



U. S. Chemical Safety and Hazard Investigation Board RECOMMENDATIONS STATUS CHANGE SUMMARY

Report:	Chevron Refinery Fire
Recommendation Number(s):	2012-3-I-CA-R14
Date Issued:	April 19, 2013
Recipient:	California State Legislature, Governor of California
New Status:	Closed –Acceptable Alternative Action
Date of Status Change:	May 30, 2018

Recommendation Text(s):

Monitor and confirm the effective implementation of the damage mechanism hazard review program (2012-03-I-CA-R9 and 2012-03-I-CA-R10), so that all necessary mechanical integrity work at all California Chevron Refineries is identified and recommendations are completed in a timely way.

Board Status Change Decision:

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 a flammable hydrocarbon process fluid which partially vaporized into a large cloud. Nineteen Chevron employees engulfed by the vapor cloud narrowly escaped 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 U. S. Chemical Safety and Hazard Investigation Board's (CSB) investigation found that the pipe failure was caused by sulfidation corrosion, a damage mechanism that causes piping walls to thin over time. The CSB also found that the California Process Safety Management (PSM) regulation did not require the conducting of formal damage mechanism hazard reviews, and that the Process Hazards Analysis (PHA) team for the crude unit at the Richmond refinery did not identify the damage mechanism sulfidation corrosion as a potential cause of a leak or rupture in the piping. Additionally, the CSB found that the California PSM regulation did not require the use of a recognized methodology for making an objective determination of the effectiveness of safeguards in place to prevent a hazardous consequence from occurring. A more detailed safeguard analysis, which requires sufficient consideration of the principles of inherently safer technology and to driving risks As Low As Reasonably Practicable (ALARP), could have identified the need to upgrade the metallurgy of the piping to a material less susceptible to sulfidation corrosion.

The CSB concluded that the systematic and documented consideration of inherently safer systems and the hierarchy of controls to the greatest extent feasible by Chevron and other

process plants during PHAs, Management of Change (MOC) analyses, prior to new construction, rebuilds, and repairs, and in the development of corrective actions from incident investigation recommendations, would provide a more adequate degree of protection from incidents like the one that occurred on August 6, 2012.

Finally, the CSB concluded that the reporting of leading and lagging process safety indicators to the relevant regulators would be an important driver for continual improvement of refinery operations in the state of California. The reporting of indicators and additional information related to activities such as damage mechanism hazard reviews and maintenance-related shutdowns promotes greater transparency and facilitates increased collaboration between regulators and industry in chemical accident prevention.

Based on these findings, the CSB issued six recommendations to the California State Legislature and the Governor. This recommendation only pertains to the monitoring and implementation of the damage mechanism hazard review program.

B. Response to the Recommendation

The newly adopted California PSM for Petroleum Refineries regulation (Section 5189.1),¹ which became effective on October 1, 2017, requires refineries to complete damage mechanism reviews under a new subsection (k) and prescribes the timing allowed for completion of the action items under new subsection (x):

(k) Damage Mechanism Review.

- (1) The employer shall complete a DMR for each existing and new process for which a damage mechanism exists. Where no DMR is performed, the employer shall document the rationale for the determination that no damage mechanisms exist. The employer shall determine and document the priority order for conducting DMRs based on the process operating history, the PHA schedule and inspection records.
- (2) The employer shall complete no less than fifty (50) percent of initial DMRs within three (3) years and all remaining DMRs within five (5) years of the effective date of this section. If the employer has conducted and documented a DMR for a process unit up to five (5) years prior to the effective date of this section, and that DMR includes the elements identified in subsection (k)(8), that DMR may be used to satisfy the employer's obligation to complete an initial DMR under this subsection.
- (3) A DMR shall be revalidated at least once every five years.
- (4) A DMR shall be reviewed as part of a major change on a process for which a damage mechanism exists, prior to approval of the change. If a major change may introduce a damage mechanism, a DMR shall be conducted, prior to approval of the change.
- (5) Where a damage mechanism is identified as a contributing factor in an incident investigation, pursuant to subsection (o), the employer shall review the most recent DMRs that are relevant

¹ For a copy of the regulation visit https://www.dir.ca.gov/title8/5189_1.html (accessed April 23, 2018).

to the investigation. If a DMR has not been performed on the processes that are relevant to the investigation, the incident investigation team shall recommend that a DMR be conducted and completed within a specified timeframe.

- (6) The DMR for a process unit shall be available to the team performing a PHA for that process unit.
- (7) The DMR shall be performed by a team with expertise in engineering, equipment and pipe inspection, damage and failure mechanisms, and the operation of the process or processes under review. The team shall include one member knowledgeable in the specific DMR methodology being used. The employer shall provide for employee participation pursuant to subsection (q).
- (8) The DMR for each process shall include:
 - (A) Assessment of process flow diagrams;
 - (B) Identification of all potential damage mechanisms, pursuant to subsection (k)(9);
 - (C) Determination that the materials of construction are appropriate for their application and are resistant to potential damage mechanisms;
 - (D) Methods to prevent or mitigate damage; and,
 - (E) Review of operating parameters to identify operating conditions that could accelerate or otherwise worsen damage, or that could minimize or eliminate damage.
- (9) For purposes of this subsection, damage mechanisms include, but are not limited to:
 - (A) Mechanical loading failures, such as ductile fracture, brittle fracture, mechanical fatigue and buckling;
 - (B) Erosion, such as abrasive wear, adhesive wear and fretting;
 - (C) Corrosion, such as uniform corrosion, localized corrosion and pitting;
 - (D) Thermal-related failures, such as creep, metallurgical transformation and thermal fatigue;
 - (E) Cracking, such as stress-corrosion cracking; and,
 - (F) Embrittlement, such as high-temperature hydrogen attack.
- (10) DMRs shall include an assessment of previous experience with the process, including the inspection history and all damage mechanism data; a review of industry-wide experience with the process; and all applicable standards, codes and practices.
- (11) At the conclusion of the analysis, the team shall prepare a written DMR report, which shall include the following:
 - (A) The process unit and damage mechanisms analyzed;
 - (B) Results of all analyses conducted, pursuant to subsection (k)(8);
 - (C) Recommendations for temporarily mitigating damage; and,
 - (D) Recommendations for preventing damage.
- (12) The report shall be provided to and, upon request, reviewed with employees whose work assignments are within the process unit described in the DMR.
- (13) The employer shall implement all recommendations in accordance with subsection (x).

(14) DMR reports shall be retained for the life of the process unit.

(x) Implementation.

(10) Except as required in subsections (x)(11) and (x)(13), each corrective action that does not require a process shutdown shall be completed within thirty (30) months after the completion of the analysis or review, unless the employer demonstrates in writing that it is infeasible to do so.

(12) Each corrective action requiring a process shutdown shall be completed during the first regularly scheduled turnaround of the applicable process, following completion of the PHA, SPA [Safeguard Protection Analysis], DMR [Damage Mechanism Review], HCA [Hierarchy of Controls Analysis], MOC [Management of Change], Compliance Audit or Incident Investigation, unless the employer demonstrates in writing that it is infeasible to do so.

In addition, California's Division of Occupational Safety and Health, or Cal/OSHA, informed the CSB that their staff will be periodically conducting Program Quality Verification (PQV) inspections at facilities under the new California PSM for Petroleum Refineries regulation, where a team of five staff members will visit each refinery in the state and audit the facility based on their compliance with each section of the new regulation. For the first time ever, the team will examine each facility's indicator data during this inspection.

B. Board Analysis and Decision

Although the requirements do not include active monitoring by the regulator, the intent of this recommendation has been met, and, the Board voted to change the status of Recommendation No. 2012-30I-CA-R14 to: **“Closed-Acceptable Alternative Action.”**