properties	brittle to rubbery, limited abrasion resistance	hard and tough	hard and tough	hard and tough, but less tough than vinyl
weather resistance	limited	excellent	chalks	very good
temperature resistance	limited	limited	excellent	limited
application characteristics	very good	pinhole	pinhole	pinhole

GLOSSARY

anode: the electrode of an electrolytic cell at which oxidation occurs, usually the electrode that has the greater tendency to go into solution; the electrode at which electrons enter the external circuit

cathode: the electrode of an electrolytic cell at which reduction occurs, usually the area that is not attacked by corrosion; the electrode at which electrons enter from the external circuit

cathodic protection: protection of a metal by coupling it to a metal that is more likely to dissolve in water; the less resistant metal becomes the anode in any corrosion cell that develops; reduction or prevention of corrosion of a metal surface by making it cathodic by the use of sacrificial anodes or impressed currents

caustic: the hydroxyl radical, OH–, formed at the cathode of a corrosion cell; it combines with iron ions (Fe) in the presence of air and light to form rust

centrifugal wheel blasting: a method of surface preparation by blasting the surface with a mixture of shot and grit propelled by centrifugal force

classification society: a society for the promulgation of rules for the construction of vessels, the supervision of such construction, the classification of vessels according to merit, and the publication of a register listing them and classifying their essential features

corrective maintenance: maintenance of equipment by making repairs as necessary for its continuing operation; also called breakdown maintenance

corrosion: destruction of a metal by chemical or electrochemical reaction with its environment; a chemical change accompanied by the production of electric current brought about by the reaction of a metal with oxygen in the presence of an electrolyte

crevice corrosion: corrosion of a metal at an area where contact is made with a material, usually nonmetallic; corrosion that occurs at a crevice where two metal plates are joined

electrolyte: a nonmetallic electric conductor in which current is carried by the movement of ions; a chemical substance or mixture, usually liquid, containing ions, which migrate in an electric field

electromotive force series (emf series) of metals: ranking of metals from those having the greatest tendency to dissolve in water to those with the greatest resistance to dissolving in water; also called the galvanic series

film: a thin, not necessarily visible, layer of material

flag of registry: country under whose governmental authority a vessel is registered

REFERENCES

Davis, J. G., G. L. Doremus, and F. W. Graham, "The Influence of Environmental Conditions on the Design of Cathodic Protection Systems for Marine Structures," Offshore Technology Conference Paper Number OTC 1461, 1971

Davis, J. G., E. P. Doremus, and R. P. Pass, "Worldwide Design Considerations for Cathodic Protection of Offshore Facilities Including Those in Deep Waters," Offshore Technology Conference Paper Number 2306, 1975

Doremus, G. L. and J. G. Davis, "Marine Anodes: The Old and New," *Materials Protection,* January, 1967

"Electrical Engineering Regulations," 46 Code of Federal Regulations, Parts 110-113

"Marine Engineering Regulations," 46 Code of Federal Regulations, Parts 50-63

OCS Orders Governing Oil and Gas Lease Operations in the Outer Continental Shelf (by region), U.S. Department of the Interior, U.S. Geological Survey

Perry, R. H. and C. H. Chilton, eds., *Chemical Engineers' Handbook,* 5th ed., McGraw Hill, 1973

"Private Aids to Navigation, Outer Continental Shelf and Waters Under the Jurisdiction of the United States," 33 Code of Federal Regulations, Part 67

"Rules and Regulations for Artificial Islands and Fixed Structures on the Outer Continental Shelf," 33 Code of Federal Regulations, Parts 140-147

"Rules and Regulations for Cargo and Miscellaneous Vessels," 46 Code of Federal Regulations, Parts 90-97

"Rules and Regulations for Mobile Offshore Drilling Units," 46 Code of Federal Regulations, Parts 107-109

Rules for Building and Classing Offshore Mobile Drilling Units, American Bureau of Shipping, 1973

Runewicz, J., "Corrosion in the Deep Oceans," *Ocean Engineering,* November 15, 1974

Uhlig, H. H., ed., *The Corrosion Handbook,* John Wiley & Sons, 1948

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PETEX
THE UNIVERSITY OF TEXAS AT AUSTIN
PETROLEUM EXTENSION SERVICE
10100 Burnet Road, Bldg. 2
Austin, TX 78758

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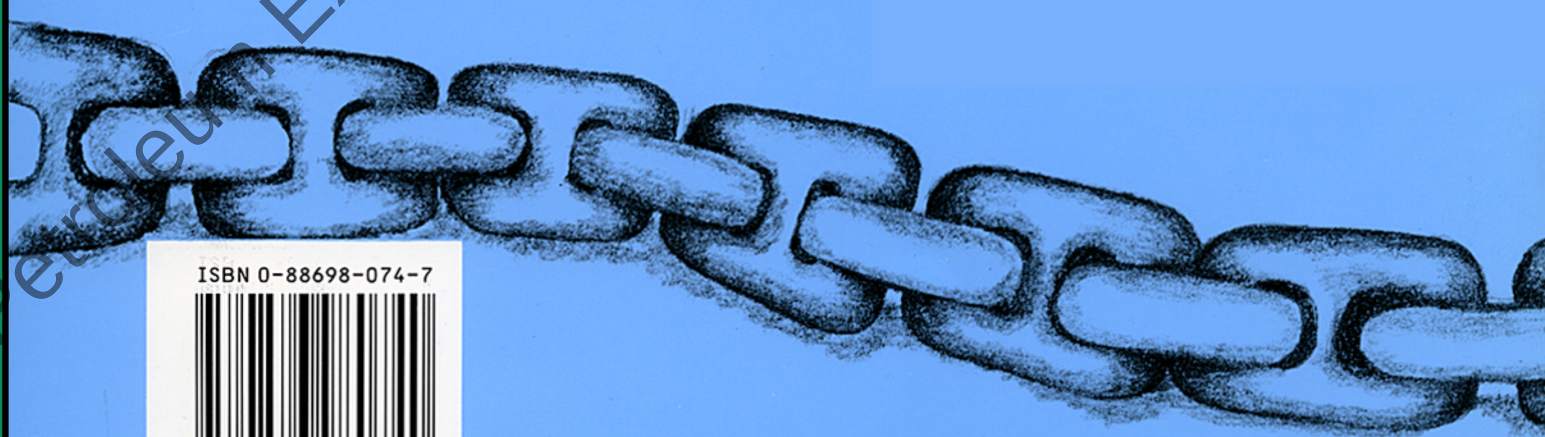

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