U. S. Chemical Safety and Hazard Investigation Board

RECOMMENDATIONS STATUS CHANGE SUMMARY

Report:	Chevron Refinery Fire
Recommendation Number(s):	2012-3-I-CA-R28
Date Issued:	January 28, 2015
Recipient:	American Petroleum Institute (API)
New Status:	Closed – Acceptable Action
Date of Status Change:	June 8, 2017

Recommendation Text:

CSB Recommendation No. 2012-03-I-CA-R28:
Revise API 570: Piping Inspection Code: In-service Inspection, Rating, Repair, and Alteration of Piping Systems to:

a. *Use terminology consistent with API RP 939-C: Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries and other API standards and recommended practices discussed in this report. Replace the terminology "high-temperature sulfur corrosion" with "sulfidation corrosion";*
b. *Specify that sulfidation corrosion rates in carbon steel piping can be significantly faster in some individual piping components than in others;*
c. *Establish a new section that details inspection requirements to identify low-silicon piping components in carbon steel circuits susceptible to sulfidation corrosion. This section shall require users to identify carbon steel piping circuits at risk to contain low-silicon components by following the requirements detailed in API RP 939-C: Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries (pursuant to 2012-03-I-CA-26(a)) and API RP 578: Material Verification Program for New and Existing Alloy Piping Systems (pursuant to 2012-03-I-CA-29). At a minimum, require users to either:*
    i. *Inspect every component within all carbon steel piping circuits susceptible to sulfidation corrosion that may contain low-silicon components once. The purpose of this practice is to identify any low-silicon components that are corroding at accelerated rates. Inspection may be performed through ultrasonic thickness measurements to establish corrosion rates for each component, destructive laboratory analysis, or other methods. Following the inspection, require users to follow the low-silicon corrosion rate monitoring requirements established in 2012-03-I-CA-R26(c); or*
    ii. *Replace the identified at-risk carbon steel piping with a steel alloy that is more resistant to sulfidation corrosion.*
d. *Incorporate as a "normative reference" API RP 939-C: Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries; and*
e. *Require users to follow the minimum leak response guidance established in API RP 2001: Fire Protection in Refineries, developed in response to recommendation 2012-03-I-CA-R31.*[1]

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[1] CSB Recommendation No 2012-03-I-CA-R31: Revise API RP 2001: Fire Protection in Refineries to require users to develop a process fluid leak response protocol specific to their own facility that must be followed when a process fluid leak is discovered. Recommend users to incorporate the following actions into their leak response protocol:
a. Establish an Incident Command structure upon identification of a process fluid leak;
b. Conduct a pre-response meeting with personnel with specific technical expertise (e.g., inspectors, operators, metallurgists, engineers, and management) and the Incident Commander to determine pressure, temperature, remaining inventory of process fluids, potential damage mechanisms that caused the leak, and worst-case leak scenario;

A. Rationale for Recommendation

On August 6, 2012, the Chevron Refinery in Richmond, California, experienced a catastrophic pipe failure in a crude unit, causing the release of flammable hydrocarbon process fluid which partially vaporized into a large cloud. Nineteen Chevron employees engulfed by the vapor cloud escaped, narrowly avoiding serious injury. The ignition and subsequent continued burning of the hydrocarbon process fluid resulted in a large plume of unknown particulates and vapor. Approximately 15,000 people from the surrounding area sought medical treatment in the weeks following the incident. The CSB's investigation found that the pipe failure was caused by sulfidation corrosion, a damage mechanism that causes piping walls to thin over time.

The CSB identified several contributing causes of the incident relating to various American Petroleum Institute (API) standards, recommended practices and guidelines, specifically with regard to piping corrosion, damage mechanisms, inspections, material verification and fire protection. API 570, *Piping Inspection Code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems,* specifies practices that must be performed regarding inspection, rating, repair, and alteration of metallic and fiberglass-reinforced plastic piping systems. In Section 8, Repairs, Alterations, and Rerating of Piping Systems, the code specifies requirements when performing on-stream piping repairs, such as weld repairs, installing a clamp, or wrapping the piping. However, API 570 does not require safety evaluation of the leak, nor does it refer to any document that outlines the necessary safety precautions and evaluations, before attempting on-stream repairs. To better align the API standards that address leak repair and leak response, API 570 should require users to follow the process leak response safety requirements established in other standards.

B. Response to the Recommendation

In February 2016, API published the fourth edition of API RP 570. API made the following changes in response to the CSB's recommendation:

> *Revise API 570: Piping Inspection Code: In-service Inspection, Rating, Repair, and Alteration of Piping Systems to:*
>
> *a. Use terminology consistent with API RP 939-C: Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries and other API standards and recommended practices discussed in this report. Replace the terminology "high-temperature sulfur corrosion" with "sulfidation corrosion";*
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> In response to part a., the 4th edition of API 570, "sulfidation corrosion" is used instead of "high-temperature sulfur corrosion." There are no longer any instances of "high-temperature sulfur corrosion" in the standard.
>
> *b. Specify that sulfidation corrosion rates in carbon steel piping can be significantly faster in some individual piping components than in others;*
>
> *c. Establish a new section that details inspection requirements to identify low-silicon piping components in carbon steel circuits susceptible to sulfidation corrosion. This section shall require users to identify carbon steel piping circuits at risk to contain low-silicon components by following the requirements detailed in API RP 939-C: Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries (pursuant to 2012-03-I-CA-26(a)) and API RP 578: Material Verification*

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c. Establish a hot zone that identifies the area of risk of exposure or injuries due to flame contact, radiant heat, or contact to hazardous materials, taking into consideration the worst-case leak scenario;
d. Limit site access around leak location to essential personnel only;
e. Isolate the leaking piping or vessel, or if isolation is not possible, shutdown of the unit when the leaking process fluid poses immediate danger to safety, health, or the environment—such as piping fluid that is toxic or near the autoignition temperature.

Program for New and Existing Alloy Piping Systems (pursuant to 2012-03-I-CA-29). At a minimum, require users to either:

i. *Inspect every component within all carbon steel piping circuits susceptible to sulfidation corrosion that may contain low-silicon components once. The purpose of this practice is to identify any low-silicon components that are corroding at accelerated rates. Inspection may be performed through ultrasonic thickness measurements to establish corrosion rates for each component, destructive laboratory analysis, or other methods. Following the inspection, require users to follow the low-silicon corrosion rate monitoring requirements established in 2012-03-I-CA-R26(c); or*

ii. *Replace the identified at-risk carbon steel piping with a steel alloy that is more resistant to sulfidation corrosion.*

In response to part b. and c., the 4th edition of API 570, API has added language that clarifies that corrosion rates in carbon steel piping can be faster in some components than others.

Section 5.12, Page 46: "In lines in older process units operating above 500 °F (260 °C) and subject to sulfidation corrosion, carbon steel piping containing less than 0.1 wt % silicon can corrode at significantly higher rates than higher silicon carbon steels (modern "silicon-killed" process). For piping systems in circuits that have been identified in sulfidation corrosion service that may contain older low silicon carbon steels, consideration should be given to conducting inspection of each piping segment in order to identify the worst case corrosion rate / limiting component."

d. *Incorporate as a "normative reference" API RP 939-C: Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries; and*

In response to part d., API has added API RP 939-C as a normative reference.

e. *Require users to follow the minimum leak response guidance established in API RP 2001: Fire Protection in Refineries, developed in response to recommendation 2012-03-I-CA-R31.*

API RP 2001 is currently under review and the 10th version is due to be published in late 2017. Instead, API states that API 570 contains a normative reference to NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, in order to provide guidance for incident responders.

While the changes to API 570 do not fulfill every aspect of the CSB's recommendation, API's actions meet the intent of the recommendation by using the term "sulfidation corrosion," the addition of language that clarifies that corrosion rates in carbon steel piping can be faster in some components than others, language regarding the inspection of low silicon carbon steel piping susceptible to sulfidation corrosion, the incorporation of API RP 939-C as a normative reference, and referencing NFPA 704 for leak response guidance.

C. Board Analysis and Decision

Overall, API made changes responsive to the CSB's recommendation in the fourth edition of API RP 570. As a result, the Board voted to designate **CSB Recommendation No. 2012-03-I-CA-R28** as **"Closed – Acceptable Action."**