DESIGNING SAFE ONSHORE OIL & GAS FACILITIES

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ABSTRACT

When designing a Production Facility, many Engineers and Production Foremen are confronted with a multitude of codes, standards, best practices and even OSHA requirements. Often, the facility design is based on old outdated codes, standards or practices. Lack of proper engineering design can lead to equipment failure, lost production, human injury or harm to the environment.

The safety of a facility is a direct function of how the facility is designed. The oil and gas industry has produced many codes and standards, which were developed primarily in response to incidents that had occurred. Understanding and learning how to apply the various codes and standards can greatly increase the operability and safety of facilities.

This paper reviews the key areas of facility design that is critical to a safe facility. The paper explains how the different codes, standards and best practices can be used to develop safe and cost effective facilities.

BASIS OF PAPER

This paper is based on SPE 141974 which was published in the Oil and Gas Facilities Journal Vol. 1 No. 4, August 2012.

KEYS TO DESIGNING SAFE ONSHORE OIL & GAS FACILITIES

Getting Management "On Board"

In order to design a safe Onshore Oil & Gas facility, management must be committed to being sure that all facilities are designed and operated in accordance with good engineering practices, standards, and regulatory requirements.

Design Facilities Using these Twelve Steps to Safer Facilities

1. **Set a Design-Standard Policy.** It is very important to adapt a policy regarding the use of industry design standards on how surface facilities should be built that can be articulated to the production-operation groups. Industry design standards were implemented to reduce the risk of injury to personnel or the occurrence of environmental events.

2. **Lay out the site for Safety.** It is very important to arrange equipment so as to minimize risk to personnel and other equipment. It is customary to identify and locate the most hazardous equipment first such as vents, flares and fired equipment. Engines and rotating equipment should be located away from potential hydrocarbon releases. Offices, control rooms & storage areas should be located in the safest area possible. Electrical equipment should be located in accordance with API 500.

3. **Design Piping Properly.** In order to design a safe and reliable facility, it is imperative that the piping system be properly designed. OSHA addresses this topic in 29CFR 1910.106(c)(1)(i) stating that "The design (including selection of materials) fabrication, assembly, test, and inspection of piping systems containing flammable or combustible liquids shall be suitable for the expected working pressures and structural stresses. Conformity with the applicable provisions of Pressure Piping, ANSI B31 series and the provisions of this paragraph, shall be considered prima facie evidence of compliance with the foregoing provisions." For Oil and Gas Facilities, the primary ASME (formerly ANSI) piping codes are:
    a. B31.3 - Process Piping

b. B31.4 - Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids
c. B31.8 - Gas Transmission and Distribution Piping Systems

Since "upstream" Oil and Gas Facilities are not specifically covered by any of these codes, it is at the user's discretion to select the applicable piping code.

4. **Select the Proper Pressure Vessel.** The U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) has set rules that require pressure vessels used in flammable and combustible liquid service to be "built in accordance with the Code for Unfired Pressure Vessels, Section VIII of the ASME Boiler and Pressure Vessel Code." OSHA later made it clear to the oil and gas producing industry that all pressure vessels must conform to ASME Section VIII.

   The name plate, which should remain permanently affixed to a pressure vessel, must display the "U" stamp as an indication that the design, fabrication and testing were done in accordance with the BPVC. In addition, the purchaser should obtain a copy of the U1A form from the manufacturer which contains additional information on materials, fabrication and inspection.

   In order to maintain the integrity of pressure vessels, they must be periodically inspected. As a result of the inspection, sometimes the vessel must be repaired or re-rated. The most common Inspection Code is API 510, "Pressure Vessel Inspection Code: In-Service Inspection, Rating, Repair and Alteration." An alternate Inspection, Repair and Re-rating Code is NBIC (National Board Inspection Code) NB-23. API 510 8.1 states "All repairs and alterations shall be performed by a repair organization in accordance with the applicable principles of the ASME Code, or the applicable construction or repair code."

5. **Picking the Right Tank.** For Atmospheric Tanks, the regulations are similar to those for Pressure Vessels in that "tanks built in accordance" with API RP 12B, 12D, or 12F "shall be used only as production tanks for storage of crude petroleum in oil-producing areas." For Atmospheric Tanks, the Inspection and repair code is API 12R1.

6. **Specifying Rotating Equipment for Safety**. Each type of rotating equipment has particular industry specification requirements. Here are a few examples:
   a. **Centrifugal Pumps** – ANSI B73.1 or API 610
   b. **Reciprocating Compressors** – API 618

7. **Relief System Design is Critical.** The purpose of a relief system is to protect piping and equipment from excessive overpressure. Relief devices must comply with the appropriate ASME Vessel codes and relief systems must also comply with state and federal laws and codes. State and federal regulations cover environmental considerations as well as safety. The most common industry references are:
   a. API 520, Standard for Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries
      i. Part I—Sizing and Selection & Part II—Installation
   b. API RP 521 Guide for Pressure-Relieving and Depressuring Systems
   c. API 537 – Standard for Flare Details for General Refinery and Petrochemical Service
   d. ASME Boiler & Pressure Vessel Code Sec VIII – Rules for Construction of Pressure Vessels

8. **Determining the Right Electrical Area Classification.** The NEC classifies hazardous locations generally into two different "divisions" for the oil and gas industry. Class I, Division 1 locations are defined as locations where ignitable concentrations of flammable gases or vapors: 1) can exist under normal operations; 2) may exist frequently because of repair or maintenance or because of leakage; or 3) may exist because of equipment breakdown that simultaneously causes the equipment to become a source of ignition. The second classification, Class I, Division 2 locations are defined as locations where: 1) volatile flammable liquids or flammable gases or vapors exist, but are normally confined within closed containers; 2) where ignitable concentrations of gases, vapors, or liquids are normally prevented by positive mechanical ventilation; or 3) adjacent to a Class I, Division 1 location where ignitable concentrations might be occasionally communicated.

9. **Design the Instrumentation and Control System for Safety.** Instrument alarms and shut-downs provide the first level of safety in the event that a process upset has occurred. Safety systems are defined in levels of protection to prevent or minimize the effects of equipment failure within the process. Most facilities are built with two levels of protection however, in some small and remote facilities, one level of protection is deemed appropriate. API 14C is an excellent reference for designing safety systems.

10. **Personnel Safety.** It is important to design facilities so as to minimize personnel risks. The design should be examined to make sure that personnel are not at risk while performing routine tasks and that all OSHA requirements are met.

11. **Conducting a Process Hazard Analysis.** The process hazard analysis (PHA) is a systematic method to identify and analyze the potential hazards associated with a facility. The results of the PHA should include findings, a risk ranking of the findings and recommendations to resolve any of the findings.

12. **Design Verification and Commissioning.** The successful Pre-Start-up Safety Review (PSSR) is a formal process to ensure that each component and system in a facility is thoroughly checked and ready to be brought into service. It is customary to use checklists so that nothing is overlooked and sign-off can be done as each section is complete.

SUMMARY

Many incidents and injuries can be prevented if production facilities are properly designed, thoroughly analyzed for potential hazards and carefully reviewed prior to start-up.