MEMORANDUM

FOR:

FROM:

SUBJECT:

On July 23, 1984, a refinery at Romeoville, Illinois, owned and operated by the Union Oil Company of California, experienced a disastrous explosion and fire. An amine absorber pressure vessel rupture released large quantities of flammable gases and vapors. Seventeen lives were lost, seventeen persons were hospitalized, and more than $100 million in damages resulted. In coordination with the Directorate of Technical Support, the following information is forwarded.

The amine absorption process removes hydrogen sulfide or carbon dioxide from a gaseous mixture. The amine is allowed to flow down through a tower where it is contacted by the gaseous mixture to be purified, which is moving up the tower. The amine, which has become contaminated with hydrogen sulfide or carbon dioxide, is discharged from the bottom of the tower to a steam stripper. The contaminated amine flows in the steam stripper countercurrent to the steam which strips the hydrogen sulfide or carbon dioxide from it. The amine is then returned to the top of the absorption tower for reuse.

Amine absorbers in refineries are subject to hydrogen attacks and various kinds of corrosion. The field investigation conducted by OSHA staff in Region V determined, among other things, that the Union Oil absorber had a lengthy history of in-service defects and appeared to have been inadequately maintained. After OSHA acquired custody of portions of the ruptured vessel, an in-depth analysis of the causal factors was initiated through the National Bureau of Standards (NBS).

NBS conducted chemical analyses, fracture mechanics analyses, stress corrosion cracking susceptibility tests, hydrogen cracking susceptibility tests, microhardness tests, fracture toughness tests, magnetic particle inspection, ultrasonic examination, galvanic corrosion and welding tests, and examined metallographic pictures. Preliminary NBS test results indicate that the subject plate material (ASTM A 516, Grade 70, Carbon Steel) of the amine absorber was susceptible to hydrogen-induced cracking. Furthermore, repair welds which had been accomplished in the field and had not been stress relieved were especially sensitive to amine-induced corrosion and cracking. Effective methods for the periodic detection of cracks are necessary.

In response to the petroleum industry's concerns, the National Association of Corrosion Engineers (NACE) conducted a survey of many similar refinery vessels and associated equipment. It is our understanding that preliminary results of the survey indicate that approximately 60 percent of 24 amine absorbers evaluated exhibited cracking. Very early data indicated that 12 of 14 monoethanolamine (MEA) units and three of five diethanolamine (DEA) units exhibited cracking. Sixteen instances of cracking were reported in associated equipment (i.e., regeneration units and piping) exposed to a chemically similar environment. Additionally, a similar survey by the Japan Petroleum Institute indicates that cracking has occurred in 72% of the amine gas treatment facilities which had responded to the survey.

Preliminary data indicate that the manner of field modification and repair of amine absorbers and associated equipment is critical to safe operation. Of particular concern are welding procedures and methods. Field welding procedures can significantly contribute to brittle failures with greater susceptibility to hydrogen embrittlement and localized corrosion of these types of refinery pressure vessels. Therefore, it should be noted that the ASME Boiler and Pressure Vessel Codes, Section IX, the ANSI/NB-23, Manual for Boiler and Pressure Vessel Inspectors, and the API 510 Pressure Vessel Inspection Code, February 1983, address the acceptable considerations and procedures for inspection, welding repair and modification of pressure vessels.

Exhibit: 28
Date: 9/20/13
Copies of this memorandum shall be forwarded to State Designees and it is recommended that all refineries within the jurisdiction of OSHA Area Offices and State Plan States be advised of the potentially hazardous circumstances relative to amine absorber units. A draft letter is attached which may be used for this purpose. Even though the petroleum industry is concerned about this condition, Area Office, State Programs and Consultation Programs personnel are encouraged to develop outreach programs which will alert refinery management to these circumstances and should advise them of the technical assistance available from the NACE and NBS.

Attachment

Draft Letter to Refineries

Dear (Refinery Manager):

It has come to our attention that refinery pressure vessels and associated equipment, involved in amine gas treatment of petroleum products, are prone to cracking and potentially catastrophic failure. As the result of a 1984 disaster at Union Oil's Chicago Refinery, the National Bureau of Standards, the National Association of Corrosion Engineers and the Japan Petroleum Institute are evaluating associated problems.

Preliminary data indicate that the manner of field modification and repair of amine absorbers and associated equipment is critical to safe operation. Of particular concern are welding procedures and methods. Field welding procedures can significantly contribute to brittle failures with greater susceptibility to hydrogen embrittlement and localized corrosion of these types of refinery pressure vessels. Therefore, it should be noted that the ASME Boiler and Pressure Vessel Codes, Section IX, the ANSI/NB-23, Manual for Boiler and Pressure Vessel Inspectors, and the API 510, Pressure Vessel Inspection Code, February 1983, address the acceptable considerations and procedures for inspection, welding repair and modification of pressure vessels. OSHA believes that close coordination between operators and the knowledgable technical community can lead to operational solutions which may avert a future catastrophe related to amine absorber units. These technical resources include:

Dr. Harry I. McHenry
Fracture and Deformation
Division Center for Materials Science
U.S. Department of Commerce
National Bureau of Standards
Boulder, Colorado 80303
Telephone: 303-497-3268

Task Group T-8-14
National Association of Corrosion Engineers
P.O. Box 218340
Houston, Texas 77218
Telephone: 713-492-0535

Thank you for your attention to this very serious problem.

Sincerely,