APPENDIX TO:

Improving Public and Worker Safety at Oil Refineries

Report of the Interagency Working Group on Refinery Safety

Table of Contents

Digital copies of documents in the Appendix can be found at:

RAND Corporation memo Refinery Process Safety Performance
and Models of Government-Industry Relations:
www.rand.org/content/dam/rand/pubs/testimonies/CT300/CT392/RAND_CT392.pdf

Cal/OSHA citations:
www.dir.ca.gov/DOSH/citation.html

CSB recommendations to the Governor and Legislature:
www.csb.gov/chevron-refinery-fire/

Chemical Safety Board Interim Investigation Report:
www.csb.gov/assets/1/19/Chevron_Interim_Report_Final_2013-04-17.pdf

Chemical Safety Board Draft Regulatory Report:
www.csb.gov/chevron-regulatory-report-draft-for-public-comment/

Chevron Incident Investigation Report:
http://richmond.chevron.com/Files/richmond/Investigation_Report.pdf

Congressional Testimony of U.S. OSHA:
www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=TESTIMONIES&p_id=1182

Labor Occupational Health Program:
Refinery Safety in California: Labor Community and Fire Agency Views:
http://lohp.org/wp-content/uploads/2013/11/LOHP_Refinery_SafetyReport_2nd_Issue.pdf

Members of the Governor’s Interagency Working Group

Agencies participating in the Working Group include the following:

- Governor’s Office of Emergency Services (Cal OES)
- California Energy Commission (CEC)
- California Environmental Protection Agency (CalEPA)
- CalEPA – Air Resources Board (ARB)
- CalEPA – Department of Toxic Substances Control (DTSC)
- CalEPA –State Water Resources Control Board (SWRCB)
- California Technology Agency (CTA)
- Department of Finance (DOF)
- Department of Public Health (DPH)
- Labor and Workforce Development Agency (LWDA)
- LWDA – Department of Industrial Relations (DIR)
- LWDA/DIR – Division of Occupational Safety and Health (Cal/OSHA)
- Office of the State Fire Marshal (OSFM)

Regulatory Agencies

A number of federal, state, regional, and local agencies – with varying degrees of coordination between agencies, as described below – enforce or otherwise administer laws and regulations to protect the safety and health of workers, communities, and the environment.

Safety and prevention of hazardous events

Occupational safety and health: The state Division of Occupational Safety and Health (Cal/OSHA) enforces regulations adopted by the state Occupational Safety and Health Standards Board (OSHSB) to protect worker safety and health. The regulations are at least as protective as regulations adopted by the U.S. Occupational Safety and Health Administration (U.S. OSHA) under the federal Occupational Safety and Health Act. Both of the state agencies are housed within the California Department of Industrial Relations (DIR), which is in turn housed within the Labor and Workforce Development Agency (LWDA).

Accidental release prevention: Regional and local Certified Unified Program Agencies (CUPAs), which are certified by the California Environmental Protection Agency (Cal/EPA), administer California's accidental release prevention (CalARP) program. The CalARP program parallels risk management plan (RPM) requirements adopted by the US Environmental Protection Agency (U.S. EPA) under the federal Clean Air Act. The Governor's Office of Emergency Services (Cal OES) provides technical assistance and evaluation of this aspect of the CUPA program.

Hazardous waste control: CUPAs administer regulations governing the generation, handling, transportation, storage and disposal of hazardous wastes. These regulations conform with those adopted by the U.S. EPA under the Resource Conservation and Recovery Act. The California Department of Toxic Substances Control (DTSC) provides technical assistance and evaluation of this aspect of the CUPA program. DTSC is housed within CalEPA.

Hazardous substances storage: CUPAs administer regulations governing aboveground storage of petroleum and underground storage of hazardous substances. These regulations conform with those adopted by the U.S. EPA under the federal Water Pollution Control Act. The California State Water Resources Control Board (SWRCB) oversees, enforces and assists with these programs. SWRCB is housed within CalEPA.

Air pollution control: Air pollution control districts (APCDs) adopt and enforce local air pollution quality plans and regulations that are consistent with standards established by the U.S. EPA and the California Air Resources Board under the federal Clean Air Act. APCDs also issue permits to refineries and other stationary air pollution sources. The ARB oversees compliance by the APCDs with state and federal law.

Emergency preparedness and response

State Emergency Plan: Cal OES prepares the state's plan for responding to significant emergencies including those involving release of hazardous materials. The plan includes coordination of hazardous materials activities by Cal/EPA and medical services by the California Health and Human Services Agency (HHSA).

Accidental release prevention: This program is described above. It includes requirements to prepare for emergencies in the event of a hazardous substances release.

Area plans: CUPAs develop and implement area plans for emergency response to a hazardous materials release. Area plans provide for emergency planning and rescue procedures, coordination between agencies including coordination of medical services, public safety, and public information for the geographic area covered by the CUPA. The regulations governing area plans are generally consistent with those adopted by the U.S. EPA under the federal Emergency Planning and Community Right-to-Know Act (EPCRA). Cal OES identifies the required content of area plans, and Cal/EPA ensures that CUPAs develop and implement them.

Business plans: CUPAs administer regulations governing business plans prepared by industrial facilities. Business plans include inventories of hazardous chemicals, emergency response plans and procedures, and training for employees on the emergency procedures. The regulations governing business plans conform with regulations adopted by the U.S. EPA under the federal Emergency Planning and Community Right-to-Know Act. Cal OES provides technical assistance and evaluation of the business plans program as part of CalEPA program oversight.

Fire Safety: CUPAs administer regulations governing hazardous material release response plans and inventory statements submitted to local fire agencies. These regulations are related to business plan requirements under EPCRA described above. The Office of the State Fire Marshall (OSFM) ensures implementation of these programs.

Public health and medical services: The California Department of Public Health (DPH) and the California Emergency Medical Services Authority (EMSA), both housed within the HHSA, notify local health departments, public health services, emergency medical services agencies, hospitals, and other medical providers during an emergency.

Community education and alerts

Business plans and area plans: These programs are described above. They include procedures to inform and alert the public.

Emergency planning and community right-to-know: The State Emergency Response Commission (SERC), whose members are appointed by the Governor, has established six local emergency planning committees throughout the state to assist with emergency response planning. Local Committees include government, environment, transportation, and hospital officials; police, fire, civil defense, and public health professionals; facility representatives; media; and, representatives from community groups. SERC and the Local Committees carry out requirements under EPCRA, including provisions to ensure public access to facility documents concerning hazardous material inventories, routine toxic chemical releases, emergency planning and emergency releases

Skip all front matter: Jump to Page 1

Testimony

Refinery Process Safety Performance and Models of Government-Industry Relations

John Mendeloff

RAND Office of External Affairs

CT-392

June 2013

Testimony submitted before the California Department of Industrial Relations and the Governor's Task Force on Refinery Safety on June 11, 2013

RAND CORPORATION

Published 2013 by the RAND Corporation
1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
1200 South Hayes Street, Arlington, VA 22202-5050
4570 Fifth Avenue, Suite 600, Pittsburgh, PA 15213-2665
RAND URL: http://www.rand.org
To order RAND documents or to obtain additional information, contact
Distribution Services: Telephone: (310) 451-7002;
Email: order@rand.org

John Mendeloff[1]
The RAND Corporation

Refinery Process Safety Performance and Models of Government-Industry Relations[2]

Before the California Department of Industrial Relations and
the Governor's Task Force on Refinery Safety
State of California

June 11, 2013

A major explosion at the Chevron refinery in Richmond California in August 2012 did not, fortunately, kill anyone, but it led 15,000 people in the community to seek medical attention. That event spurred the Governor to establish a Task Force to examine what steps should be taken to improve refinery safety in the State.

RAND was asked by Christine Baker, the Director of the Department of Industrial Relations, to investigate several issues in order to inform the Task Force's discussions. This memo is the response to that request. It has 3 parts. The first summarizes information about different regulatory models and provides some recommendations about how to proceed in adopting new models. The second briefly summarizes suggestions about the role that measures of "leading indicators" can play in future regulation. The third reviews what existing measures tell us about changes over time and comparisons across continents.

Models of Regulation

The American model of work safety regulation relies on inspectors to detect hazards at facilities and ensure that they are corrected. California's model is similar except that it puts a greater emphasis on investigating serious accidents that have occurred and less on planned inspections. Over the last 25 years, a perspective has developed that argues that this model is poorly suited to ensure safety at very complex facilities, especially those characterized by risks that have low frequency but very high disaster potential. This perspective emerged first in Europe, triggered by disasters in the North Sea and at Seveso, Italy. The former led the United Kingdom (UK) and Norway to develop a "safety case" approach to regulating off-shore oil platforms in the 1990s, an approach later expanded to other high-hazard process industries. The European Union's Seveso

[1] The opinions and conclusions expressed in this testimony are the author's alone and should not be interpreted as representing those of RAND or any of the sponsors of its research. This product is part of the RAND Corporation testimony series. RAND testimonies record testimony presented by RAND associates to federal, state, or local legislative committees; government-appointed commissions and panels; and private review and oversight bodies. The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors.
[2] This testimony is available for free download at http://www.rand.org/pubs/testimonies/CT392.html.

Directives ordered some similar measures for all member states. The safety case approach puts the responsibility on facilities to explain what they will do in order to try to ensure their safety. The regulatory authority has to judge whether this effort is acceptable and then takes a role of auditing to ensure that the firm does what it says it would do. It generally does not inspect to find hazards, leaving that job to the company.

The major efforts in the United States to address safety issues in refineries (and the chemical and petrochemical industries) also emerged in the early 1990s. They included the Occupational Safety and Health Administration's (OSHA) Process Safety Management (PSM) standard of 1992 and the Environmental Protection Agency's requirement for Risk Management Programs (RMPs). Both of these were focused on facilities which used minimum quantities of specified toxic substances. OSHA's PSM rule mandated many of the standard activities already used in industry to ensure safe operations. Both OSHA and the EPA required that firms have a written document that explained how the firm would carry out these requirements. The EPA document had to be submitted to the agency and redone every 5 years. It also required that process safety incidents related to the chemicals included in the RMP had to be reported to EPA, although this requirement appears to have been weakly enforced and suffered from major non-compliance.[3]

Both regulatory agencies appear to have devoted only limited resources to refineries. For example, in the 5 years from September 2007 through July 2012, there were 63 inspections at California refineries (excluding accident investigations). With about 16 operating refineries, this is about 80 "refinery-years;" so there was less than 1 inspection per refinery per year. Federal OSHA has inspected refineries even less frequently, despite a recent campaign focused on refinery safety.

Moreover, the inspections that Cal-OSHA has carried out have not been very effective at detecting hazards. During the same period, 5 of 15 complaint inspections cited a violation, including only one serious violation. Among the 48 programmed inspections, only 4 cited a violation, including only one serious violation. Thus even when there have been inspections, they have contributed relatively little to hazard abatement. We believe Cal-OSHA could be more effective if it shifted its role to place more emphasis on monitoring whether the companies are meeting their own measurable goals for process safety.

One point that needs to be stressed is that both the safety case model in the UK and the Industrial Safety Ordinance (ISO) approach used in California's Contra Costa County involve considerably more resources than OSHA or Cal-OSHA have deployed in the refinery industry.

[3] Gomez M, Casper, Smith (2007)

According to Ian Travers, the Director of the Hazardous Facilities Unit that oversees UK safety cases, the Unit typically conducts several audits each year at refineries to assess their safety case activities.[4] Although we have not calculated the resources used by Contra Costa County agencies, their interactions with refineries clearly have been much more frequent than those by Cal-OSHA. The implication of these findings is that any new initiative, whatever its form, is likely to require additional resources if it is to be effective.

Some have argued that the safety case process often leads to initial gains in hazard recognition and abatement. However, it must remain "a living document" in order to fulfill its objectives. As Ian Travers commented, the main potential concern with the safety case approach is that describing and documenting how you will manage risks is not the same as actually managing risks.

The Governor's Task Force held numerous hearings for labor, community, and industry representatives. At a meeting with the last group on March 18 in Santa Monica, the participant from Shell in Contra Costa County, who had also spent considerable time in a Southern California refinery, said that she believed that the attention to safety was noticeably greater in the North as a result of Contra Costa's ISO program. None of the other industry representatives there spoke to that point, either to agree or disagree.

In developing new public policies, it is generally better, other things equal, to choose options that can achieve a goal with a minimum of disruption. Familiar routines, in this regard, are preferable to brand new ones. This maxim suggests giving serious consideration to strengthening the Contra Costa ISO model rather than requiring all to adopt new methods.

However, we have to acknowledge that, at this point, we don't have a sufficient understanding of all that goes on in the ISO regime to be able to identify the exact ways in which it differs from the UK safety case operation. While there may be useful lessons to be gained by further examination of the UK system, we still think that it makes the most sense to extend and improve the ISO model as the basis for new proposals.

The Role of Leading Indicators

Above, we referred to the role of the regulator in auditing the firm's safety program. But what practices or conditions should it be auditing? You can't look at everything. Everyone seems to agree that the traditional measure of injury rates has two major flaws: first, it doesn't tell you

[4] Personal communication, March 17, 2013.

much about low-frequency, high severity risks like explosions. In addition, although past injury rates may be predictive of future injury rates, what is needed are measures of activities that are known or believed to be effective at preventing explosions and similar events. These are referred to as “leading indicators.” The terms “leading” and “lagging” indicators can be a source of confusion. In the simplest terms, a “lagging indicator” is a measure of the riskiness of a facility during a certain prior period. In contrast, a “leading indicator” helps to predict riskiness in a future period.

But a more meaningful distinction is between indicators which have preventive potential and those which do not. Both may be predictive. The number of injuries this year may predict the number next year, but it cannot prevent them. In contrast, more frequent inspections of safety equipment may prevent injuries and, if they do, a measure of that activity will also contribute to predictions. In this sense, a useful leading indicator must be an activity or condition that has preventive value. We usually lack hard evidence about preventive value, which means that the judgments are now made primarily on the basis of professional judgment.

At the request of the US Chemical Safety Board, the American Petroleum Institute developed a recommended practice (RP 754) that obligates its member firms to adopt several types of both lagging and leading indicators. All of the lagging indicators focus only on events that pertain to process safety hazards (e.g., releases from pressure vessels and pipes), not general safety hazards. For leading indicators, the API did not stipulate which ones firms should use, but gave several examples, including whether various activities have been completed on schedule, fatigue risk management measures (e.g., overtime), completion of emergency response drills, safety critical equipment inspection and deficiency management.

RP754 *requires* each company’s facilities to report a summary of both lagging and leading indicators to the employees and their representatives. It also *requires* a summary of lagging indicators be provided to local communities and emergency management officials. It says that the Company *may* provide refinery-specific summaries of leading indicator data to the communities and EMS officials.

California should take advantage of the API’s increased commitment to the principle of reporting to the public. The Contra Costa ISO already does require more reporting than RP754. United Steelworker unions in Northern California have been considering which process measures should be reported. The State can bring union and management together statewide and use their recommendations to decide on a new set of measures that, ideally, are reliable, relevant, easy to measure, and auditable. The most important measures to focus on are the leading indicators, because they can drive the auditing process. The lagging indicators of process safety events are likely to have low statistical power—that is, they are unlikely to be able to identify statistically significant changes at refineries and differences among refineries (Mendeloff et al. 2012).

Evidence of the Effectiveness of Alternative Regulatory Models

A study commissioned by the UK's Health and Safety Executive (HSE) in 2004 reviewed the evidence regarding the costs and benefits of the safety case approach (Vectra 2004). It found essentially no hard evidence on the net benefits of the policy. There was a great deal of opinion, most of it (but not all) suggesting that the policy had led to better hazard identification. There was also a good deal of questioning by industry about whether the program was worthwhile. Ian Travers indicated that there had not been any strong empirical work since that review that would alter the conclusion. Our review of the literature since 2004 did not find articles that suggest otherwise.

A review of the various sources of information about measures of process safety outcomes ("lagging indicators") that provide comparisons over time or across countries suggests the following points:

- The number of fatal process safety accidents at refineries in the US has declined from the level it had reached in the 1980s.
- The US Chemical Safety Board has stated that it believes that U.S. refinery safety is worsening. This view reflects, in part, the fact that, prior to 2007, only about 10% of the roughly 50 investigations carried out by the CSB involved refineries. Today, 6 of its 12 active investigations involve refineries.
- Swiss Re (2006), a large re-insurer, reports finding that refinery safety practices in the US make them less safe than those in Europe.
- The United States has a disproportionate share of the world's highest cost refinery disasters over the last 30 years, suffering half of the events despite having less than one-quarter of world's refineries and refining capacity. (Marsh and McLennan 2011)
- The lagging measure of the rate for process safety events reported by API for US refineries (for 2011) and by its European counterpart for European refineries (for 2010) show that the European rate was about twice as high. This result is fairly surprising because most Western European fatality rates are considerably lower than US rates across most industries (Mendeloff and Staetsky, 2012). We suspect that process safety events are underreported to a greater extent in the US.

Although uncertainty remains, we interpret the available data to indicate that process safety performance at US refineries is worse than it is in Europe. We think the evidence is mixed about whether US refinery safety has improved or declined during the last 30 years.

Summary and Recommendations:

We have found that:

1—US safety performance at refineries has not been good by international standards.

2—However, Cal-OSHA inspections of refineries typically find so few hazards that they contribute relatively little to refinery safety.

As a result, we make the following recommendations:

1—Place more responsibility on firms to lay out how they will ensure safety and have regulators focus on auditing their performance.

2—Adopt an incremental approach for making the transition from the current enforcement program to the one recommended.

References

ANSI/API. Recommended Practice 754: Process Safety Performance Indicators for the Refining and Petrochemical Industries, First Edition. April 2010.

CONCAWE, 2011, " European downstream oil industry safety performance
Statistical summary of reported incidents – 2010," August 2011, Report 5/11.

Gomez, M., Casper, S., Smith, E.A. "The CSB Incident Screening Database Description, summary statistics and uses." *Journal of Hazardous Materials*. (2007), doi:10.1016/j.jhazmat.2007.07.122.

Marsh and McLennan Energy Practice, "The 100 Largest Losses: 1972-2011: Large Property Damage Losses in the Hydrocarbon Industry."

Mendeloff, J and Staetsky, L. 2012. "Implications of the Use of Risk Assessment in the EU for the United States," RAND Center for Health and Safety in the Workplace, WR-912-ASSEF, January 2012

Mendeloff. J., Han, B., Fleishman, L., Vesely, J. 2012. "Evaluation of Process Safety Indictors Collected in Conformance with ANSI/API Recommended Practice 754." RAND Center for Health and Safety in the Workplace, PM-4140 (2012).

Vectra Group Limited. 2003. "Literature Review on the Perceived Benefits and Disadvantages of the UK Safety Case Regime." Report to the Health and Safety Executive.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management District Office
1450 Enea Circle, Suite 550 (Index Code 4037)
Concord, CA 94520-7996
Phone: (925) 602-2665 Fax: (925) 602-2668

Citation and Notification of Penalty

To:
Chevron U.S.A. Inc.

and its successors
841 Chevron Way
Richmond, CA 94801

Inspection Site:
841 Chevron Way
Richmond, CA 94801

Inspection Number: 314331877
Inspection Date(s): 08/06/2012 - 01/30/2013

Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Report #: 04-13
Reporting ID: 0950663

The violation(s) described in this Citation and Notification of Penalty is (are) alleged to have occurred on or about the day(s) the inspection was made unless otherwise indicated within the description given below.

This Citation and Notification of Penalty (hereinafter Citation) is being issued in accordance with California Labor Code Section 6317 for violations that were found during the inspection/investigation. **This Citation or a copy must be prominently posted upon receipt by the employer at or near the location of each violation until the violative condition is corrected or for three working days, whichever is longer.** Violations of Title 8 of the California Code of Regulations or of the California Labor Code may result in some instances in prosecution for a misdemeanor.

YOU HAVE A RIGHT to contest this Citation and Notification of Penalty by filing an appeal with the Occupational Safety and Health Appeals Board. To initiate your appeal, you **must** contact the Appeals Board, in writing or by telephone, within 15 working days from the date of receipt of this Citation. If you miss the 15 working day deadline to appeal, the Citation and Notification of Penalty becomes a final order of the Appeals Board, not subject to review by any court or agency.

Informal Conference - You may request an informal conference with the Manager of the District Office which issued the Citation within 10 working days after receipt of the Citation. However, if the citation is appealed, you may request an informal conference at any time prior to the day of the hearing. Employers are encouraged to schedule a conference at the earliest possible time to assure an expeditious resolution of any issues. At the informal conference, you may discuss the existence of the alleged violation, classification of the violation, abatement date or proposed penalty.

Be sure to bring to the conference any and all supporting documentation of existing conditions as well as any abatement steps taken thus far. If conditions warrant, we can enter into an agreement which resolves this matter without litigation or contest.

APPEAL RIGHTS

The Occupational Safety and Health Appeals Board (Appeals Board) consists of three members appointed by the Governor. The Appeals Board is a separate entity from the Division of Occupational Safety and Health (Division) and employs experienced attorneys as administrative law judges to hear appeals fairly and impartially. To initiate an appeal from a Citation and Notification of Penalty, you must contact the Appeals Board, in writing or by telephone, within 15 working days from the date of receipt of a Citation. After you have initiated your appeal, you must then file a completed appeal form with the Appeals Board, at the address listed below, for each contested citation. <u>Failure to file a completed appeal form with the Appeals Board may result in dismissal of the appeal</u>. Appeal forms are available from district offices of the Division, or from the Appeals Board:

Occupational Safety and Health Appeals Board

2520 Venture Oaks Way, Suite 300

Sacramento, CA 95833

Telephone: (916) 274-5751 or (877) 252-1987

Fax: (916) 274-5785

If the Citation you are appealing alleges more than one item, you must specify on the appeal form which items you are appealing. You must also attach to the appeal form a legible copy of the Citation you are appealing.

Among the specific grounds for an appeal are the following: the safety order was not violated, the classification of the alleged violation (e.g., serious, repeat, willful) is incorrect, the abatement requirements are unreasonable or the proposed penalty is unreasonable.

<u>Important:</u> You must notify the Appeals Board, not the Division, of your intent to appeal within 15 working days from the date of receipt of the Citation. Otherwise, the Citation and Notification of Penalty becomes a final order of the Appeals Board not subject to review by any court or agency. <u>An informal conference with the Division does not constitute an appeal and does not stay the 15 working day appeal period</u>. If you have any questions concerning your appeal rights, call the Appeals Board, (916) 274-5751 or (877) 252-1987.

PENALTY PAYMENT OPTIONS

Penalties are due within 15 working days of receipt of this Citation and Notification of Penalty unless contested. If you are appealing any item of the citation, remittance is still due on all items that are not appealed. Enclosed for your use is a Penalty Remittance Form for payment.

If you are paying by credit card (MasterCard and Visa), please have the Penalty Remittance Form on-hand when you are ready to make our payment. The company name, index code, reporting ID, and Citation number(s) will be required in order to ensure that the payment is accurately posted to your account. Please go to www.dir.ca.gov/dosh to access the secure payment processing site.

If you are paying by check, return one copy of the Citation, along with the Notice of Proposed Penalties Sheet and the Penalty Remittance Form and mail to:

Department of Industrial Relations
Cashier, Accounting Office
P. O. Box 420603
San Francisco, CA 94142-0603

CAL/OSHA does not agree to any restrictions, conditions or endorsements put on any check or money order for less than the full amount due, and will cash the check or money order as if these restrictions, conditions, or endorsements do not exist.

NOTIFICATION OF CORRECTIVE ACTION

For violations which you do not contest, you should notify the Division of Occupational Safety and Health promptly by letter that you have taken appropriate corrective action within the time frame set forth on this Citation and Notification of Penalty. Please inform the District Office listed on the Citation by submitting the CAL/OSHA Form 160 and/or 161 with the abatement steps you have taken and the date the violation was abated, together with adequate supporting documentation, e.g., drawings or photographs of corrected conditions, purchase/work orders related to abatement actions, air sampling results, etc. The adjusted penalty for serious and general violations **has already been** reduced by 50% on the presumption that the employer will correct the violations by the abatement date. **If the CAL/OSHA Form 161 is not received in the District Office within 10 days following the abatement date, the abatement credit is revoked, causing the penalty to double.**

Note: **Return** the CAL/OSHA Form 160/161 to the District Office listed on the Citation and as shown below:

Division of Occupational Safety and Health
1450 Enea Circle, Suite 550
Concord, CA 94520

EMPLOYEE RIGHTS

Employer Discrimination Unlawful - The law prohibits discrimination by an employer against an employee for filing a complaint or for exercising any rights under Labor Code Section 6310 or 6311. An employee who believes that he/she has been discriminated against may file a complaint no later than six (6) months after the discrimination occurred with the Division of Labor Standards Enforcement.

Employee Appeals - An employee or authorized employee's representative may, within 15 working days of the issuance of a citation, special order, or order to take special action, appeal to the Occupational Safety and Health Appeals Board the reasonableness of the period of time fixed by the Division of Occupational Safety and Health (Division) for abatement. An employee appeal may be filed with the Appeals Board or with the Division. No particular format is necessary to initiate the appeal, but the notice of appeal <u>must</u> be in writing.

If an Employee Appeal is filed with the Division, the Division shall note on the face of the document the date of receipt, include any envelope or other proof of the date of mailing, and promptly transmit the document to the Appeals Board. The Division shall, no later than 10 working days from receipt of the Employee Appeal, file with the Appeals Board and serve on each party a clear and concise statement of the reasons why the abatement period prescribed by it is reasonable.

Employee Appeal Forms are available from the Appeals Board, or from a District Office of the Division.

Employees Participation in Informal Conference. Affected employees or their representatives may notify the District Manager that they wish to attend the informal conference. If the employer objects, a separate informal conference will be held.

DISABILITY ACCOMMODATION

Disability accommodation is available upon request. Any person with a disability requiring an accommodation, auxiliary aid or service, or a modification of policies or procedures to ensure effective communication and access to the programs of the Division of Occupational Safety and Health, should contact the Disability Accommodation Coordinator at the local district office or the Statewide Disability Accommodation Coordinator at 1-866-326-1616 (toll free). The Statewide Coordinator can also be reached through the California Relay Service, by dialing 711 or 1-800-735-2929 (TTY) or 1-800-855-3000 (TTY-Spanish).

Accommodations can include modifications of policies or procedures or provision of auxiliary aids or services. Accommodations include, but are not limited to, an Assistive Listening System (ALS), a Computer-Aided Transcription System or Communication Access Realtime Translation (CART), a sign-language interpreter, documents in Braille, large print or on computer disk, and audio cassette recording. Accommodation requests should be made as soon as possible. Requests for an ALS or CART should be made no later than five (5) days before the hearing or conference.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 1 Item 1 Type of Violation: General

8 CCR 5155(e)(1) Workplace Monitoring.

(1) Whenever it is reasonable to suspect that employees may be exposed to concentrations of airborne contaminants in excess of levels permitted in section 5155(c), the employer shall monitor (or cause to have monitored) the work environment so that exposures to employees can be measured or calculated.

On August 6, 2012, the Employer failed to monitor the work environment for an uncontrolled leak of petroleum hydrocarbons located within the 4 Crude Unit so that exposures of employees to concentrations of airborne contaminants identified in 5155(c) (i.e. toluene, benzene, xylenes, particulates, etc.) could be measured or calculated.

Date By Which Violation Must be Abated:	03/18/2013
Proposed Penalty:	$ 1350.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Phone: (925) 602-2665 Fax: (925) 602-2668

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 1 Item 2 Type of Violation: General

8 CCR 5189(d)(3)(A)(2)- Information pertaining to the equipment in the process.

(A) Information pertaining to the equipment in the process shall include at least the following:
2. Piping and instrument diagrams (P&ID's);

The Employer's piping and instrument diagrams (P&ID"s) Failed to include information pertaining to the guided wave monitoring devices on the 8-inch #4 side-cut line located on the C-1100 Column in Crude Unit #4.

P&ID number D-308308-22

Date By Which Violation Must be Abated: 03/18/2013
Proposed Penalty: $ 1350.00

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 2 Item 1 Type of Violation: Serious

8 CCR 1511. General Safety Precautions.

8 CCR 1511(b) Prior to the presence of its employees, the employer shall make a thorough survey of the conditions of the site to determine, so far as practicable, the predictable hazards to employees and the kind and extent of safeguards necessary to prosecute the work in a safe manner in accordance with the relevant parts of Plate A-2-a and b of the Appendix.

On August 6, 2012, Chevron, the Employer responsible for safety and health conditions at the work site, failed to make a thorough survey of the conditions of the site to determine, so far as practicable, the predictable hazards and the kind and extent of safeguards necessary to prosecute the work in a safe manner which would protect Brand Energy Services, Inc. employees during the erection of scaffolding at the source of an uncontrolled leak of petroleum hydrocarbons located underneath piping insulation located within the 4 Crude Unit.

Date By Which Violation Must be Abated: 03/18/2013
Proposed Penalty: $ 25000.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Concord District Office (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 3 Item 1 Type of Violation: Serious

8CCR 5141(a)-(c)

8CCR 5141(a) Engineering Controls. Harmful exposures shall be prevented by engineering controls whenever feasible. (b) Administrative Controls. Whenever engineering controls are not feasible or do not achieve full compliance, administrative controls shall be implemented if practicable. (c) Control by Respiratory Protective Equipment. Respiratory protective equipment, in accordance with Section 5144, shall be used to prevent harmful exposures as follows:
(1) During the time period necessary to install or implement feasible engineering controls;
(2) Where feasible engineering controls and administrative controls fail to achieve full compliance; and
(3) In emergencies.

On August 6, 2012, the Employer failed to prevent harmful exposures to employees by failing to implement effective engineering controls, administrative controls, or by requiring the use of respiratory protective equipment for Chevron and contract employees located in direct vicinity of an uncontrolled leak of petroleum hydrocarbons located within the 4 Crude Unit.

Date By Which Violation Must be Abated:	03/18/2013
Proposed Penalty:	$ 25000.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 4 Item 1 Type of Violation: Serious

8CCR 5189. Process Safety Management of Acutely Hazardous Materials.

8CCR 5189(e) Process Hazard Analysis.

(1) The employer shall perform a hazard analysis appropriate to the complexity of the process for identifying, evaluating, and controlling hazards involved in the process and shall determine and document the priority order for conducting process hazard analyses based on the extent of process hazards, number of potentially affected employees, age of the process and process operating history, using at least one of the following methodologies.

(A) What-If;
(B) Checklist;
(C) What-If/Checklist;
(D) Hazard and Operability Study (HAZOP);
(E) Failure Mode and Effects Analysis (FMEA); or
(F) Fault-Tree Analysis.

The Employer failed to perform an effective Process Hazard Analysis of the 4 Crude Unit. Specifically, it failed to identify, evaluate and control potential hazards caused by upstream and downstream units that provide and receive feed from the #4 Crude Unit.

Date By Which Violation Must be Abated: 03/18/2013
Proposed Penalty: $ 25000.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Concord District Office (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Phone: (925) 602-2665 Fax: (925) 602-2668

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 5 Item 1 Type of Violation: Serious

8 CCR 5189(l)(2)(A) - Management of Change
(2) The procedures shall assure that the following are addressed prior to any change:
(A) The technical basis for the proposed change;
(B) Impact of change on safety and health

The Employer failed to address in writing in the Management of Change (MOC number 25789) completed on November 21, 2012, the technical basis for the change and the impact of the change on safety and health with regard to changing the 8-inch section of pipe from carbon steel to 9 Chrome piping on the 4 Sidecut line located within the 4 Crude Unit.

Date By Which Violation Must be Abated:	03/18/2013
Proposed Penalty:	$ 25000.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 6 Item 1 Type of Violation: Serious

8CCR 5192 (q)(3)(D)

Employees engaged in emergency response and exposed to hazardous substances presenting an inhalation hazard or potential inhalation hazard shall wear positive pressure self-contained breathing apparatus (SCBA) while engaged in emergency response, until such time that the individual in charge of the ICS determines through the use of air monitoring that a decreased level of respiratory protection will not result in hazardous exposures to employees.

On August 6, 2012, an emergency responder, the engineer in charge on Engine Foam Truck 60, was operating a fire monitor in the direct vicinity of an uncontrolled release of petroleum hydrocarbons located in the 4 Crude Unit. This responder was not wearing a positive pressure self-contained breathing apparatus (SCBA).

Date By Which Violation Must be Abated: 03/18/2013
Proposed Penalty: $ 25000.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 7 Item 1 Type of Violation: Serious

8CCR 5192(q)(3)(E)

(E) The individual in charge of the ICS shall limit the number of emergency response personnel at the emergency site in those areas of potential or actual exposure to incident or site hazards, to those who are actively performing emergency operations. However, operations in hazardous areas shall be performed using the buddy system in groups of two or more.

On August 6, 2012, the Employer's incident commander failed to limit the number of personnel in the direct vicinity of an uncontrolled leak of petroleum hydrocarbons that expanded into a catastrophic event within the 4 Crude Unit, in that multiple employees not actively performing emergency operations were present in areas of potential or actual exposure to incident or site hazards.

Date By Which Violation Must be Abated:	03/18/2013
Proposed Penalty:	$ 25000.00

Citation 8 Item 1 Type of Violation: Serious Willful

3203(a)(2). Injury and Illness Prevention Program

(a) Effective July 1, 1991, every employer shall establish, implement and maintain an effective Injury and Illness Prevention Program (Program). The Program shall be in writing and, shall, at a minimum:

(2) Include a system for ensuring that employees comply with safe and healthy work practices. Substantial compliance with this provision includes recognition of employees who follow safe and healthful work practices, training and retraining programs, disciplinary actions, or any other such means that ensures employee compliance with safe and healthful work practices.

The Employer's Injury and Illness Prevention Program was not effectively implemented, because on August 25, 2012, the employer failed to ensure that employees were following Chevron's safe work procedures for access to the fire-damaged restricted area, which was also designated by Cal/OSHA as an Order to Preserve zone. Employees did not follow the safe work procedures jointly established by Chevron and Cal/OSHA and entered the restricted area carrying a rolling ladder to take a lower explosive limit (LEL) gas sample at the hole in the C-1100 4 Sidecut piping located within the 4 Crude Unit.

Date By Which Violation Must be Abated: 03/18/2013
Proposed Penalty: $ 70000.00

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 9 Item 1 Type of Violation: Serious Willful

3203(a)(6)(B). Injury and Illness Prevention Program

(a) Effective July 1, 1991, every employer shall establish, implement and maintain an effective Injury and Illness Prevention Program (Program). The Program shall be in writing and, shall, at a minimum:

(6) Include methods and/or procedures for correcting unsafe or unhealthy conditions, work practices and work procedures in a timely manner based on the severity of the hazard:

(B) When an imminent hazard exists, which cannot be immediately abated without endangering employee(s) and/or property, remove all exposed personnel from the area except those necessary to correct the existing condition. Employees necessary to correct the hazardous condition shall be provided the necessary safeguards.

The employer's Injury and Illness Prevention Program was not effectively implemented, because on August 25, 2012, the Employer failed to prohibit employees from entering a fire-damaged restricted area where imminent hazards existed as a result of the August 6, 2012 fire within the 4 Crude Unit. The restricted area was also designated by Cal/OSHA as an Order to Preserve zone. Employees were instructed to breach the red "danger" tape barricades that designated the restrictive area. Employees entered the restricted area carrying a rolling ladder to take a lower explosive limit (LEL) gas sample at the hole in the C-1100 4 Sidecut piping located within the 4 Crude Unit.

Date By Which Violation Must be Abated: 03/18/2013
Proposed Penalty: $ 70000.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 10 Item 1 Type of Violation: Serious Willful

8CCR 3383(b). Body Protection.

8CCR 3383(b) Clothing appropriate for the work being done shall be worn. Loose sleeves, tails, ties, lapels, cuffs, or other loose clothing which can be entangled in moving machinery shall not be worn.

On August 6, 2012, Chevron, the Employer responsible for safety and health conditions at the work-site, failed to ensure that contract employees from Brand Energy Services, who were erecting scaffolding to provide access to the leaking 4 Sidecut piping located within the 4 Crude Unit, were wearing clothing appropriate for the work that would protect Brand Energy Services employees from the hazards of uncontrolled leaking petroleum hydrocarbons exceeding 600 degrees Fahrenheit, including potential thermal burns.

Date By Which Violation Must be Abated:	03/18/2013
Proposed Penalty:	$ 70000.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 11 Item 1 Type of Violation: Serious Willful

8CCR 5144(c)(1)(D)
Respiratory Protection Program.

5144(c)(1)(D)
In any workplace where respirators are necessary to protect the health of the employee or whenever respirators are required by the employer, the employer shall establish and implement a written respiratory protection program with worksite-specific procedures. The program shall be updated as necessary to reflect those changes in workplace conditions that affect respirator use. The employer shall include in the program the following provisions, as applicable: (D) Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations.

On August 6, 2012, the Employer failed to implement the requirements of its respiratory protection program for proper use of respirators in routine and reasonably foreseeable emergency situations while responding to an uncontrolled petroleum hydrocarbon leak located within the 4 Crude Unit as follows:

1) Chevron, as the Employer responsible for safety and health conditions at the work-site, failed to ensure that contract employees from Brand Energy Services were using respiratory protection where reasonably foreseeable exposures to leaking petroleum hydrocarbons existed during the erection of scaffolding to provide access to the source of the leak.

2) Chevron failed to ensure that employees who were not part of the emergency response to an uncontrolled petroleum hydrocarbon leak located within the 4 Crude Unit, but were working in the direct vicinity of the leak were using respiratory protection where reasonably foreseeable exposures to leaking petroleum hydrocarbons existed. Several non-incident response employees working in the vicinity of the 4 Crude Unit were engulfed in a dense vapor cloud without respiratory protection.

Date By Which Violation Must be Abated:	03/18/2013
Proposed Penalty:	$ 70000.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 12 Item 1 Type of Violation: **Serious Willful**

8CCR 5189(f)(1)(A)(4)

(f) Operating Procedures.

(1) The employer shall develop and implement written procedures that provide clear instructions for safely conducting activities involved in each process consistent with the process safety information and shall address at least the following:

(A) Steps for each operating phase:

4. Emergency operations, including emergency shutdowns, and who may initiate these procedures;

On August 6, 2012, the Employer failed to implement its Emergency Procedure, 4CU-XE-103 (" C-1100 Overhead Small Leak, No Fire or Small Leak, Small Fire") to shutdown the 4 Crude Unit where an uncontrolled hydrocarbon leak was located underneath the #4 side-cut piping insulation. Instead of using this Emergency Procedure, which was developed precisely for this type of event, the Employer took an offensive action using a pike pole and fire hoses to pry and blast the insulation from the pipe.

Date By Which Violation Must be Abated:	03/18/2013
Proposed Penalty:	$ 70000.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 13 Item 1 Type of Violation: Serious Willful

8CCR 5189(f)(1)(C) Operating Procedures.
The employer shall develop and implement written procedures that provide clear instructions for safely conducting activities involved in each process consistent with the process safety information and shall address at least the following: (C) Safety and Health Considerations:

1. Properties of, and hazards presented by, the chemicals used in the process;
2. Precautions necessary to prevent exposure, including administrative controls, engineering controls, and personal protective equipment;
3. Control measures to be taken if physical contact or airborne exposure occurs;
4. Safety procedures for opening process equipment (such as pipeline breaking).
5. Verification of raw materials and control of hazardous chemical inventory levels; and,
6. Any special or unique hazards.

On August 6, 2012, the Employer failed to implement its own written procedures to prevent exposure consistent with the Employer's process safety information to respond to an uncontrolled petroleum hydrocarbon leak located within the 4 Crude Unit, as follows:

1. The Employer failed to shutdown the 4 Crude Unit consistent with engineering controls outlined in the Emergency Procedure "C-1100 Overhead Small Leak, No Fire or Small Leak, Small Fire - 4CU-XE-103";

2. The Employer, after deciding to not shut down the 4 Crude Unit, failed to perform a Joint Job Site Visit (JJSV), Job Hazard Analysis (JHA), and Health and Safety Evaluation (HSE) consistent with the Employer's administrative controls, which are required by the Employer's written safety programs, prior to responding to the leak;

3. The Employer (Chevron), the employer responsible for safety and health conditions at the work site, supervising Brand Energy Services employees, failed to abide by its own Stop Work Authority program when Brand employees raised concerns about the hazardous conditions present at the work site and ordered Brand employees to continue.

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

4. The Employer failed to ensure that personal protective equipment was adequate and used by all exposed Chevron and Brand Energy Services' employees prior to engaging in response efforts; and

5. The Employer failed to utilize available information pertaining to the unique hazards identified from past piping inspections related to the piping condition prior to engaging in response efforts for the uncontrolled leak.

Date By Which Violation Must be Abated:	03/18/2013
Proposed Penalty:	$ 70000.00

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 14 Item 1 Type of Violation: Serious Willful

8 CCR 5189(j) (3) Mechanical Integrity. Equipment Deficiencies.

(j)(3) Equipment deficiencies. The employer shall correct deficiencies in equipment which are outside acceptable limits defined by the process safety information in subsection (d) before further use, or in a safe and timely manner provided means are taken to assure safe operation.

The Employer failed to correct deficiencies in its high-temperature 4 Sidecut piping located within the 4 Crude Unit that were identified by its Reliability Department after conducting inspection and testing in accordance with recognized and generally accepted good engineering practices, with the American Petroleum Institute document, RP 939C "Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries," and with the Employer's own guidelines, entitled, "Corrosion Mitigation Plan 2006 and Updated Inspection Strategies for Preventing Sulfidation Corrosion Failures in Chevron Refineries." The Employer failed to replace the 4 Sidecut line located within the 4 Crude Unit, in accordance with recommendations received from its Reliability Department as early as 2002.

Date By Which Violation Must be Abated:	03/18/2013
Proposed Penalty:	$ 70000.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Phone: (925) 602-2665 Fax: (925) 602-2668

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 15 Item 1 Type of Violation: **Serious Willful**

8 CCR 5192(q)(2). Emergency Response to Hazardous Substance Releases. (2) Elements

(1) Emergency response plan: An emergency response plan shall be developed and implemented to handle anticipated emergencies prior to the commencement of emergency response operations. The plan shall be in writing and available for inspection and copying by employees, their representatives, and Division personnel.

(2) Elements of an emergency response plan: The employer shall develop an emergency response plan for emergencies which shall address, as a minimum, the following to the extent that they are not addressed elsewhere:

(A) Pre-emergency planning and coordination with outside parties.
(B) Personnel roles, lines of authority, training and communication.
(C) Emergency recognition and prevention
(D) Safe distances and places of refuge
(E) Site security and control
(F) Evacuation routes and procedures
(G) Decontamination
(I) Emergency alerting and response procedures
(K) Personal protective equipment (PPE) and emergency equipment

On August 6, 2012, the Employer failed to implement its emergency response plan for an uncontrolled petroleum hydrocarbon leak located within the 4 Crude Unit. The Employer, specifically, failed to address and implement the following elements in the plan prior to commencement of emergency operations:

1. Personnel roles, lines of authority, training, and communication: Lines of authority were unclear regarding when the unit would be shutdown and actions which could disturb the leaking pipe would cease. Firefighters used a pike pole and then fire hoses to remove insulation off of a leaking pipe while it was on line and under

---

pressure. Emergency shutdown of the unit was not initiated until after a major release and fire occurred. Emergency responders were not clear regarding what frequency they were to communicate on.

2. Emergency recognition and prevention: The Employer failed to recognize the potential for a large release of ignitable hydrocarbon liquid, aerosol and vapor from a pressurized leaking pipe-line during the erection of the scaffolding or from the offensive actions using a pike pole and fire hoses to pry and blast the insulation from the pipe.

3. Safe distances and places of refuge: The exclusion zone was not sized adequately to provide safe distances to protect all employees in the area from the release of hydrocarbon aerosol and vapor.

4. Site security and control: Access to the leak area was not adequately controlled. Individuals not actively performing response actions were allowed close access to the source of the leak.

5. Decontamination: Decontamination equipment, such as deluge showers, was not staged in appropriate locations. One employee, soaked with hydrocarbon in the release, was hosed off with a water hose that was located after his exposure.

6. Personal protective equipment: Requirements for protective clothing and respirators were not adequately planned or implemented. When the release expanded, many employees were not protected by respiratory protection and were engulfed in a dense hydrocarbon mist and vapor cloud. This cloud later ignited.

Date By Which Violation Must be Abated:	03/18/2013
Proposed Penalty:	$ 70000.00

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663;4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Inspection Number: 314331877
Inspection Dates: 08/06/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: A0572
Optional Inspection Nbr: 04-13

Phone: (925) 602-2665 Fax: (925) 602-2668

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801

Citation 16 Item 1 Type of Violation: Serious Willful

8CCR 6845. Piping, Fittings, and Valves.

8 CCR 6845(a)(1). Excluded and optional piping systems specified in Section 1.2.2 of API 570-2003, are subject to inspection and testing by the employer in accordance with good engineering practices.

Reference 8 CCR 5189(j)(2)(B). Inspection and testing procedures shall follow recognized and generally accepted good engineering practices.

The Employer failed to conduct inspection and testing of its high-temperature 4 Sidecut piping located within the 4 Crude Unit in accordance with recognized and generally accepted good engineering practices, with the American Petroleum Institute document, RP 939C, "Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries," and with the Employer's own guidelines, entitled, "Corrosion Mitigation Plan 2006 and Updated Inspection Strategies for Preventing Sulfidation Corrosion Failures in Chevron Refineries." Both guidelines recommend that 100 percent of areas of vulnerability be inspected to identify damaged mechanisms.

Date By Which Violation Must be Abated:	03/18/2013
Proposed Penalty:	$ 70000.00

[redacted]
Phone: (925) 602-2665 Fax: (925) 602-2668
Compliance Officer/District Manager

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management District Office
1450 Enea Circle, Suite 550 (Index Code 4037)
Concord, CA 94520-7996
Phone: (925) 602-2665 Fax: (925) 602-2668

NOTICE OF PROPOSED PENALTIES

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 Chevron Way, Richmond, CA 94801
Mailing Address: 841 Chevron Way, Richmond, CA 94801

Issuance Date: 01/30/2013

Reporting ID: 0950663
Index Code: 4037

Summary of Penalties for Inspection Number 314331877

Citation 1, General	=	$	2700.00
Citation 2, Serious	=	$	25000.00
Citation 3, Serious	=	$	25000.00
Citation 4, Serious	=	$	25000.00
Citation 5, Serious	=	$	25000.00
Citation 6, Serious	=	$	25000.00
Citation 7, Serious	=	$	25000.00
Citation 8, Serious	=	$	70000.00
Citation 9, Serious	=	$	70000.00
Citation 10, Serious	=	$	70000.00
Citation 11, Serious	=	$	70000.00
Citation 12, Serious	=	$	70000.00
Citation 13, Serious	=	$	70000.00
Citation 14, Serious	=	$	70000.00
Citation 15, Serious	=	$	70000.00
Citation 16, Serious	=	$	70000.00
TOTAL PROPOSED PENALTIES	=	$	782700.00

Penalties are due within 15 working days of receipt of this notification unless contested. If you are appealing any item of this citation, remittance is still due on all items that are not appealed. Enclosed for your use is a Penalty Remittance Form.

If you are paying by credit card (MasterCard and Visa): Please have this form on-hand when you are ready to make your payment. The company name, index code, reporting ID and Citation number(s) will be required to ensure that the payment is accurately posted to your account. Please go to www.dir.ca.gov/dosh to access the secure payment processing site.

If you are paying by check: Mail this Notice of Proposed Penalties, the Penalty Remittance Form, along with a copy of the Citation and Notification of Penalty to:

DEPARTMENT OF INDUSTRIAL RELATIONS
CASHIER, ACCOUNTING OFFICE
P. O. BOX 420603
SAN FRANCISCO, CA 94142-0603

CAL/OSHA does not agree to any restrictions, conditions or endorsements put on any check or money order for less than the full amount due, and will cash the check or money order as if these restrictions, conditions or endorsements do not exist.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management District Office
1450 Enea Circle, Suite 550 (Index Code 4037)
Concord, CA 94520-7996
Phone: (925) 602-2665 Fax: (925) 602-2668

Citation and Notification of Penalty

To:
Chevron U.S.A. Inc.

and its successors
841 CHEVRON WAY
RICHMOND, CA 94801

Inspection Site:
841 CHEVRON WAY
RICHMOND, CA 94801

Inspection Number: 314332370
Inspection Date(s): 08/30/2012 - 01/30/2013

Issuance Date: 01/30/2013
CSHO ID: T6126
Optional Report #: 001-13
Reporting ID: 0950663

The violation(s) described in this Citation and Notification of Penalty is (are) alleged to have occurred on or about the day(s) the inspection was made unless otherwise indicated within the description given below.

This Citation and Notification of Penalty (hereinafter Citation) is being issued in accordance with California Labor Code Section 6317 for violations that were found during the inspection/investigation. **This Citation or a copy must be prominently posted upon receipt by the employer at or near the location of each violation until the violative condition is corrected or for three working days, whichever is longer.** Violations of Title 8 of the California Code of Regulations or of the California Labor Code may result in some instances in prosecution for a misdemeanor.

YOU HAVE A RIGHT to contest this Citation and Notification of Penalty by filing an appeal with the Occupational Safety and Health Appeals Board. To initiate your appeal, you **must** contact the Appeals Board, in writing or by telephone, within 15 working days from the date of receipt of this Citation. If you miss the 15 working day deadline to appeal, the Citation and Notification of Penalty becomes a final order of the Appeals Board, not subject to review by any court or agency.

Informal Conference - You may request an informal conference with the Manager of the District Office which issued the Citation within 10 working days after receipt of the Citation. However, if the citation is appealed, you may request an informal conference at any time prior to the day of the hearing. Employers are encouraged to schedule a conference at the earliest possible time to assure an expeditious resolution of any issues. At the informal conference, you may discuss the existence of the alleged violation, classification of the violation, abatement date or proposed penalty.

Be sure to bring to the conference any and all supporting documentation of existing conditions as well as any abatement steps taken thus far. If conditions warrant, we can enter into an agreement which resolves this matter without litigation or contest.

APPEAL RIGHTS

The Occupational Safety and Health Appeals Board (Appeals Board) consists of three members appointed by the Governor. The Appeals Board is a separate entity from the Division of Occupational Safety and Health (Division) and employs experienced attorneys as administrative law judges to hear appeals fairly and impartially. To initiate an appeal from a Citation and Notification of Penalty, you must contact the Appeals Board, in writing or by telephone, within 15 working days from the date of receipt of a Citation. After you have initiated your appeal, you must then file a completed appeal form with the Appeals Board, at the address listed below, for each contested citation. Failure to file a completed appeal form with the Appeals Board may result in dismissal of the appeal. Appeal forms are available from district offices of the Division, or from the Appeals Board:

Occupational Safety and Health Appeals Board

2520 Venture Oaks Way, Suite 300

Sacramento, CA 95833

Telephone: (916) 274-5751 or (877) 252-1987

Fax: (916) 274-5785

If the Citation you are appealing alleges more than one item, you must specify on the appeal form which items you are appealing. You must also attach to the appeal form a legible copy of the Citation you are appealing.

Among the specific grounds for an appeal are the following: the safety order was not violated, the classification of the alleged violation (e.g., serious, repeat, willful) is incorrect, the abatement requirements are unreasonable or the proposed penalty is unreasonable.

Important: You must notify the Appeals Board, not the Division, of your intent to appeal within 15 working days from the date of receipt of the Citation. Otherwise, the Citation and Notification of Penalty becomes a final order of the Appeals Board not subject to review by any court or agency. An informal conference with the Division does not constitute an appeal and does not stay the 15 working day appeal period. If you have any questions concerning your appeal rights, call the Appeals Board, (916) 274-5751 or (877) 252-1987.

PENALTY PAYMENT OPTIONS

Penalties are due within 15 working days of receipt of this Citation and Notification of Penalty unless contested. If you are appealing any item of the citation, remittance is still due on all items that are not appealed. Enclosed for your use is a Penalty Remittance Form for payment.

If you are paying by credit card (MasterCard and Visa), please have the Penalty Remittance Form on-hand when you are ready to make our payment. The company name, index code, reporting ID, and Citation number(s) will be required in order to ensure that the payment is accurately posted to your account. Please go to www.dir.ca.gov/dosh to access the secure payment processing site.

If you are paying by check, return one copy of the Citation, along with the Notice of Proposed Penalties Sheet and the Penalty Remittance Form and mail to:

Department of Industrial Relations
Cashier, Accounting Office
P. O. Box 420603
San Francisco, CA 94142-0603

CAL/OSHA does not agree to any restrictions, conditions or endorsements put on any check or money order for less than the full amount due, and will cash the check or money order as if these restrictions, conditions, or endorsements do not exist.

NOTIFICATION OF CORRECTIVE ACTION

For violations which you do not contest, you should notify the Division of Occupational Safety and Health promptly by letter that you have taken appropriate corrective action within the time frame set forth on this Citation and Notification of Penalty. Please inform the District Office listed on the Citation by submitting the CAL/OSHA Form 160 and/or 161 with the abatement steps you have taken and the date the violation was abated, together with adequate supporting documentation, e.g., drawings or photographs of corrected conditions, purchase/work orders related to abatement actions, air sampling results, etc. The adjusted penalty for serious and general violations **has already been** reduced by 50% on the presumption that the employer will correct the violations by the abatement date. **If the CAL/OSHA Form 161 is not received in the District Office within 10 days following the abatement date, the abatement credit is revoked, causing the penalty to double.**

Note: **Return** the CAL/OSHA Form 160/161 to the District Office listed on the Citation and as shown below:

Division of Occupational Safety and Health
1450 Enea Circle, Suite 550
Concord, CA 94520

EMPLOYEE RIGHTS

Employer Discrimination Unlawful - The law prohibits discrimination by an employer against an employee for filing a complaint or for exercising any rights under Labor Code Section 6310 or 6311. An employee who believes that he/she has been discriminated against may file a complaint no later than six (6) months after the discrimination occurred with the Division of Labor Standards Enforcement.

Employee Appeals - An employee or authorized employee's representative may, within 15 working days of the issuance of a citation, special order, or order to take special action, appeal to the Occupational Safety and Health Appeals Board the reasonableness of the period of time fixed by the Division of Occupational Safety and Health (Division) for abatement. An employee appeal may be filed with the Appeals Board or with the Division. No particular format is necessary to initiate the appeal, but the notice of appeal must be in writing.

If an Employee Appeal is filed with the Division, the Division shall note on the face of the document the date of receipt, include any envelope or other proof of the date of mailing, and promptly transmit the document to the Appeals Board. The Division shall, no later than 10 working days from receipt of the Employee Appeal, file with the Appeals Board and serve on each party a clear and concise statement of the reasons why the abatement period prescribed by it is reasonable.

Employee Appeal Forms are available from the Appeals Board, or from a District Office of the Division.

Employees Participation in Informal Conference. Affected employees or their representatives may notify the District Manager that they wish to attend the informal conference. If the employer objects, a separate informal conference will be held.

DISABILITY ACCOMMODATION

Disability accommodation is available upon request. Any person with a disability requiring an accommodation, auxiliary aid or service, or a modification of policies or procedures to ensure effective communication and access to the programs of the Division of Occupational Safety and Health, should contact the Disability Accommodation Coordinator at the local district office or the Statewide Disability Accommodation Coordinator at 1-866-326-1616 (toll free). The Statewide Coordinator can also be reached through the California Relay Service, by dialing 711 or 1-800-735-2929 (TTY) or 1-800-855-3000 (TTY-Spanish).

Accommodations can include modifications of policies or procedures or provision of auxiliary aids or services. Accommodations include, but are not limited to, an Assistive Listening System (ALS), a Computer-Aided Transcription System or Communication Access Realtime Translation (CART), a sign-language interpreter, documents in Braille, large print or on computer disk, and audio cassette recording. Accommodation requests should be made as soon as possible. Requests for an ALS or CART should be made no later than five (5) days before the hearing or conference.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663; 4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314332370
Inspection Dates: 08/30/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: T6126
Optional Inspection Nbr: 001-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 CHEVRON WAY, RICHMOND, CA 94801

Citation 1 Item 1 Type of Violation: Serious

T8CCR2395.78. Bonding in Hazardous Locations.

Regardless of the voltage of the electrical system, the electrical continuity of metal noncurrent-carrying parts of equipment, raceways, and other enclosures in any hazardous location as defined in Article 59 of these Orders shall be assured by any of the methods specified for services that are approved for the wiring method used.

On or before 08/30/12 the employer failed to assure the electrical continuity of electrical systems installed within hazardous locations throughout the refining plant. The following instances were not corrected as of the dates indicated below:

1. An electrical conduit and connection fitting installed under the first deck of Jet Stripper C-732, located in North ISOMAX adjacent to turbine pump 737, were completely separated from the conduit junction body. As of September 20, 2012, the vertically mounted rigid metal conduit (RMC) and exposed wiring remained unrepaired.

2. A bonding jumper was completely detached from a fixed grounding lug that was securely threaded to the connector on the end of a Liquid-Tight Flexible Metal Conduit (LFMC). As of September 27, 2012, the loose bonding wire remained disconnected from the electrical conduit serving controller #FV415 and associated equipment operating within D&R, Plant 37.

3. Two sections of flexible metallic conduit (FMC) at ground level in front of tubes #33 and #66 on the fourth deck of South ISOMAX, F-350, A-Cell/A-Train, sustained physical damage that left the interlocked helical coiling strips separated and stretched to the point where their bonding and grounding capabilities were significantly impaired. As of October 19, 2012, the damaged conduit and exposed wiring remained unrepaired.

Date By Which Violation Must be Abated:	03/04/2013
Proposed Penalty:	$ 6750.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663; 4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314332370
Inspection Dates: 08/30/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: T6126
Optional Inspection Nbr: 001-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 CHEVRON WAY, RICHMOND, CA 94801

Citation 2 Item 1 Type of Violation: Serious

T8CCR2473.1(b). Conductors Entering Boxes, Cabinets, or Fittings.

(a) Conductors entering cutout boxes, cabinets, or fittings shall be protected from abrasion, and openings through which conductors enter shall be effectively closed.

(b) Unused openings in cabinets, boxes, and fittings shall be effectively closed.

On or before October 27, 2012 the Employer failed to effectively plug an unused opening on the end of a Rigid Metal Conduit (RMC) fitting installed within a hazardous location at D&R, Plant 37, feed to temperature controller #38TI091B, C590 tray #1.

Date By Which Violation Must be Abated: 03/04/2013
Proposed Penalty: $ 6750.00

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663; 4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314332370
Inspection Dates: 08/30/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: T6126
Optional Inspection Nbr: 001-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 CHEVRON WAY, RICHMOND, CA 94801

Citation 3 Item 1 Type of Violation: **Serious**

T8CCR2473.2(a). Covers and Canopies.

All pull boxes, junction boxes, and fittings shall be provided with covers identified for the purpose. If metal covers are used, they shall be grounded. In completed installations, each outlet box shall have a cover, faceplate, or fixture canopy. Covers of outlet boxes having holes through which flexible cord pendants pass shall be provided with bushings designed for the purpose or shall have smooth, well-rounded surfaces on which the cords may bear.

On or before August 30, 2012, the Employer failed to provide covers on electrical conduit bodies installed in hazardous locations throughout the refining plant. The following instances were not corrected as of the dates indicated below.

1. As of 09/19/12, the Employer failed to replace a missing cover on a rigid conduit body installed in a hazardous location containing natural/methane gas on the fourth floor deck of South ISOMAX, Furnace 305, C-CELL.

2. As of 09/27/12, the Employer failed to replace a missing cover on a rigid conduit body installed in a hazardous location at the Distillation and Refining unit, located 15 feet above the ground next to furnace #F-447.

Date By Which Violation Must be Abated: 03/04/2013
Proposed Penalty: $ 6750.00

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663; 4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Inspection Number: 314332370
Inspection Dates: 08/30/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: T6126
Optional Inspection Nbr: 001-13

Phone: (925) 602-2665 Fax: (925) 602-2668

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 CHEVRON WAY, RICHMOND, CA 94801

Citation 4 Item 1 Type of Violation: Serious

T8CCR5162(a). Emergency Eyewash and Shower Equipment.

5162 (a) Plumbed or self-contained eyewash or eye/facewash equipment which meets the requirements of sections 5, 7, or 9 of ANSI Z358.1-1981, Emergency Eyewash and Shower Equipment, incorporated herein by this reference, shall be provided at all work areas where, during routine operations or foreseeable emergencies, the eyes of an employee may come into contact with a substance which can cause corrosion, severe irritation or permanent tissue damage or which is toxic by absorption.

As of September 26, 2012, an eyewash/shower station located near V2606 in SRU, where exposure to corrosive or severely irritating liquids is possible, had been painted dark green, the same color as surrounding beams, making it difficult for an injured worker with corrosive or irritating material is in his\her eyes to access the eyewash.

Date By Which Violation Must be Abated:	03/04/2013
Proposed Penalty:	$ 6750.00

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663; 4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Inspection Number: 314332370
Inspection Dates: 08/30/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: T6126
Optional Inspection Nbr: 001-13

Phone: (925) 602-2665 Fax: (925) 602-2668

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 CHEVRON WAY, RICHMOND, CA 94801

Citation 5 Item 1 Type of Violation: Serious

T8CCR5189(j)(3). Process Safety Management of Acutely Hazardous Materials.

Equipment deficiencies. The employer shall correct deficiencies in equipment which are outside acceptable limits defined by the process safety information in subsection (d) before further use, or in a safe and timely manner provided means are taken to assure safe operation.

On or before 08/30/12 the Employer failed to ensure that every broken or damaged electrical conduit, fitting, receptacle, or vapor proof light fixture installed at each processing unit in the refining plant was effectively repaired or replaced in a timely manner.

Date By Which Violation Must be Abated:	03/04/2013
Proposed Penalty:	$ 6750.00

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 CHEVRON WAY, RICHMOND, CA 94801

Citation 6 Item 1 Type of Violation: **Willful Serious**

T8CCR5189(l).Process Safety Management of Acutely Hazardous Materials.

(1) The employer shall establish and implement written procedures to manage changes (except for "replacement in kind") to process chemicals, technology, and equipment, and changes to facilities.

(2) The procedures shall assure that the following are addressed prior to any change:

(A) The technical basis for the proposed change;
(B) Impact of change on safety and health;
(C) Modifications to operating procedures;
(D) Necessary time period for the change; and,
(E) Authorization requirements for the proposed change.

As of the September 2012 dates indicated below, the Employer had not implemented its written procedures with regard to (A) Technical basis for the change, and (D) Necessary time period for the change, for the following three changes to its facilities.

1. As of September 12, 2012, MOC (Management of Change) number 16210, an injection fitting seal of a leak in a 3 inch block valve controlling flow at the east natural gas split at furnace F-305C on the 4th deck in South Isomax was in place 13 months beyond its MOC expiration date. The necessary time period for the change was not implemented.

2. As of September 27, 2012, MOC number 18408, a globe valve injection fitting on the 1S/C to 2 S/C on a 400 degree hydrocarbon line in the D&R 4 Crude plant was 2 years and 7 months beyond its MOC expiration date. The necessary time period for the change was not implemented.

3. As of September 27, 2012, MOC number 21513, an injection fitting for valve packing on a motor operated valve controlling the flow of 600 psi flammable product at the base of V-4030A in the D&R PenHex area had been in place since January, 2010. It was not replaced, as recommended in the MOC, at the next opportunity. In the technical basis for the change, the maximum time period before replacement was stated to be 5 years.

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 CHEVRON WAY, RICHMOND, CA 94801

But it was not replaced at the turnaround in January 2011 and was given until December 31, 2017, a period of 8 years. Neither the maximum time period of 5 years, nor the instruction to replace "at the next opportunity," was implemented.

Date By Which Violation Must be Abated: 03/04/2013
Proposed Penalty: $ 70000.00

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663; 4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314332370
Inspection Dates: 08/30/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: T6126
Optional Inspection Nbr: 001-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 CHEVRON WAY, RICHMOND, CA 94801

Citation 7 Item 1 Type of Violation: Serious

T8CCR6773(b). Fire Protection and Fire Fighting Equipment.

(b) Fire protection and fire fighting equipment shall be inspected, tested and maintained in serviceable condition. A record shall be kept showing the date when fire extinguishers and hose lines were last inspected, tested, repaired, or renewed. Fire protection and fire fighting equipment after any use shall promptly be made serviceable and restored to its proper location.

On or before 08/30/2012, the Employer failed to inspect, test, and maintain a section of an exposed fire service main, thus leaving it in a non-serviceable condition. Fire protection systems served by this fire service main include onsite fire hydrants and fixed monitor nozzles strategically placed to provide fire protection in the following areas: Flare gas recovery compressor, C-730 and associated furnace, north and south flare areas, cooling water tower, and the east side of TKN and RLOP plants.

As of September 20, 2012, the fire service main remained in a non-serviceable condition.

Date By Which Violation Must be Abated:	03/04/2013
Proposed Penalty:	$ 6750.00

Citation 8 Item 1 Type of Violation: **Willful Serious**

T8CCR6845(a). Piping, Fittings, and Valves.

(a) The design, fabrication, and assembly of piping systems installed prior to July 26, 2006, shall comply with General Industry Safety Orders and ASME B31.3- 1990, Chemical Plant and Petroleum Refinery Piping herein incorporated by reference. The design, fabrication, and assembly of piping systems installed on or after July 26, 2006, and the testing, inspection, and repair of all piping systems shall comply with Article 146 of the General Industry Safety Orders; API 570, Piping Inspection Code, Second Edition, October 1998, Addendum 3, August 2003; and ASME B31.3-2002, Process Piping; herein incorporated by reference.

As of September, 2012, dates indicated, a total of nine temporary nonwelding repairs identified below were not removed at the most recent turnaround:

1. MOC number 20968, a clamp covering two flanges and a valve at the outlet of furnace F-340 in South Isomax., conveying hot (>600 deg F) natural gas. As of September 12, 2012, this was in place 2 years and 6 months past its last turnaround.

2. MOC number 18856, a valve packing injection fitting for a valve conveying natural gas to furnace F305 in South Isomax. As of September 18, 2012, this had been in place 30 months past its last turnaround.

3. MOC number 16210, an injection fitting in a block valve for the F 305 east split in South Isomax, conveying hot (>600 deg F) natural gas. As of September 12, and 18, 2012. It had been in place for 6 years and was 30 months beyond the last turnaround.

4. MOC number 17395, a clamp covering the mating surface edge of two flanges for a feed gas orafice for furnace F 305 in South Isomax, conveying natural gas. As of September 12, 2012, it was still in place more than 5 years later and 30 months past the last turnaround.

5. MOC number 19758, a clamp enclosing an elbow at Stanchion A6 overhead in the TKN plant of North Isomax, conveying nitrogen at up to 200 psi. As of September 20, 2012. was still in place 2 years and 7 months past the last turnaround.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management (0950663; 4037)
1450 Enea Circle, Suite 550
Concord, CA 94520

Phone: (925) 602-2665 Fax: (925) 602-2668

Inspection Number: 314332370
Inspection Dates: 08/30/2012 - 01/30/2013
Issuance Date: 01/30/2013
CSHO ID: T6126
Optional Inspection Nbr: 001-13

Citation and Notification of Penalty

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 CHEVRON WAY, RICHMOND, CA 94801

6. MOC number 21513, an injection fitting in a valve on a 6 inch line conveying flammable liquid/vapor at the base of V-4030A in D & R PenHex. As of September 27, 2012, was still present 11 months beyond the last turnaround maintenance opportunity.

7. MOC number 21434,a valve packing injection fitting at 40 MOV inlet block valve for drier V4030A in D& R, PenHex, conveying hydrogen. As of September 27, 2012, this was still present 11 months beyond the last turnaround maintenance opportunity.

8. MOC number 18408, a globe valve injection fitting at on the 1 S/C to 2 S/C on the D-308312 line in D&R unit, 4 Crude plant, conveying hydrocarbon at 400 deg F, 300 psi. As of September 27, 2012, this fitting was in place for 4 years, 5 months and was still present 11 months past the most recent turnaround.

9. MOC number 15197, consisting of 3 injection fittings, two for packing and one for a flange, on LT 92 top block valve to V4090, conveying C1 to C5 hydrocarbons and and chlorine. As of September 27, 2012, these three injection fittings were still present, 7 years later, and 1 year and 8 months past the most recent turnaround.

Date By Which Violation Must be Abated:	03/04/2013
Proposed Penalty:	$ 70000.00

[redacted]

Phone: (925) 602-2665 Fax: (925) 602-2668
Compliance Officer/District Manager

See pages 1 through 4 of this Citation and Notification of Penalty for information on employer and employee rights and responsibilities.

State of California
Division of Occupational Safety and Health
Cal/OSHA Process Safety Management District Office
1450 Enea Circle, Suite 550 (Index Code 4037)
Concord, CA 94520-7996
Phone: (925) 602-2665 Fax: (925) 602-2668
(925) 602-2665

NOTICE OF PROPOSED PENALTIES

Company Name: Chevron U.S.A. Inc.
Inspection Site: 841 CHEVRON WAY, RICHMOND, CA 94801
Mailing Address: 841 CHEVRON WAY, RICHMOND, CA 94801

Issuance Date: 01/30/2013

Reporting ID: 0950663
Index Code: 4037

Summary of Penalties for Inspection Number 314332370

Citation 1, Serious	=	$	**6750.00**
Citation 2, Serious	=	$	**6750.00**
Citation 3, Serious	=	$	**6750.00**
Citation 4, Serious	=	$	**6750.00**
Citation 5, Serious	=	$	**6750.00**
Citation 6, Willful	=	$	**70000.00**
Citation 7, Serious	=	$	**6750.00**
Citation 8, Willful	=	$	**70000.00**
TOTAL PROPOSED PENALTIES	=	$	**180500.00**

Penalties are due within 15 working days of receipt of this notification unless contested. If you are appealing any item of this citation, remittance is still due on all items that are not appealed. Enclosed for your use is a Penalty Remittance Form.

If you are paying by credit card (MasterCard and Visa): Please have this form on-hand when you are ready to make your payment. The company name, index code, reporting ID and Citation number(s) will be required to ensure that the payment is accurately posted to your account. Please go to www.dir.ca.gov/dosh to access the secure payment processing site.

If you are paying by check: Mail this Notice of Proposed Penalties, the Penalty Remittance Form, along with a copy of the Citation and Notification of Penalty to:

DEPARTMENT OF INDUSTRIAL RELATIONS
CASHIER, ACCOUNTING OFFICE
P. O. BOX 420603
SAN FRANCISCO, CA 94142-0603

CAL/OSHA does not agree to any restrictions, conditions or endorsements put on any check or money order for less than the full amount due, and will cash the check or money order as if these restrictions, conditions or endorsements do not exist.

DEPARTMENT OF INDUSTRIAL RELATIONS
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH - CAL/OSHA
Cashier, Accounting Office
P.O. Box 420603
San Francisco, CA 94142-0603
Phone (415) 703-4291 or (415) 703-4295 FAX (415) 703-3037

PENALTY REMITTANCE FORM

CIVIL PENALTY INFORMATION INSPECTION NUMBER 314332370 REPORTING ID 0950663 INDEX CODE 4037

ESTABLISHMENT NAME Chevron U.S.A. Inc.

CONTACT PERSON ______

PHONE NO. ______ FAX NO. ______

SITE ADDRESS 841 CHEVRON WAY, RICHMOND

MAILING ADDRESS 841 CHEVRON WAY, RICHMOND, CA, 94801

CITATION INFORMATION (Penalties are due within 15 working days of receipt of this notification unless contested. If you are appealing any item of this citation, remittance is still due on all items that are not appealed.)

Payment is for the following Citation Items: e.g. Citation 1, Items 1-5; Citation 3

______

TYPE OF PAYMENT ENCLOSED

CHECK OR MONEY ORDER INFORMATION

CHECK ENCLOSED IN THE AMOUNT OF $______

MONEY ORDER ENCLOSED IN THE AMOUNT OF $______

(Please make check or money order payable to **CAL/OSHA** and mail to the Cashier, Accounting Office, at the above address. Reference the Inspection Number on the "memo" portion of your check or money order.)

Go to www.dir.ca.gov/dosh to access the on-line third party secure payment processing site.
OR Complete this section and fax to (415) 703-3037
CREDIT CARD INFORMATION

VISA OR MASTERCARD CREDIT CARD NO. ______ EXPIRATION DATE ______

CREDIT CARD SECURITY CODE (last 3 digits on back of card) ______

NAME OF CARDHOLDER ______ SIGNATURE ______

CARDHOLDER PHONE NO. ______ FAX NO. ______

AMOUNT OF PAYMENT $______

------------------------------ FOR OFFICE USE ONLY ------------------------------

AUTHORIZATION NO. ______ DATE PROCESSED ______

PROCESSED BY ______

Please call (415) 703-4291 or 703-4295 or complete the information above and fax to (415) 703-3037

Cal/OSHA-2 PRF Rev 7/08

State of California
Department of Industrial Relations
Division of Occupational Safety and Health

NORTH PROCESS SAFETY MANAGEMENT OFFICE
1450 Enea Circle, Suite 550
Concord, CA 94520-7996
Tel: 925-602-2667
Fax: 925-602-2667

EMPLOYER'S SIGNED STATEMENT OF ABATEMENT OF SERIOUS VIOLATIONS

2. EMPLOYER: CHEVRON U.S.A. INC.

dba CHEVRON U.S.A. INC.

ADDRESS: 841 CHEVRON WAY
Street
RICHMOND, CA 94801
City State Zip

3. The law requires that violations observed during the inspection/investigation completed on ______ of the place of employment located at 841 CHEVRON WAY RICHMOND, CA 94801 be corrected within the time limit specified. Labor Code 6320(b), requires that yo submit this signed statement under penalty of perjury which describes the measures for abating each citation which alleges a serious violation. **If the signed statement is not received within 10 working days after the end of the period fixed for abatement, the Division will be required to revoke any adjustments to the civil penalty based upon the assumption that you will abate the violation.** This action will result in a doubling of the civil penalty for serious violations. If you have filed a timely appeal with reference to a particular citation, the abatement date is stayed during the appeal process and the Signed Statement need not be submitted at this time. In addition, if there are problems beyond your control that prevent meeting a specified abatement date, contact the Division early so that a request for extension can be considered.

4. THIS FORM MUST BE RECEIVED AT THE ABOVE ADDRESS ON OR BEFORE:

______

This signed statement shall be posted for three (3) working days at or near each place the serious violation referred to in the citation occured.

****

5. DESCRIBE AND LIST THE SPECIFIC MEASURES TAKEN TO ABATE EACH SERIOUS VIOLATION

Citation Number	Number of Instances	Measures Taken to Abate Serious Violation	Abatement Date

[ ] Continued on additional page

6. All affected employees and their representatives have been informed about statement activities referenced in this document in conformance with 8CCR Section 340.4(g). ☐ **YES** ☐ **NO**

7. I have reviewed the foregoing statement and declare under penalty of perjury that it is true and correct to the best of my knowledge and all submitted abatement information is accureate.

Executed at ______, California, by

Signature: ______ Date: ______

Name: ______ Title: ______

8. **OFFICE USE ONLY**

Safety Engineer/Industrial Hygienist: ______ Date: ______

District Manager: ______ Date: ______

[ ] Close/Comments

9. Region 6 District 3 Inspection No. 314332370 Identification No. T6126 Cal/OSHA Rpt. No. 001 Fiscal Year 13

10. Date mailed or Delivered: 26 Jul 2011

U.S. Chemical Safety and Hazard Investigation Board

2175 K Street, NW • Suite 650 • Washington, DC 20037-1809
Phone: (202) 261-7600 • Fax: (202) 261-7650
www.csb.gov

CSB

In reply, please refer to:
2012-03-I-CA-R9 thru R14

The Honorable Edmund G. Brown, Jr., Governor
The Honorable Gavin Newsom, Lieutenant Governor
The Honorable Darrell Steinberg, President pro Tempore of the Senate
The Honorable John A. Pérez, Speaker of the Assembly

Sacramento, CA, 95814

MAY 0 7 2013

Dear Sirs:

The U.S. Chemical Safety and Hazard Investigation Board (CSB) recently issued its interim report on the August 6, 2012 incident at the Chevron Refinery in Richmond, California. On that date, the refinery experienced a catastrophic pipe failure in a crude unit, causing the release of flammable hydrocarbon process fluid which partially vaporized into a large vapor 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 and quantified 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 Richmond Refinery conducted a Process Hazard Analysis of the crude unit as required by California Code of Regulations, Title 8, Section 5189, *Process Safety Management of Acutely Hazardous Materials* (PSM), however, this regulation does not require the conducting of formal damage mechanism hazard reviews. Despite Chevron's extensive knowledge of sulfidation corrosion at the corporate level, the CSB's investigation found that the PHA team for the crude unit at the Richmond refinery did not identify this damage mechanism as a potential cause of a leak or rupture in the piping.

The CSB also found that the California PSM regulation does 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 required 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 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.

The CSB also concluded that 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. Reporting of indicators and additional information related to activities such as 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, as follows:

Recommendation No. 2012-03-I-CA-R9:
Revise the California Code of Regulations, Title 8, Section 5189, Process Safety Management of Acutely Hazardous Materials, to require improvements to mechanical integrity and process hazard analysis programs for all California oil refineries. These improvements shall include engaging a diverse team of qualified personnel to perform a documented damage mechanism hazard review. This review shall be an integral part of the Process Hazard Analysis cycle and shall be conducted on all PSM-covered process piping circuits and process equipment. The damage mechanism hazard review shall identify potential process damage mechanisms and consequences of failure, and shall ensure safeguards are in place to control hazards presented by those damage mechanisms. Require the analysis and incorporation of applicable industry best practices and inherently safety systems to the greatest extent feasible into this review.

Recommendation No. 2012-03-I-CA-R10:
For all California oil refineries, identify and require the reporting of leading and lagging process safety indicators, such as the action item completion status of recommendations from damage mechanism hazard reviews, to state and local regulatory agencies that have chemical release prevention authority. These indicators shall be used to ensure that requirements described in 2012-03-I-CA-R9 are effective at improving mechanical integrity and process hazard analysis performance at all California oil refineries and preventing major chemical incidents.

Recommendation No. 2012-03-I-CA-R11:[1]
Establish a multi-agency process safety regulatory program for all California oil refineries to improve the public accountability, transparency, and performance of chemical accident prevention and mechanical integrity programs. This program shall:

1. *Establish a system to report to the regulator the recognized methodologies, findings, conclusions and corrective actions related to refinery mechanical integrity inspection and repair work arising from Process Hazard Analyses, California oil refinery turnarounds and maintenance-related shutdowns;*

---

[1] The Board also issued recommendations to The Board of Supervisors of Contra Costa County, the Mayor and City Council of Richmond, The California Air Quality Management Divisions, the U.S. Environmental Protection Agency, and the California Environmental Protection agency to participate in the regulatory program described in Recommendation No. 2012.03-I-CA-R11.

discuss California's implementation of these recommendations and obtain documentation of relevant actions taken. We would appreciate a response within **60 days** detailing the state's plans for implementation of these recommendations and indicating the person(s) authorized to correspond with the CSB on this matter.

If you have any questions or need further information, please contact Ms. Morgan at (202) 261-7642, or Christina.Morgan@csb.gov. In all future correspondence pertaining to these recommendations, please refer to the recommendation numbers 2012-3-I-CA-R9 through R14, and copy Ms. Morgan.

Sincerely,

Daniel Horowitz /RME

Rafael Moure-Eraso, PhD, CIH
Chairperson

CC: David Lanier, Legislative Director, Office of the Governor
Marty Morgenstern, Secretary, California Labor & Workforce Development Agency
Christine Baker, Director, Department of Industrial Relations (DIR)
Ellen Widess, Chief, Division of Occupational Safety and Health (Cal/OSHA)
Garrett D. Brown, Special Assistant to the Chief, Cal/OSHA
Manuel Gomez, Director, Office of Recommendations, CSB
Bill Hoyle, Senior Investigator, Office of Investigations, CSB
Don Holmstrom, Director, Western Regional Office, CSB
Christina Morgan, Recommendations Specialist, CSB

Summary of Chemical Safety Board's
Investigations of Petroleum Refineries

There are five completed investigations of petroleum refineries and four current investigations at petroleum refineries. Listed below is a summary of each.

<u>Completed Investigations of Petroleum Refineries</u>

1. Valero Refinery Propane Fire
   Location: Sunray, TX
   Accident Occurred On: 02/16/2007
   Final Report Released On: 07/09/2008
   Accident Type: Oil and Refining - Fire and Explosion
   Company Name: Valero

   <u>Summary of Incident</u>

   On February 16, 2007, a propane fire erupted at the Valero McKee Refinery in Sunray, Texas, north of Amarillo. Three workers suffered serious burns, and the refinery was forced to shut down. The fire began following a leak in the propane de-asphalting unit and spread quickly, in part because of the rapid collapse of a major pipe rack carrying flammable hydrocarbons. Some of the rack's support columns had not been fireproofed.

2. BP America Refinery Explosion
   Location: Texas City, TX
   Accident Occurred On: 03/23/2005
   Final Report Released On: 03/20/2007
   Accident Type: Oil and Refining - Fire and Explosion
   Company Name: BP

   <u>Summary of Incident</u>

   At approximately 1:20 p.m. on March 23, 2005, a series of explosions occurred at the BP Texas City refinery during the restarting of a hydrocarbon isomerization unit. Fifteen workers were killed and 180 others were injured. Many of the victims were in or around work trailers located near an atmospheric vent stack. The explosions occurred when a distillation tower flooded with hydrocarbons and was overpressurized, causing a geyser-like release from the vent stack.

3. Giant Industries Refinery Explosions and Fire
Location: Gallup, NM
Accident Occurred On: 04/08/2004
Final Report Released On: 10/26/2005
Accident Type: Oil and Refining - Fire and Explosion
Company Name: Giant Industries

Summary of Incident

On April 8, 2004, four workers were seriously injured when highly flammable gasoline components were released and ignited at the Giant Industries Ciniza refinery, east of Gallup, New Mexico. The release occurred as maintenance workers were removing a malfunctioning pump from the refinery's hydrofluoric acid (HF) alkylation unit. Unknown to personnel, a shut-off valve connecting the pump to a distillation column was apparently in the open position, leading to the release and subsequent explosions.

4. Motiva Enterprises Sulfuric Acid Tank Explosion
Location: Delaware City, DE
Accident Occurred On: 07/17/2001
Final Report Released On: 08/28/2002
Accident Type: Oil and Refining - Fire and Explosion
Company Name: Motiva Enterprises

Summary of Incident

On July 17, 2001, an explosion occurred at the Motiva Enterprises refinery in Delaware City, Delaware. A work crew had been repairing a catwalk above a sulfuric acid storage tank farm when a spark from their hot work ignited flammable vapors in one of the tanks. This tank had holes in its roof and shell due to corrosion. The tank collapsed, and one the contract workers was killed; eight others were injured. A significant volume of sulfuric acid was released to the environment.

5. Tosco Avon Refinery Petroleum Naphtha Fire
Location: Martinez, CA
Accident Occurred On: 02/23/1999
Final Report Released On: 03/21/2001
Accident Type: Oil and Refining - Fire and Explosion
Company Name: Tosco Corporation

Summary of Incident

On February 23, 1999, a fire occurred in the crude unit at Tosco Corporation. Avon Oil Refinery in Martinez, California. Workers were attempting to replace piping attached to a 150-foot-tall fractionator tower while the process unit was in operation. During removal of the piping, naphtha was released onto the hot fractionator and ignited. The flames engulfed five workers located at different heights on the tower. Four men were killed, and one sustained serious injuries.

Current Investigations of Petroleum Refineries

1. Chevron Refinery Fire
Location: Richmond, CA
Accident Occurred On: 08/06/2012
Accident Type: Oil and Refining - Fire and Explosion
Company Name: Chevron

Summary of Incident

An August 6, 2012, release of flammable vapor led to a fire at the Chevron Refinery in Richmond, California.

2. Tesoro Refinery Fatal Explosion and Fire
Location: Anacortes, WA
Accident Occurred On: 04/02/2010
Accident Type: Oil and Refining - Fire and Explosion
Company Name: Tesoro

Summary of Incident

An explosion and fire led to the fatal injury of seven employees when a nearly forty-year-old heat exchanger catastrophically failed during a maintenance operation to switch a process stream between two parallel banks of exchangers at the Tesoro refinery in Anacortes, Washington.

3. Silver Eagle Refinery Flash Fire and Explosion and Catastrophic Pipe Explosion
Location: Woods Cross, UT
Accident Occurred On: 01/12/2009
Accident Type: Oil and Refining - Fire and Explosion
Company Name: Silver Eagle Refinery

Summary of Incident

On the evening of January 12, 2009, 2 refinery operators and 2 contractors suffered serious burns resulting from a flash fire at the Silver Eagle Refinery in Woods Cross, Utah. The accident occurred when a large flammable vapor cloud was released from an atmospheric storage tank, known as tank 105, which contained an estimated 440,000 gallons of light naphtha. The vapor cloud found an ignition source and the ensuing flash fire spread up to 230 feet west of the tank farm. On November 4, 2009, a second accident occurred at the Silver Eagle Refinery in Woods Cross, Utah, when a powerful blast wave - - caused by the failure of a 10 inch pipe - damaged nearby homes.

4. BP America Refinery Ultracracker Explosion
Location: Texas City, TX
Accident Occurred On: 01/14/2008
Accident Type: Oil and Refining - Fire and Explosion
Company Name: BP

Summary of Incident

On January 14, 2008, a worker was fatally injured when the top of a large steel filter housing suddenly blew off in the refinery's ultracracker unit. This unit is across a roadway from the ISOM unit, where a 2005 accident killed 15 workers and injured 180 others.

U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD

INTERIM INVESTIGATION REPORT

CHEVRON RICHMOND REFINERY FIRE

CHEVRON RICHMOND REFINERY

RICHMOND, CALIFORNIA

AUGUST 6, 2012

KEY ISSUES

- INHERENTLY SAFER DESIGN
- DAMAGE MECHANISM HAZARD REVIEW
- EFFECTIVE ANALYSIS OF PROCESS SAFEGUARDS IN PROCESS HAZARD ANALYSIS

Summary

On August 6, 2012, the Chevron U.S.A. Inc. Refinery in Richmond, California, experienced a catastrophic pipe failure in the #4 Crude Unit. The pipe ruptured, releasing flammable, hydrocarbon process fluid which partially vaporized into a large vapor cloud that engulfed nineteen Chevron employees. All of the employees escaped, narrowly avoiding serious injury. The flammable portion of the vapor cloud ignited just over two minutes after the pipe ruptured. The ignition and subsequent continued burning of the hydrocarbon process fluid resulted in a large plume of unknown and unquantified particulates and vapor traveling across the Richmond, California, area. In the weeks following the incident, approximately 15,000 people from the surrounding area sought medical treatment due to the release. Testing commissioned by the U.S. Chemical Safety and Hazard Investigation Board (CSB) and the California Division of Occupational Safety and Health (Cal/OSHA) determined that the pipe failed due to thinning caused by sulfidation corrosion, a common damage mechanism in refineries. As a result of the incident, the Chevron Richmond Refinery crude unit remains out of commission over eight months later. In addition, Cal/OSHA issued the refinery 17 citations related to the incident and eight additional citations, with a total proposed fine of nearly one million dollars. In this interim report, the CSB is issuing recommendations to Chevron, the City of Richmond, Contra Costa County, Cal/OSHA, the State of California, and the U.S. Environmental Protection Agency, addressing the need for inherently safer design, rigorous and documented damage mechanism hazard reviews, and thorough analyses of process safeguards.

This interim investigation report contains detailed analyses of and makes recommendations to Chevron and regulatory bodies at the local, state, and federal level. The CSB believes the findings and recommendations presented in this report can be applied to refineries, chemical plants, and other industries nationwide to improve process safety.

The CSB plans to release a comprehensive Final Investigation Report later in 2013 that will include analyses and recommendations relating to technical and regulatory investigation findings which are not included in this interim report. The Final Investigation Report will cover topics including: the importance of having a competent, well-funded regulator and an adaptable regulatory regime; Chevron safety culture; process safety indicator data collection and reporting; emergency planning and response; stop work authority; and recommendations for improvement of petroleum industry standards and recommended practices. Some of these issues are previewed at the end of this interim report under *Additional Issues Currently Under Investigation*.

Table of Contents

Figures

Acronyms and Abbreviations

ALARP	As Low As Reasonably Practicable
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
BIN	Business Improvement Network
bpd	Barrels Per Day
BPTC	BP Texas City
CAA	Clean Air Act
Cal/OSHA	California Division of Occupational Safety and Health
CCPS	Center for Chemical Process Safety
CCR	California Code of Regulations
Chevron ETC	Chevron Energy Technology Company
CML	Condition Monitoring Locations
CSB	U.S. Chemical Safety and Hazard Investigation Board
CSHO	Compliance Safety and Health Officer
CWS	Community Warning System
EPA	Environmental Protection Agency
°F	degree Fahrenheit
HSE	Health and Safety Executive
ISO	Industrial Safety Ordinance
ISS	Inherently Safer Systems
IST	Inherently Safer Technology
KPI	Key Process Indicator

LEPC	Local Emergency Planning Committee
LOPA	Layers of Protection Analysis
MOC	Management of Change
NEP	National Emphasis Program
OEM	U.S. EPA Office of Emergency Management
OSHA	Occupational Safety and Health Administration
P&P	Policy and Procedures
PHA	Process Hazard Analysis
PMI	Positive Materials Identification
psig	Pounds Per Square Inch Gauge
PSM	Process Safety Management
RISO	City of Richmond Industrial Safety Ordinance
RLOP	Richmond Lube Oil Project
RMP	Risk Management Plan
SIP	Shelter-In-Place
TML	Thickness Monitoring Location
UK	United Kingdom
USW	United Steelworker International Union
wt. %	Weight Percent

Background and Findings

1. On August 6, 2012, the Chevron U.S.A. Inc. Refinery in Richmond, California (Chevron Richmond Refinery), experienced a catastrophic pipe rupture in the #4 Crude Unit (crude unit). The ruptured pipe released a flammable hydrocarbon process fluid which then partially vaporized into a large vapor cloud that engulfed nineteen Chevron U.S.A. Inc. (Chevron) employees. At 6:33 pm, approximately two minutes after the release, the flammable portion of the vapor cloud ignited.[i] Eighteen of the employees safely escaped from the cloud just before ignition; one employee, a firefighter, was inside a fire engine that caught fire when the vapor cloud ignited (Figure 1). Because he was wearing full body fire-fighting protective equipment, he was able to make his way to safety. Six Chevron employees suffered minor injuries during the incident and subsequent emergency response efforts.

[i] Surveillance footage provided by Chevron. Chevron clarified to CSB that video time is approximately 5 minutes out of sync. The video can be found at http://www.csb.gov/videoroom/detail.aspx?VID=69 (accessed February 8, 2013).

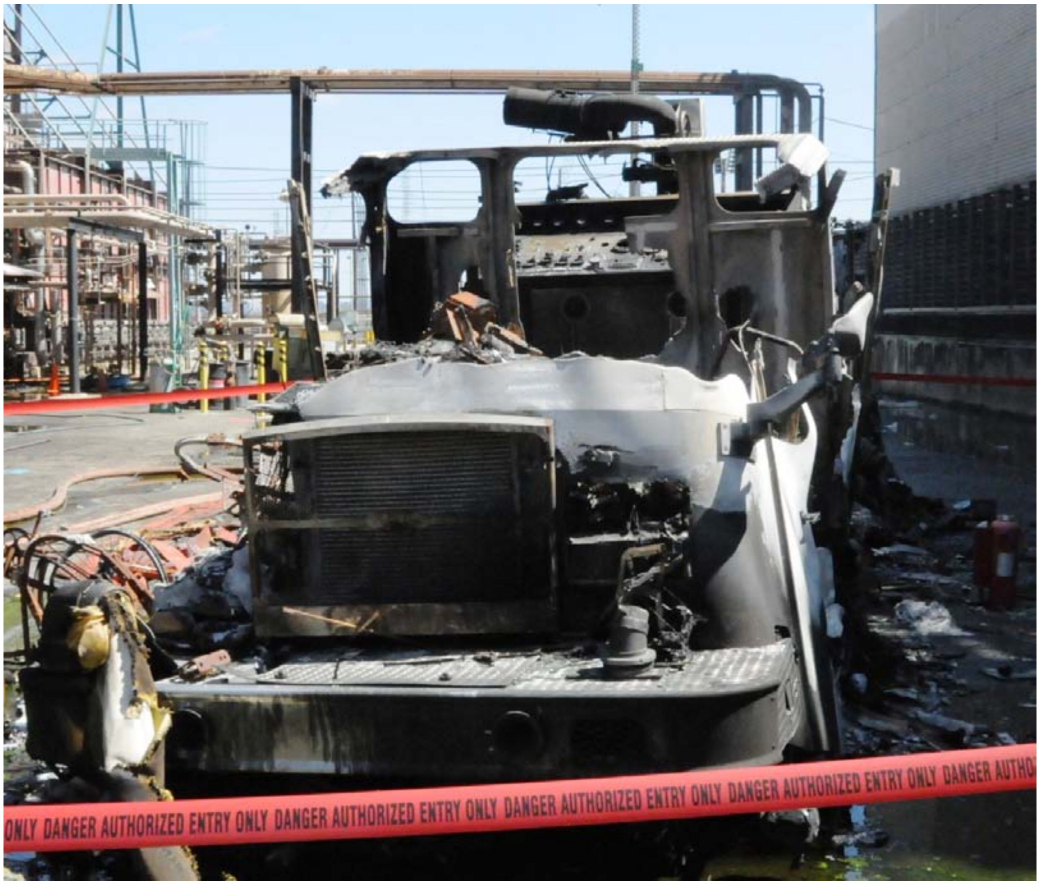


Figure 1. The burned remains of the fire truck that was consumed by the fire. A firefighter was in the cab when the vapor cloud ignited. The fire truck was positioned approximately 65 feet from the leak location.

2. The ignition and subsequent continued burning of the hydrocarbon process fluid resulted in a large plume of unknown and unquantified particulates and vapor traveling across the Richmond, California, area (Figures 2 and 3). This resulted in a Community Warning System (CWS) Level 3 alert,[i] and a shelter-in-place[ii] (SIP) was issued at 6:38 pm[1] for the cities of Richmond, San Pablo, and North Richmond. It was lifted later that night at 11:12 pm after the fire was fully under control. In the weeks following the incident, nearby medical facilities received over 15,000 members of the public seeking treatment for ailments including breathing problems, chest pain, shortness of breath, sore throat, and headaches. Approximately 20 people were admitted to local hospitals as inpatients for treatment.

Figure 2. Vapor cloud (white) over Richmond area and smoke (black) from Chevron Richmond Refinery fire as seen from San Rafael in Marin County.[2]

[i] A Community Warning System Level 3 alert indicates that a facility within Contra Costa County has had a release that has offsite impact and is categorized by any of the following:

1. Off-site impact that may cause eye, skin, nose and/or respiratory irritation to the general population.
2. Fire, explosion, heat, or smoke with an off-site impact. Example: On a process unit/storage tank where mutual aid is requested to mitigate the event and the fire will last longer than 15 minutes.
3. Hazardous material or fire incident where the incident commander or unified command, through consultation with the Contra Costa Health Services Hazardous Material Incident Response Team, requests that sirens should be sounded.

See http://cchealth.org/hazmat/pdf/incident_notification_policy.pdf (accessed April 9, 2013).

[ii] Contra Costa County considers a shelter-in-place to include going inside a home or nearest building, closing doors and windows, and turning off heating, ventilation, and air conditioning. *See* http://cchealth.org/emergencies/shelter-in-place.php (accessed February 6, 2013).

Figure 3. Initial vapor cloud formation (white cloud) and subsequent ignition (black smoke) as seen from a pier in San Francisco, California.

3. The incident occurred from the piping referred to as the "4-sidecut" stream, one of several process streams exiting the C-1100 Crude Unit Atmospheric Column (Figure 4).[i] A plot plan of the crude unit shows the leak location relative to C-1100 (Figure 5). As shown in Figure 6, light gas oil (the crude unit 4-sidecut process fluid) exits the atmospheric column via a 20-inch nozzle and is split into a 12-inch line and an 8-inch line. The August 6, 2012, pipe rupture (Figure 7) occurred on a 52-inch long component[ii] of the 4-sidecut 8-inch line (the 52-inch component). The line operated at a temperature of 640 degrees Fahrenheit (°F)[iii] and had an operating pressure of approximately 55 pounds per square inch gauge (psig) at the rupture location. At the

[i] The atmospheric column separates crude oil feed into different streams through distillation. These streams are further processed in other units in the refinery.
[ii] The term "component" refers to a portion of piping between welds or flanges. It includes straight run piping and pipe fittings.
[iii] The auto-ignition temperature for this process, the temperature at which a material will combust in the presence of sufficient oxygen without an ignition source, was also 640 °F. This number is based on the Chevron Light Gas Oil Material Safety Data Sheet. Chemical testing of 4-sidecut samples following the incident indicated lower auto-ignition temperatures; however, these samples may not have been representative of typical 4-sidecut process fluid.

time of the incident, light gas oil was flowing through the 8-inch line at a rate of approximately 10,800 barrels per day (bpd).[i]

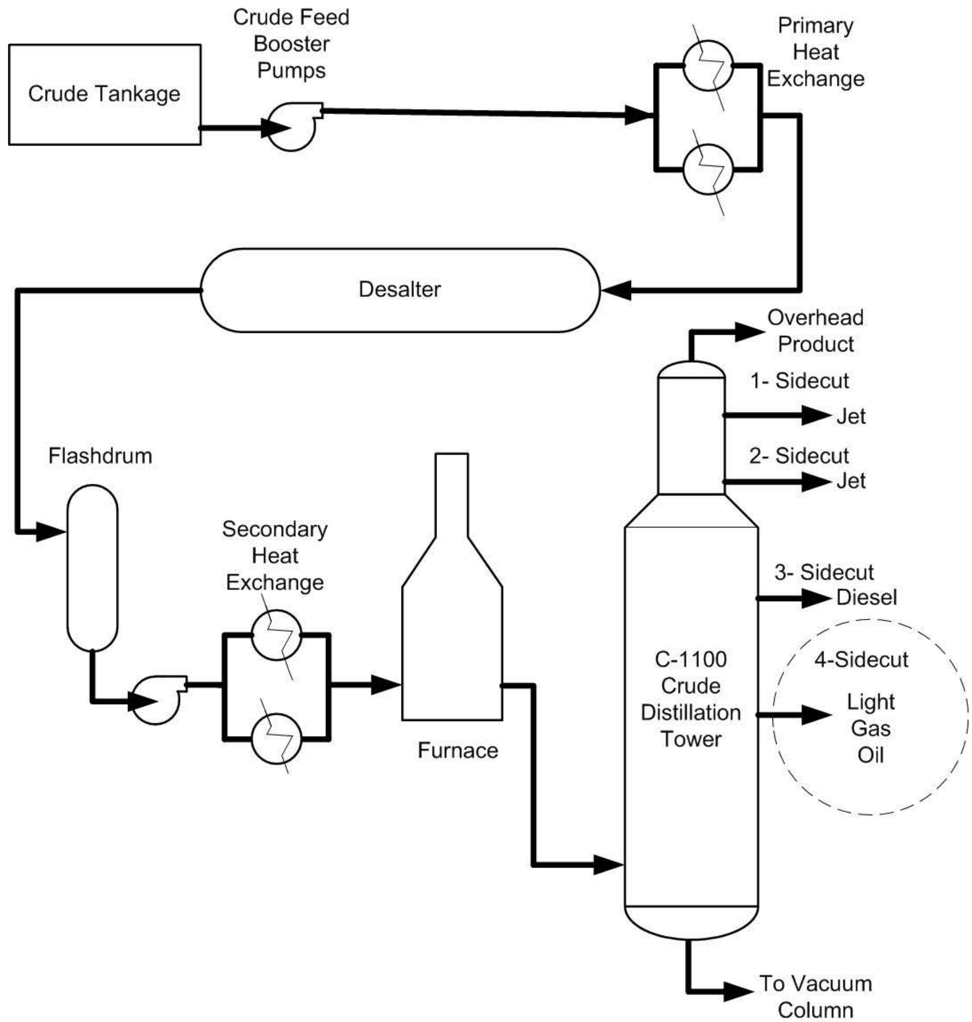


Figure 4. C-1100 Crude Unit Atmospheric Column and Upstream Process Equipment.

[i] This is the equivalent of 315 gallons per minute (gpm). A barrel equals 42 gallons.

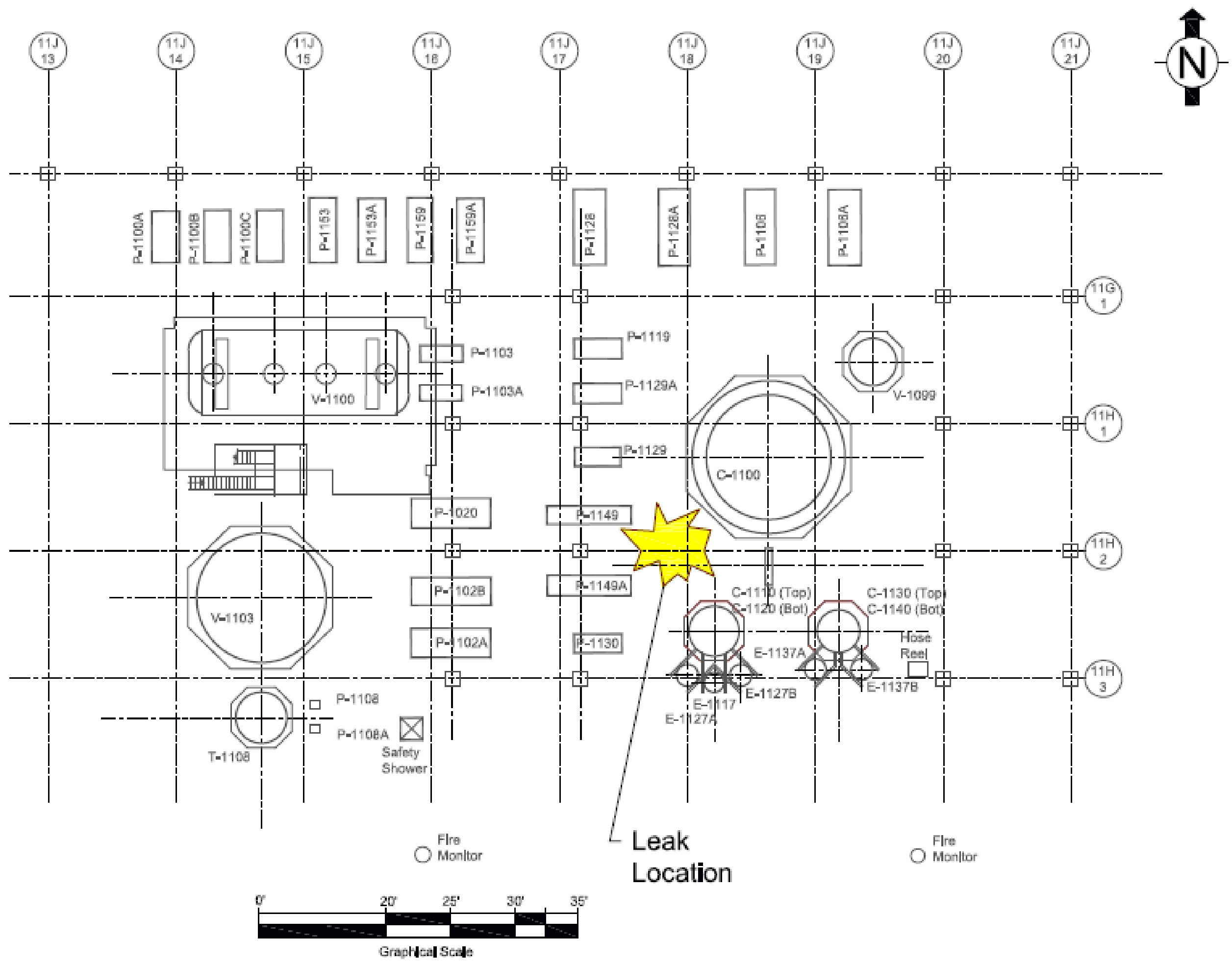


Figure 5. Overhead view of the equipment in the #4 Crude Unit showing the leak location, commonly referred to as a plot plan.

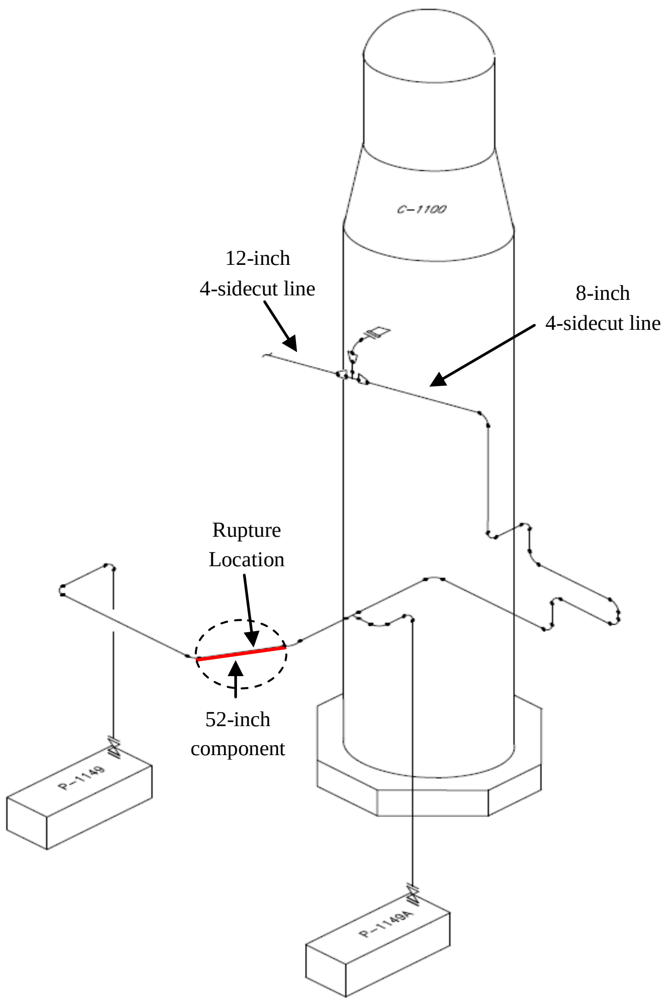


Figure 6. 4-sidecut line configuration and rupture location.

4. The CSB commissioned Anamet, Inc., a materials engineering and laboratory testing company, to conduct testing of the 4-sidecut pipe, including the failed 52-inch component. The testing concluded that the rupture was due to pipe wall thinning caused by sulfidation corrosion,[3] which is discussed below.

5. Anamet's metallurgical analysis found that the 52-inch component where the rupture occurred had experienced extreme thinning; the average wall thickness near the rupture location was approximately 40 percent thinner than a dime[i] (the thinnest American coin). Between 1976 and 2012, the 52-inch piping component had lost, on average, 90 percent of its original wall thickness in the area near the rupture. The piping had an initial nominal wall thickness of 0.322-inch[ii] when it was installed in 1976.

Figure 7. Photo of rupture on 4-sidecut 52-inch component.

[i] The U.S. Mint reports that a dime has a thickness of 1.35 mm, or 0.053 inches. Information can be found at http://www.usmint.gov/about_the_mint/?action=coin_specifications (accessed February 14, 2013).
[ii] This portion of the 4-sidecut line was constructed of 8-inch Schedule 40 carbon steel piping.

Sulfidation Corrosion

6. Sulfidation corrosion is a damage mechanism[i] that is well understood in the refining industry. The sulfidation corrosion industry guidance document, American Petroleum Institute (API) Recommended Practice (RP) 939-C *Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries*[ii] notes:

> [Sulfidation] …is not a new phenomenon, but was first observed in the late 1800s in a pipe still (crude separation) unit, due to the naturally occurring sulfur compounds found in crude oil. When heated for separation, the various fractions in the crude were found to contain sulfur compounds that corroded the steel equipment.[4]

7. Sulfidation corrosion, also known as sulfidic corrosion,[5] is a damage mechanism that causes thinning in iron-containing materials, such as steel, due to the reaction between sulfur compounds and iron at temperatures ranging from 450 °F to 800 °F.[6] This damage mechanism causes pipe walls to gradually thin over time. Sulfidation corrosion is common in crude oil distillation[iii] where naturally occurring sulfur and sulfur compounds found in crude oil feed, such as hydrogen sulfide,[iv] are available to react with steel piping and equipment. Process variables that affect corrosion rates include the total sulfur content of the oil, the sulfur species present, flow conditions, and the temperature of the system. Virtually all crude oil feeds contain sulfur compounds and, as a result, sulfidation corrosion is a damage mechanism present at every refinery that processes crude oil. Sulfidation corrosion can cause thinning to the point of pipe failure when not properly monitored and controlled.

8. The reaction between sulfur and iron produces a layer of iron sulfide scale[v] on the inside surface of piping.[7] This reaction can be compared to that of oxygen and iron which also produces a scale, commonly known as rust. The type of scale formed by sulfidation corrosion is dependent upon the components contained in the steel. Certain scales formed are protective and actually reduce the reaction rate between sulfur compounds and iron, minimizing sulfidation corrosion

[i] Piping damage mechanisms are any type of deterioration encountered in the refining and chemical process industry that can result in flaws/defects that can affect the integrity of piping (e.g. corrosion, cracking, erosion, dents, and other mechanical, physical or chemical impacts). *See* API 570. "Piping Inspection Code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems." 3rd ed., Section 3.1.1.5, November 2009.

[ii] API RP 939-C is one of several relevant American Petroleum Institute recommended practices and standards under evaluation by the CSB as part of this investigation. To the casual observer API RP 939-C appears to obligate the industry to take significant actions. However, the CSB concluded it was written to be permissive so that industry compliance with specific provisions would not be required. The complete findings from this evaluation will be included in the CSB's Final Report.

[iii] Distillation separates mixtures into broad categories of its components by heating the mixture in a distillation column where different products boil off and are recovered at different temperatures. *See* http://www.eia.gov/todayinenergy/detail.cfm?id=6970 (accessed April 4, 2013).

[iv] Hydrogen sulfide is the most aggressive sulfur compound that causes sulfidation corrosion.

[v] Scale is a nonmetallic layer on the surface of metals and is often a result of corrosion.

rates. For instance, sulfidation corrosion affecting steel alloys containing greater than two weight percent (wt. %) chromium produces a protective scale that inhibits the reaction between the iron and sulfur compounds, thereby reducing corrosion rates.[i] With increasing percentages of chromium, the reaction is further slowed, greatly diminishing corrosion rates.[8,ii] For example, stainless steel (an 18 wt. % chromium alloy) is nearly 15 times more resistant to sulfidation corrosion than 9-Chrome (a 9 wt. % chromium alloy).[9] Conversely, sulfidation corrosion rates are significantly higher in steels containing very little chromium. Carbon steel, the Chevron 4-sidecut line material of construction, was manufactured with a maximum concentration of 0.40 % chromium.[10] The scale formed on carbon steel is less protective and allows continued reaction between the sulfur compounds and iron.[11] Thus, carbon steel corrodes at a rate that is significantly faster than other materials of construction, such as high chromium steels.

9. In addition to its inherently faster rate of sulfidation corrosion when compared with higher chromium steels, carbon steel also experiences significant variation in corrosion rates due to variances in silicon content, a component used in the steel manufacturing process. Carbon steel piping containing silicon content less than 0.10 wt. % can corrode at accelerated rates,[12] up to sixteen times faster than carbon steel piping containing higher percentages of silicon as shown in Figure 8. This figure shows how carbon steel corrosion rates can greatly vary depending on silicon content.

[i] At greater than two wt. % chromium, sulfur compounds react with the steel to form $FeCr_2S_4$ scale. This scale provides more protection than the FeS scale that forms on carbon steel piping. *See* Niccolls, E. H., J. M. Stankiewicz, J. E. McLaughlin, and K. Yamamoto. "High Temperature Sulfidation Corrosion in Refining." *17th International Corrosion Congress.* Las Vegas: NACE International, 2008.

[ii] It has also been found that chromium "poisons" the decomposition of sulfur compounds to hydrogen sulfide which also slows down the sulfidation corrosion rate. *See* Couper, A.S. "High Temperature Mercaptan Corrosion of Steels." *19th Annual Conference of the National Association of Corrosion Engineers*. Pages 396t-401t, New York: March 1963.

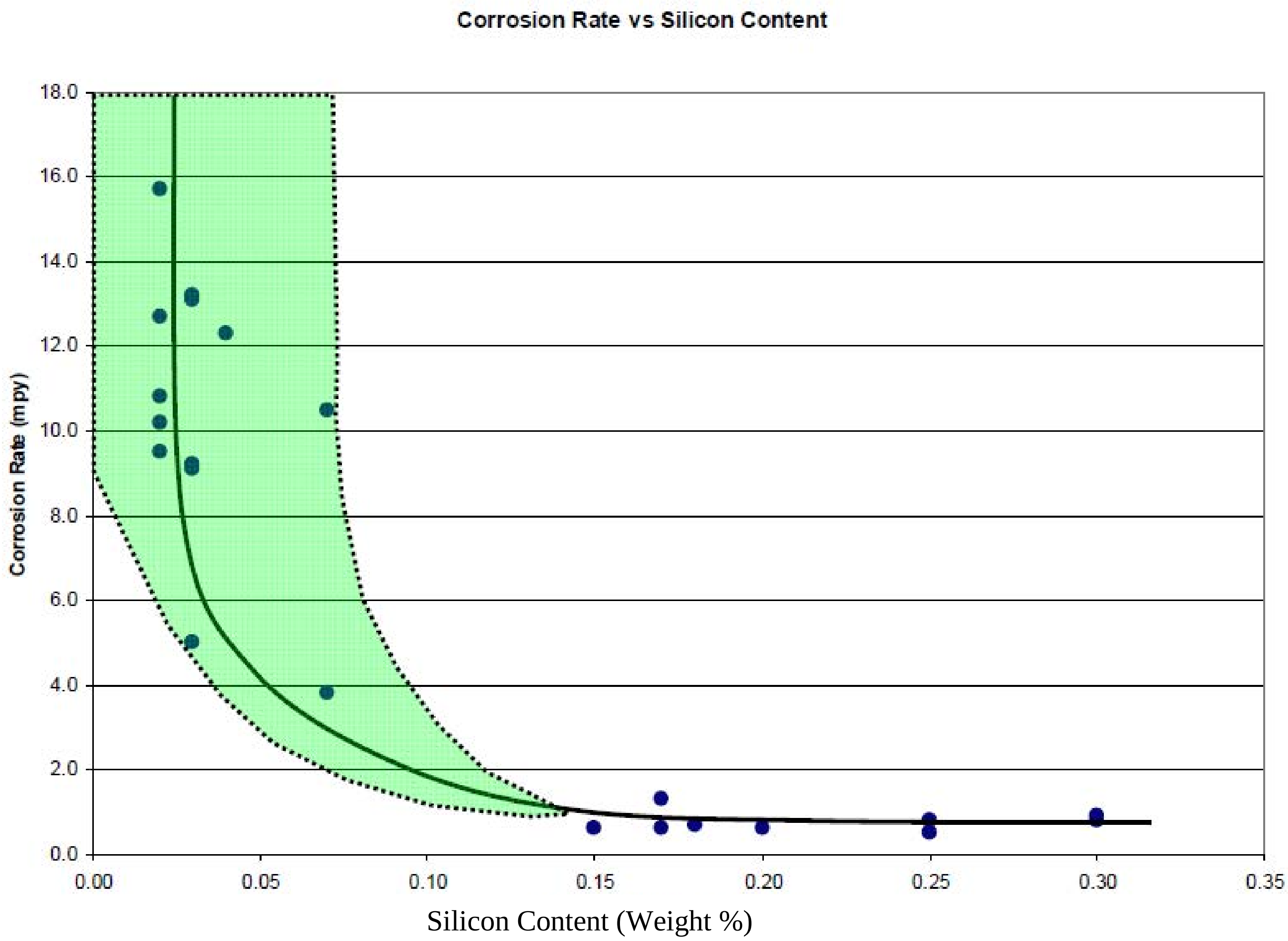


Figure 8. This graph shows how corrosion rates increase in carbon steel containing decreasing percentages of silicon. This information can be found in Annex C of API RP 939-C.[i]

10. The refining industry has been aware of increased rates of sulfidation corrosion in low-silicon carbon steel piping since as early as 1974,[13] nearly 40 years before the August 6, 2012, incident and two years before the Chevron crude unit was constructed. Prior to the incident, Chevron documented its understanding of the significant consequences of sulfidation corrosion. This is reflected in Chevron's *Corrosion Prevention and Metallurgy Manual*, which states:

> Sulfidation corrosion has caused severe fires and fatalities in the refining industry, primarily because it causes corrosion over a relatively large area, so failures tend to involve ruptures or large leaks rather than pinhole leaks. It can be insidious in that moderately high corrosion rates can go undetected for years before failure. Finally, process changes that increase the temperature or sulfur content can creep up over time and

[i] The y-axis of this figure is in units of mils per year (mpy). A "mil" is 1/1000 inch.

multiply corrosion rates so that what was thought to be a low corrosion rate system becomes corrosive enough to fail before the increased corrosion rate is recognized.

11. Carbon steel piping is manufactured to meet certain specifications, including American Society for Testing and Materials (ASTM) A53B,[14] ASTM A106,[15] and API 5L.[16] ASTM A53B and API 5L do not contain minimum silicon content requirements for carbon steel piping,[17] while ASTM A106 requires the piping to be manufactured with a minimum silicon content of 0.10 wt. %. As a result, manufacturers have used different levels of silicon in the carbon steel pipe manufacturing process. Thus, depending on the manufacturing specification for carbon steel susceptible to sulfidation corrosion, corrosion rates could vary depending on the silicon content within the steel.

12. In the mid 1980s, pipe manufacturers began to simultaneously comply with all three manufacturing specifications (ASTM A53B, ASTM A106, and API 5L) when manufacturing carbon steel piping. The majority of carbon steel piping purchased following this time period likely has a minimum of 0.10 wt. % silicon content. However, piping purchased and installed prior to the mid-1980s could still contain low silicon components that are susceptible to high, variable sulfidation corrosion rates.

13. Over 95 percent of the 144 refineries in operation in the U.S., including the Chevron Richmond Refinery,[i] were built before 1985,[18] and thus before piping manufacturers began producing carbon steel in compliance with all three manufacturing specifications. Therefore, the original carbon steel piping in these refineries is likely to contain varying percentages of silicon content and may experience highly variable sulfidation corrosion rates.

14. The Chevron Richmond Refinery 4-sidecut piping circuit containing the 52-inch component that failed was constructed of ASTM A53B carbon steel, which had no minimum specification for silicon content. Post-incident testing of samples of the 4-sidecut piping from the Chevron Richmond Refinery identified silicon content ranging from 0.01 wt. % to 0.2 wt. %. Of twelve samples taken from the 8-inch and 12-inch 4-sidecut line, six had a silicon concentration of less than 0.10 wt. %. The 52-inch pipe component that ruptured on the day of the incident had a silicon content of only 0.01 wt. %. The elbow component directly upstream of the 52-inch component that failed had a silicon concentration of 0.16 wt. % and showed considerably less thinning (Figure 9).

[i] The Chevron Richmond Refinery was constructed in 1902.

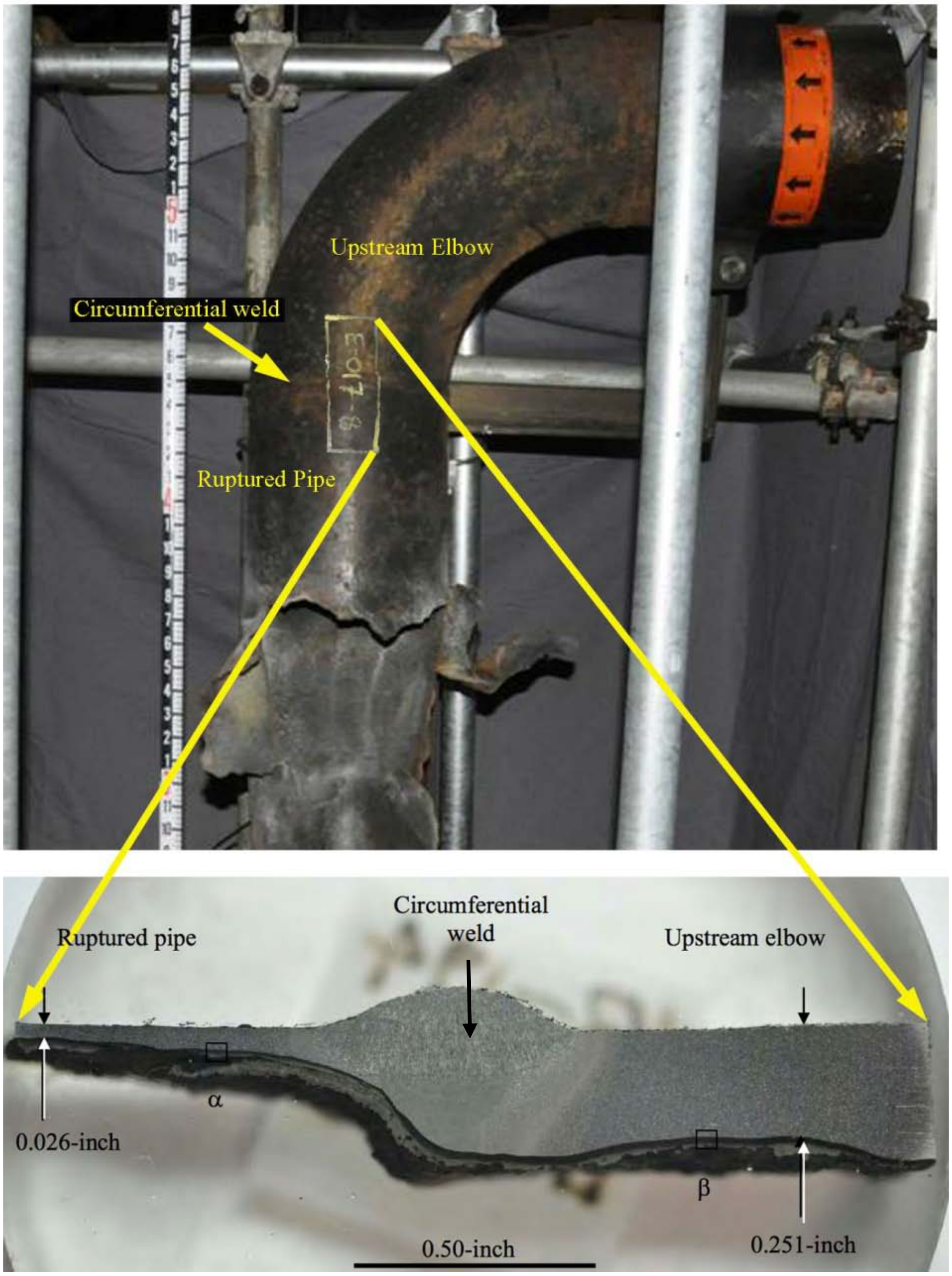


Figure 9. 4-sidecut piping sample (E-017-8) analyzed by Anamet Labs showing the relative thickness of low silicon piping on the left and the high silicon piping on the right. The ruptured pipe component (left) contained 0.01 % silicon and the upstream elbow component (right) contained 0.16 % silicon.[19] The initial nominal thickness of this piping was 0.322-inch.

Sulfidation Corrosion Inspection Techniques

15. As evidenced by the chemical analysis performed on the Chevron 4-sidecut piping post-incident, carbon steel piping components within a single circuit[i] can contain varying percentages of silicon, resulting in a large variation in sulfidation corrosion rates by component. Historically, sulfidation corrosion monitoring techniques required the measurement of pipe thickness at only a minimal number of permanent Condition Monitoring Locations (CMLs)[ii] along the piping. These CMLs are most frequently placed on elbows and fittings.[iii] However, due to details of the manufacturing process, carbon steel pipe fittings generally contain high percentages of silicon.[20] When measurements are only taken at high-silicon containing fittings, the measurements can fail to identify high corrosion rates within a pipe circuit caused by low-silicon components. At the Chevron Richmond Refinery, the 4-sidecut piping had a total of 24 CMLs[iv] on piping and fittings. The CSB found that there were no CMLs placed on the low silicon piping component that failed. Chevron identified accelerated corrosion in the 52-inch component in a 2002 inspection. However, no CML was added to ensure future monitoring, and the 52-inch component was not inspected again. Instead, the CSB found that Chevron relied on inspection data gained primarily from high silicon pipe-fitting components, such as elbow components. This inspection data did not reflect the corrosion rates of the lower-silicon components of the 4-sidecut piping. Relying on the limited inspection data from the CMLs on the high silicon components, Chevron management denied multiple recommendations to replace the 4-sidecut line. As illustrated by the Chevron incident, inspection techniques alone may not accurately identify the most aggressive corrosion rates throughout an entire circuit of carbon steel piping. Low-silicon components can remain uninspected and unidentified until failures such as the August 6, 2012, Chevron incident occur. As will be discussed below, upgrading metallurgy is a more effective means of managing sulfidation corrosion.

16. Determining silicon content in existing carbon steel piping and equipment in the field is a difficult undertaking. To properly characterize the silicon content in each component in a piping circuit, every component must be inspected. This is known as 100 percent component inspection. Two techniques are currently used to determine silicon content in existing carbon steel piping circuits with unknown chemical composition: performing chemical analysis and pipe wall thickness measurements of every component.

---

[i] A piping circuit is a length of pipe and the fittings associated with a particular process service that operate at similar conditions. A circuit usually begins and ends at either a branch or a piece of process equipment such as a vessel or a pump. Reference to piping by circuits allows piping to be grouped conveniently by proximity and operating service. Piping circuits may also be referred to as piping runs.

[ii] A condition monitoring location (CML) is a designated area where periodic thickness examinations are conducted. Each CML represents as many as four inspection locations located circumferentially around the pipe. CMLs are also referred to as thickness monitoring locations (TMLs). CML was historically referred to as corrosion monitoring locations (CMLs) and that terminology is sometimes still used within the industry.

[iii] A fitting is a piping component usually associated with a change in direction or diameter.

[iv] Many of these CMLs were added during the 2011 turnaround.

17. Many field-portable instruments used for positive material identification cannot adequately identify silicon content.[21] If original manufacturing quality assurance data[i] are not available, as is generally the case with older plants, then chemical verification requires destructive testing. Metal shavings must be taken from each carbon steel piping component for chemical analysis in a laboratory.[22] This method requires that the insulation be removed for access to the piping so that each individual piping component can be sampled and verified.

18. Carbon steel components containing low concentrations of silicon can also potentially be identified by performing thickness measurements of every component within a carbon steel circuit.[23] This practice is only useful if the piping circuit has been exposed to sulfidation corrosion for a long enough time period so that variances in corrosion rate caused by differences in silicon content may be detected. Chemical analysis is therefore the most accurate technique to identify low-silicon carbon steel components. As with chemical analysis, the thickness measurement method requires that each individual piping component be identified by removing insulation (so every weld seam can be located), a time consuming and costly undertaking, or by using non-destructive examination techniques. Thickness measurements on high temperature piping typically can only be done accurately and safely during unit turnarounds.[ii] Although these various methods were available to detect the location of the field welds, Chevron had not used them to identify the 4-sidecut pipe segment locations.

19. API Recommended Practice 939-C *Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries* describes the challenges faced when attempting to thoroughly inspect carbon steel lines susceptible to sulfidation corrosion. The recommended practice states that older ASTM A53 piping, such as the Chevron piping that failed on August 6th, creates a “major inspection challenge”[24] and that “unless the refinery is fortunate enough to have located an inspection point on that particular [low silicon] section of pipe or fitting, it is very difficult to detect the thinning component.”[25] It states that in some applications, carbon steel will appear to be adequate based on measured corrosion rates until failure occurs at some undocumented or unidentified low-silicon component.[26]

20. Unlike silicon concentration, the chromium concentration of steel can easily be verified in the field using portable positive material identification instruments. In addition, steel alloys containing at least 9 wt. % chromium are more resistant to sulfidation corrosion and do not run the risk of extreme variations in corrosion rates within components in the same piping circuit.[iii] This makes alloys with higher chromium content an inherently safer choice in high temperature

---

[i] Manufacturing quality assurance data, also known as mill data, provides the chemical composition of the steel.

[ii] A “turnaround” is a scheduled shutdown of a process unit to perform maintenance, repairs, upgrades, and inspection of process equipment.

[iii] The protective scale, $FeCr_2S_4$, begins to be the dominant scale formed in steels containing a chromium content of five wt. %. The 5Cr steel alloy can be manufactured to contain anywhere from 4% to 6% chromium. Thus, “the sulfidation corrosion rate can vary dramatically in 5Cr steels even in the same operating environment.” *See* Niccolls, E. H., J. M. Stankiewicz, J. E. McLaughlin, and K. Yamamoto. "High Temperature Sulfidation Corrosion in Refining." *17th International Corrosion Congress.* Las Vegas: NACE International, 2008.

sulfidation corrosion environments.[i] As shown in the Modified McConomy Curves[ii] from API RP 939-C (Figure 10), 9-Chrome[iii] corrodes 15 times faster than stainless steel,[iv] and carbon steel[v] corrodes 125 times faster than stainless steel.[27]

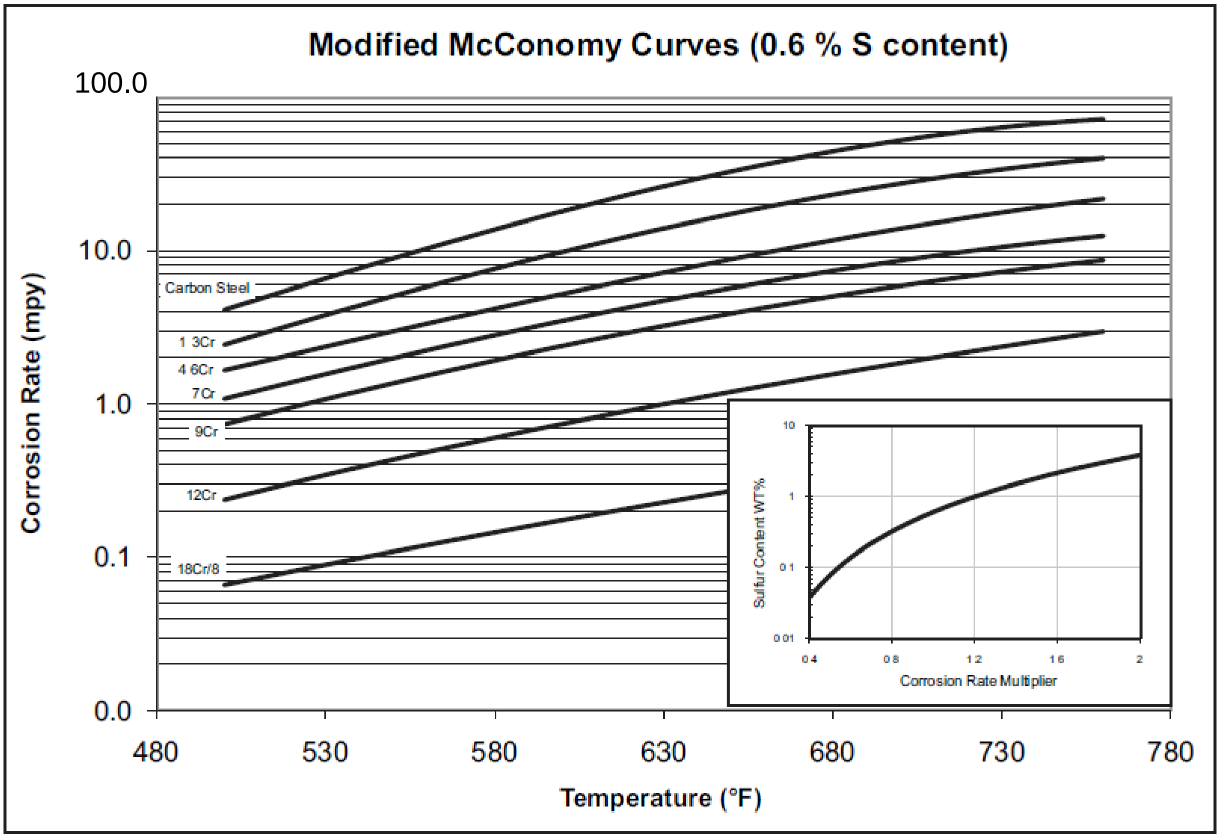


Figure 10. Modified McConomy Curves from API RP 939-C.

[i] Steels with higher chromium content are inherently safer than carbon steel with respect to sulfidation corrosion. However, analysis is still required to ensure that the best material of construction is selected.
[ii] Modified McConomy Curves are the set of curves API RP 939-C uses to predict sulfidation corrosion rates versus temperature for several steel alloys.
[iii] 9-Chrome contains 9 wt. % chromium.
[iv] Stainless steel contains 18 wt. % chromium.
[v] ASTM A53B carbon steel contains a maximum of 0.40 wt. % chromium.

Chevron Sulfidation Corrosion Knowledge and Expertise

21. Figure 11 shows a timeline of Chevron's key sulfidation events. Chevron technical staff has considerable knowledge and expertise regarding sulfidation corrosion, specifically with respect to corrosion rate variations caused by differing silicon concentration in carbon steel piping. Chevron employees have authored industry papers on sulfidation corrosion and had significant influence in the development of the industry sulfidation corrosion recommended practice, API RP 939-C. This recommended practice, first published in 2009, was developed under Chevron leadership. At the approximate time of publication of API RP 939-C, Chevron Energy Technology Company (Chevron ETC)[i] created an internal document on the subject of sulfidation corrosion. Chevron ETC metallurgists released a formal report dated September 30, 2009 (nearly 3 years prior to the incident) to Chevron refinery-based reliability managers and chief inspectors entitled *Updated Inspection Strategies for Preventing Sulfidation Corrosion Failures in Chevron Refineries*.

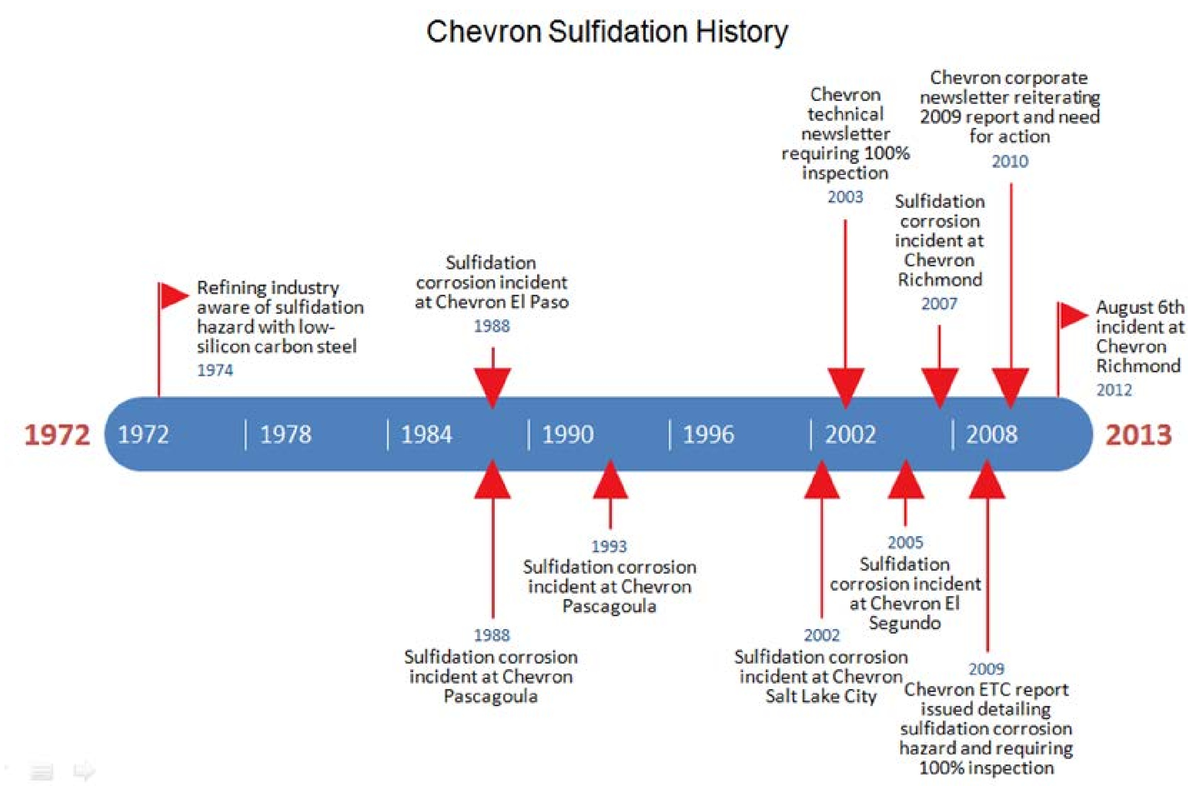


Figure 11. Chevron's key sulfidation events between 1974 and 2013.

[i] The Chevron Energy Technology Company is a separate business unit within the Chevron Corporation that provides technology solutions and technical expertise for Chevron operations worldwide. *See* http://richmond.chevron.com/home/aboutchevronrichmond.aspx (accessed April 4, 2013)

22. Sulfidation experts acknowledged in the Chevron ETC report that, “Until now, Chevron has not directly addressed the risk of low Si[licon] carbon steel…”[i] and that the report lays out a program that “seeks to close these gaps, and to maximize the effectiveness of our inspection.” The report clearly indicates that Chevron understood both the potential consequence and the high likelihood of a rupture or catastrophic failure from sulfidation corrosion and calls out Chevron’s need for action:

> Sulfidation corrosion failures are not common in Chevron or in the industry but they are of great concern because of the comparatively high likelihood of blowout or catastrophic failure […] . This can happen because corrosion occurs at a relatively uniform rate over a broad area so a pipe can get progressively thinner until it actually bursts rather than leaking at a pit or local thin area. In addition the process fluid is often above its autoignition temperature. The combination of these factors means that sulfidation corrosion failures frequently result in large fires. […] [S]everal case histories of sulfidation corrosion failures that have occurred in Chevron or in the industry several of which are blowouts.

This Chevron ETC report specifically recommends that inspectors perform 100 percent component inspection on high temperature carbon steel piping susceptible to sulfidation corrosion. However, this 100 percent component inspection program was not implemented at the Richmond refinery prior to the August 6, 2012 incident. The Chevron ETC report defines a priority ranking system to help focus the inspection implementation efforts. The process conditions of the 4-sidecut stream placed it in the highest priority for inspection.

23. Chevron ETC technical experts issued a corporate newsletter in 2010 that again warned of the potential consequence of sulfidation failures. In this newsletter, the 100 percent component inspection recommendation from the 2009 report was reiterated for piping systems such as the crude unit 4-sidecut piping. The newsletter states:

> Sulfidation corrosion failures … are of great concern because of the comparatively high likelihood of “blowout” or catastrophic failure. This typically happens because corrosion occurs at a relatively uniform rate over a broad area, so a pipe can get progressively thinner until it actually bursts rather than leaking at a pit or local thin area. In addition, the process fluid is often above its autoignition temperature. The combination of these factors means that sulfidation corrosion failures frequently result in large fires. Chevron and the industry have experienced numerous failures from this mechanism and recent incidents have reinforced the need for revised inspection strategies and a robust PMI (Positive Materials Identification) program.

[i] A 2003 corporate technical newsletter recommended 100 percent component inspection of carbon steel piping susceptible to sulfidation corrosion following a 2002 Chevron Salt Lake City sulfidation corrosion incident.

The Chevron ETC 100 percent component inspection recommendation for high risk piping systems, established in 2009, was not implemented at Richmond; therefore, the thin-walled low silicon 4-sidecut piping component remained in service until it catastrophically failed on August 6, 2012.

24. Chevron and Chevron ETC metallurgists, materials engineers, and piping inspectors had expertise regarding sulfidation corrosion. They educated personnel and advocated for identification and control of damage mechanisms, including sulfidation corrosion. However, they had limited practical influence to implement their recommendations. These individuals did not participate in the crude unit Process Hazard Analysis (PHA)[i] and did not affect decisions concerning control of sulfidation corrosion during the crude unit turnaround process.[ii]

[i] A process hazard analysis is a hazard evaluation to identify, evaluate, and control the hazards involved in a process. Facilities that process a threshold quantity of hazardous materials, such as the Chevron Richmond refinery, are required to conduct a process hazard analysis per the California Code of Regulations Title 8 Section 5189. Process Safety Management of Acutely Hazardous Materials (1992). PHAs are also required by the California Accidental Release Prevention Program and the federal EPA Risk Management Program.

[ii] The turnaround process includes both the planning stage prior to the shutdown and the activities staged during the shutdown.

Other Significant Sulfidation Occurrences

25. The refining industry has experienced numerous sulfidation corrosion failures, primarily in piping.[28] API RP 939-C identifies 45 sulfidation corrosion failures, one third of which were found to have occurred in carbon steel piping containing low levels of silicon.[29]

26. The August 6, 2012, Chevron Richmond Refinery 4-sidecut pipe rupture was not the first sulfidation corrosion-related incident to occur at a Chevron refinery. In 1988, a low silicon carbon steel (0.02 wt. % silicon) piping component failed at the Chevron's former El Paso Refinery[i] in El Paso, Texas. In addition, two sulfidation corrosion incidents occurred at the Chevron Pascagoula refinery in Pascagoula, Mississippi: one in 1993 and one in 1988 on a low-silicon carbon steel component.

27. In 2002, the Chevron Salt Lake City Refinery experienced a fire when process piping failed as a result of sulfidation corrosion in a low silicon ASTM A53 carbon steel piping component. Chevron communicated the incident throughout the company in a technical newsletter. Chevron experts found that despite regular monitoring of the line for 30 years in compliance with industry standards, their inspection program failed to prevent the failure. Corrosion rates at the unmonitored failure location were found to be five times greater than corrosion rates at the monitored piping locations. The monitored locations were constructed of high silicon ASTM A106 piping (Figure 12). Chevron also found that in the years preceding the failure, both the temperature[ii] and hydrogen sulfide concentration in the process had been increasing. Each of these factors increased corrosion rates and contributed to the failure. In 2003, following this incident, Chevron experts recommended that refineries inspect every piping component (100 % component inspection) in all high-risk piping systems: those operating above 550 °F and containing hydrogen sulfide.

[i] The El Paso Refinery is now owned by Western Refining.

[ii] The temperature in the line had been increased by over 170 °F throughout the life of the unit. During the two years prior to failure, temperatures of the line exceeded the measurement capabilities of the temperature measurement device and so the actual temperature increase cannot be determined.

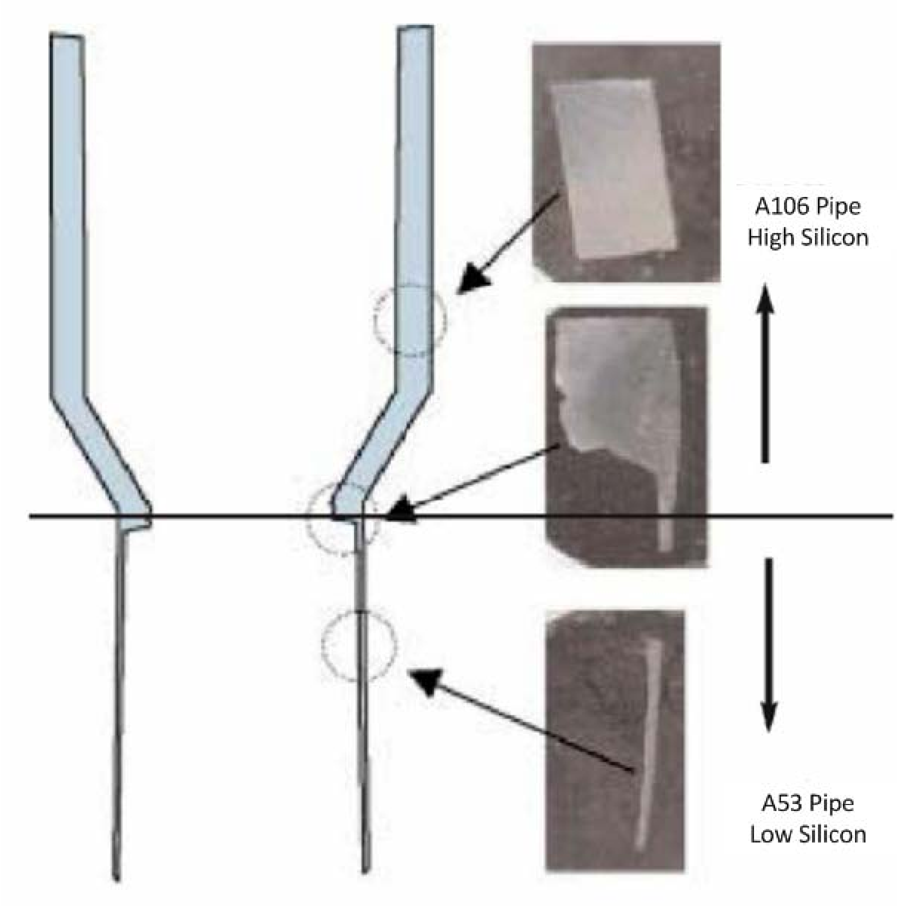


Figure 12. Schematic of failed piping from the Chevron Salt Lake Refinery. Similar to the Chevron Richmond Refinery incident, the failed piping contained low amounts of silicon and corroded significantly faster than adjacent piping components.

28. In January 2007, a failure due to sulfidation corrosion caused a serious fire in the Chevron Richmond Refinery crude unit resulting in a CWS Level 3 alert, initiating a shelter-in-place for the surrounding community. A carbon steel piping spool[i] failed catastrophically during operation (Figure 13). The carbon steel piping contained a low percentage of silicon (<0.005 wt. %). The process fluid ignited, injuring a nearby worker. Chevron informed Contra Costa Health Services' Hazardous Materials Program[ii] (Contra Costa County) in a letter that the metallurgy had been upgraded following this incident as an inherently safer solution. However, the CSB learned that this upgrade was limited to only the immediate piping spool that failed. The inherently safer, more corrosion resistant metallurgy was not implemented more broadly in crude unit high temperature service as a result of this incident.

[i] A piping spool is a small, removable section of piping. In some cases, a piping spool is installed or removed in order to provide a temporary connection or complete disconnection between two piping circuits.
[ii] Contra Costa Health Services' Hazardous Materials program is designed to respond to emergencies and monitor hazardous materials within Contra Costa County. *See* http://cchealth.org/hazmat/ (accessed April 17, 2013).

Figure 13. Failed piping component that resulted in the 2007 Richmond crude unit fire. This carbon steel piping was found to contain less than 0.005 percent silicon.

29. Following the August 6, 2012, incident, personnel at the Chevron El Segundo, California, refinery, a near duplicate of the Richmond refinery, inspected their refinery's crude unit 4-sidecut piping. Significant thinning was discovered in the line; the piping from the atmospheric crude column to the pumps was removed and substituted with 9-Chrome, an upgraded and inherently safer material of construction.

30. On November 9, 2009, the Silver Eagle refinery in Woods Cross, Utah, experienced a catastrophic piping failure due to sulfidation corrosion in a 10-inch pipe, while conducting a temporary operation at higher than normal operating temperature. The pipe was located on the

bottom of a reactor in the de-waxing unit. The failed pipe released hydrogen which subsequently exploded, damaging over 100 homes in the nearby neighborhood.

31. On October 6, 2011, an explosion and fire resulted from a catastrophic piping failure at a Canadian refinery in Regina, Saskatchewan, injuring 52 workers. The piping component that failed was substantially thinner than neighboring components. Prior to the incident, the company's inspection data indicated that wall thickness in the overall piping system was within acceptable limits. However, the specific component that failed was not inspected. Although Canadian authorities are still investigating, metallurgical testing has indicated that hydrogen sulfide corrosion contributed to the catastrophic failure.

32. In February 2012, the BP refinery crude unit in Cherry Point, Washington, suffered a failure due to sulfidation corrosion, causing a large fire. This incident demonstrates that even when applying inherently safer concepts to reduce the potential for major hazards, it is still vital to fully understand all processes and piping configurations and incorporate a rigorous inspection program. The piping that failed was constructed of 9-Chrome. The line was used only during start-up operations and otherwise remained in-service and non-flowing. Such lines that do not have regular process flow yet remain in contact with process fluids are commonly referred to as "dead legs." The failure location was a high-point in the piping connected to the top of an operating process line. Hydrogen sulfide evolved from the process fluid and collected in the 9-Chrome piping. The concentrated vapor-phase hydrogen sulfide severely corroded the 9-Chrome, causing the failure. CMLs were located on adjacent elbow components; however, no CMLs were placed on the straight-run piping component where the failure occurred. The Cherry Point sulfidation failure demonstrates that even with more corrosion-resistant, inherently safer metallurgy, failure from sulfidation corrosion still may occur if piping is not effectively inspected or piping configurations are not adequately evaluated. In addition it is important to conduct a thorough analysis to determine the best material of construction for the process conditions.

Process Hazard Analysis

33. Chevron personnel analyze numerous deviations[i] for each portion of a process when conducting a Process Hazard Analysis (PHA). These include conditions such as changes in flow and temperature and pressure extremes. Specifically of interest, one of the deviations analyzed was "leak/rupture" of the particular vessel or pipe. For each deviation, the team's responsibility was to identify causes, consequences, safeguards, and recommendations. The 4-sidecut line was analyzed in the most recent crude unit PHA. Corrosion was *not* identified as a potential cause of a leak/rupture in the piping (emphasis added).

34. Sometimes referred to as a corrosion review, a damage mechanism hazard review analyzes risks presented by all process failure mechanisms such as corrosion and cracking. Common process failure mechanisms are described in API 571: *Damage Mechanisms Affecting Fixed Equipment in the Refining and Petrochemical Industries*.[30] Such a review ensures that potential hazards caused by process conditions, process materials, and external mechanisms are properly identified, analyzed, and systems are put in place to control or eliminate the hazard. Despite Chevron knowledge and expertise of potential damage mechanisms (such as sulfidation corrosion), the CSB found these hazards are only identified in a PHA if the participants conducting the PHA happen to have personal knowledge of the relevant mechanism. The Chevron PHA teams do not typically seek assistance from corrosion experts.[ii] The inclusion of a damage mechanism hazard review as part of the PHA is not required by the state of California, the California Division of Occupational Safety and Health (Cal/OSHA),[iii] Contra Costa County, the City of Richmond,[iv] or Chevron standards. Because Chevron does not conduct, and is not required to conduct, a formal damage mechanism hazard review, damage mechanisms are only identified when the PHA team happens to have some knowledge of the mechanism. As a result, many damage mechanisms which occur in various processes are not properly addressed.

---

[i] Deviations using guide words (such as no, more, less, as well as) and process parameters (such as flow, pressure, temperature) are analyzed in PHAs. *See* Center for Chemical Process Safety (CCPS). "Guidelines for Hazard Evaluation Procedures." 2nd ed., Page 132, 1992.

[ii] The Crude Unit Business Improvement Network (BIN) Leader, a crude unit expert, reviews portions of the PHA with the PHA team. However, this review did not identify the potential for sulfidation corrosion failures in the 4-sidecut piping. A rigorous review of corrosion and damage mechanisms present in the crude unit was not performed during the PHA process.

[iii] The state of California, under an agreement with the federal Occupational Safety and Health Administration, or OSHA, operates an occupational safety and health program in accordance with Section 18 of the Occupational Safety and Health Act of 1970. *See* http://www.osha.gov/dcsp/osp/stateprogs/california.html (accessed April 17, 2013). The Department of Industrial Relations administers the California Occupational Safety and Health Program, commonly referred to as Cal/OSHA. The program applies to all public and private sector places of employment in the state, with some exceptions. *See* http://www.dir.ca.gov/dosh/dosh1.html (accessed April 17, 2013).

[iv] The City of Richmond adopted an ordinance on Industrial Safety, Richmond Municipal Code Chapter 6.43 (also known as the RISO), on December 18, 2001, "for the purposes of protecting public health and safety by prevention of accidental release of hazardous materials and to assure protection of the environment." Richmond Municipal Code §6.43.040 (February 5, 2013). There are two facilities, including Chevron, that are located in the City of Richmond and subject to this ordinance. More information about the RISO is provided later in the report.

35. During a hazard analysis process such as a PHA, the evaluation team has to determine the likelihood of a hazardous consequence occurring. Then the team must identify safeguards which will reduce the risk of the hazard to an acceptable level. A recognized methodology for consistently and objectively making these determinations could include the use of quantitative, semi-quantitative, or qualitative tools.[31] Chevron does not employ a prescribed methodology for determining the likelihood that an incident will occur or whether a safeguard will be effective. Instead, Chevron relies upon the judgment of the people on the PHA team, who base their conclusions upon their collective experiences, beliefs, and areas of expertise. In its 2009 crude unit PHA, Chevron simply cited non-specific, judgment-based qualitative safeguards such as: utilizing metallurgy to minimize corrosion, having effective maintenance and inspection programs, and providing pipe wall corrosion allowances.[i] The effectiveness of these safeguards was neither evaluated nor documented; instead the safeguards were merely listed in the PHA. Had the adequacy of these safeguards been verified, improved safeguards intended to protect against sulfidation-induced failure of carbon steel piping could have been recommended.

36. Following the August 6th incident, Cal/OSHA inspected the Chevron facility and issued citations. Only one citation related to PHAs, and it was not associated with evaluating the effectiveness of safeguards. Rather, the emphasis was that Chevron's PHA did not adequately account for hazards caused by other units associated with the crude unit. The citation stated "The Employer [Chevron] failed to perform an effective Process Hazard Analysis [PHA] of the crude unit. Specifically, it failed to identify, evaluate, and control potential hazards caused by upstream and downstream units that provide and receive feed from the crude unit."[32] Had the Cal/OSHA regulation required documentation of the effectiveness of safeguards, Chevron would have been obligated to conduct this analysis and Cal/OSHA inspectors could rely on the regulation for support during inspections.

[i] Corrosion allowance refers to extra wall thickness added as a safety factor to the design of a piece of equipment beyond that needed solely for mechanical considerations such as design temperature and pressure. This extra thickness is provided to accommodate for expected loss of wall thickness due to corrosion over the life of the equipment.

Operational Changes

37. The original design of the 4-sidecut circuit included equipment which had the effect of removing dissolved hydrogen sulfide, the most aggressive sulfur compound associated with sulfidation corrosion, from the 4-sidecut light gas oil process fluid. As a result, the 4-sidecut equipment was effective in reducing the sulfidation corrosion rate. This allowed the 4-sidecut equipment to be constructed of carbon steel. In 1991, this 4-sidecut equipment was taken out of service. No management of change[i] (MOC) was performed to analyze the effect of the elimination of this hydrogen sulfide-removing equipment on 4-sidecut corrosion rates. Such an MOC would have ensured that the increase in sulfur concentration on the carbon steel 4-sidecut piping was reviewed prior to removing the equipment.

38. Crude oil feedstock used at the Chevron Richmond Refinery is obtained from a variety of different sources that are blended before processing. These various crudes have different compositions, such as varying sulfur compounds and concentrations. These crudes can have differing corrosion effects on process equipment and piping. There is an increasing trend in crude oil refining to process less expensive "opportunity crudes" because they can provide significant cost savings to the company.[ii] However, these crudes may contain more undesirable characteristics such as high sulfur content, high naphthenic acid content, or very heavy hydrocarbons[33] that a refinery may not have been originally designed to process. Refinery equipment may not be the proper material of construction to achieve the design life of the equipment when exposed to the different operating conditions. Additional mitigation may be needed to reduce risk. In 1984, the Chevron Richmond Refinery crude oil feed contained approximately 85 volume % Alaskan North Slope (1 wt. %) crude oil. As the refinery began running more high-sulfur content crudes, the sulfur content in the 4-sidecut line steadily increased (Figure 14), as discussed below.

[i] Management of change requires that employers have procedures to manage changes to process chemicals, technology, equipment, and procedures. The procedures must address the technical basis for the change, the impact on safety and health, and training required for employees affected by the change.

[ii] Crude oil costs can account for up to 90% of the operating costs in a refinery. *See* Qu, Dingrong, Xiaohui Liu, Xiu Jiang, Zhenggui Lan, and Guangbin Shan. "Setting Critical Operational TAN and Sulfur Level for Crude Distillation Units." *Corrosion 2011 Conference & Expo.* Paper No. 11362. NACE International, 2011.

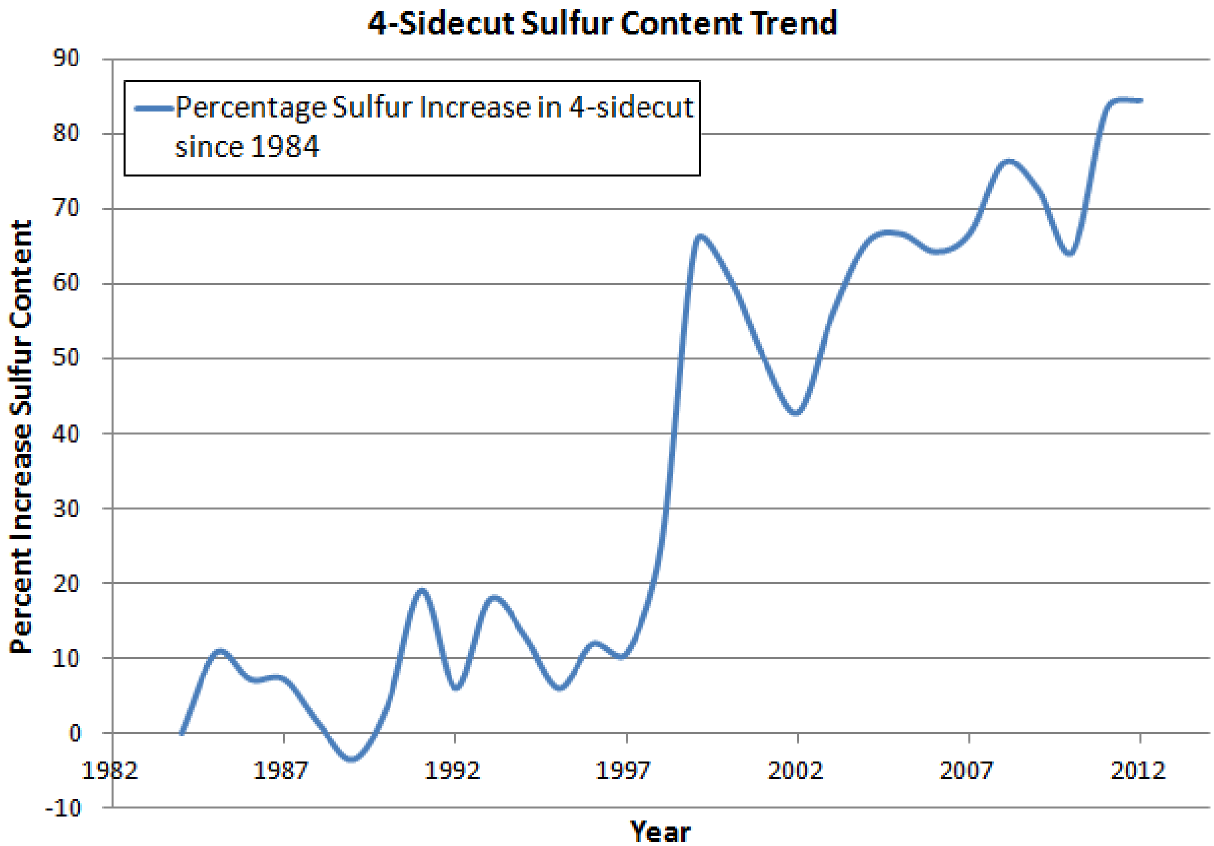


Figure 14. Graph shows the percentage increase from 1984 values of the sulfur content in the 4-sidecut.

39. When Chevron introduces a new crude, an MOC is generated to evaluate the potential impact on the refinery.[i] While Chevron stayed under its established crude unit design basis for total wt. % sulfur of the blended feed to the crude unit, the sulfur composition significantly increased over time. Historic data indicates that the sulfur in the 4-sidecut stream has increased from 0.8 to 1.6 wt%. This increase in sulfur composition likely increased corrosion rates in the 4-sidecut line. Chevron did not conduct an MOC analyzing the impact that increases in sulfur composition would have on corrosion in the crude unit. Chevron also did not change its corrosion monitoring programs in response to the increased sulfur content.

40. The CSB found that increased Chevron Richmond usage of non-domestic crude feed stock over time resulted in higher sulfur content in the process fluid passing through the 4-sidecut piping. Specifically, the percentage of sulfur in the Richmond refinery crudes increased nearly 85% between 1984 and 2012, including a significant jump of 32% from 1998 to 1999. This increase in sulfur content corresponded with a simultaneous increase in the usage of non-domestic crude feed at the Richmond refinery.

[i] Chevron MOCs on new crudes considered general operational issues but did not analyze corrosion effects from sulfidation corrosion.

41. Sulfidation corrosion rates increase in piping circuits as temperature and sulfur content increase. Accordingly, the 4-sidecut sulfidation corrosion rate increased between 1984 and 2012 due to the increase in sulfur content in the line. The CSB found that for the 26-year period from the installation of the piping in 1976 through 2002, the 52-inch 4-sidecut component had lost approximately 33 percent of its wall thickness. From the single inspection of the 52-inch component in 2002 to the incident in 2012 – just ten years – an additional 57 percent of the original component nominal wall thickness was lost near the rupture location due to sulfidation corrosion.[i] In addition to the sulfur content increase, the 4-sidecut draw temperature increased from 625 °F in 1992 to 680 °F in 2002. Corrosion rates and remaining life calculations based on past sulfur content and temperatures may not accurately reflect current corrosion rates if process conditions have changed. Inspection based on historical corrosion rates may be too infrequent to detect an increase in corrosion caused by adverse changes in process conditions, potentially leading to equipment failure.

42. API RP 939-C states that refinery feed stock changes reduce the relevance of past inspection data when predicting future corrosion rates:

> Oil refineries that processed a consistent diet of a particular crude oil or crude blend could often base future predictions on past experience. However, over the past 20+ years, global economics have resulted in many refineries processing tens of different crudes in any given year; thus, minimizing the accuracy, or even feasibility, of predictions based on historical data. Additionally, the verification of the actual corrosion rate experienced while processing a specific crude oil is very difficult.[34]

43. API 570 *Piping Inspection Code: In-service Inspection, Rating, Repair, and Alteration of Piping Systems*, the API standard for inspecting piping, recommends companies to incorporate process changes into inspection programs. The standard states:

> The owner/user is … responsible for implementing an effective MOC process that will review and control changes to the process and to the hardware. An effective MOC process is vital to the success of any piping integrity management program in order that the inspection group will be able to anticipate changes in corrosion or other deterioration variables and alter the inspection plan to account for those changes. The MOC process shall include the appropriate materials/corrosion experience and expertise in order to effectively forecast what changes might affect piping integrity. The inspection group shall be involved in the approval process for changes that may affect piping integrity.

[i] The 4-sidecut 52-inch component had an original wall thickness of 0.322 inches. Metallurgical analysis found the thinnest portion of the 52-inch 4-sidecut component was 0.03 inches.

> *Changes to the hardware and the process shall be included in the MOC process to ensure its effectiveness* [emphasis added].[35]

Chevron failed to comply with the requirements of API 570 when it did not conduct an MOC to thoroughly evaluate the change of increasing sulfur weight percentage in crude oil feed and to assess how it might affect corrosion rates within the 4-sidecut piping circuit. After the August 6, 2012, incident, Cal/OSHA inspected the Chevron Richmond Refinery and issued citations.[i] However, Cal/OSHA did not issue any citations for failing to perform an MOC when sulfur composition in the crude oil feed was increased.

Chevron Sulfidation Corrosion Inspection and Mitigation

44. In the ten years prior to the incident, a small number of Chevron personnel with knowledge and understanding of sulfidation corrosion made at least six recommendations (listed in the following six paragraphs and included in Figure 15) to increase inspections or upgrade the metallurgy in the 4-sidecut piping. The recommendations made by these personnel were not implemented by Chevron management.

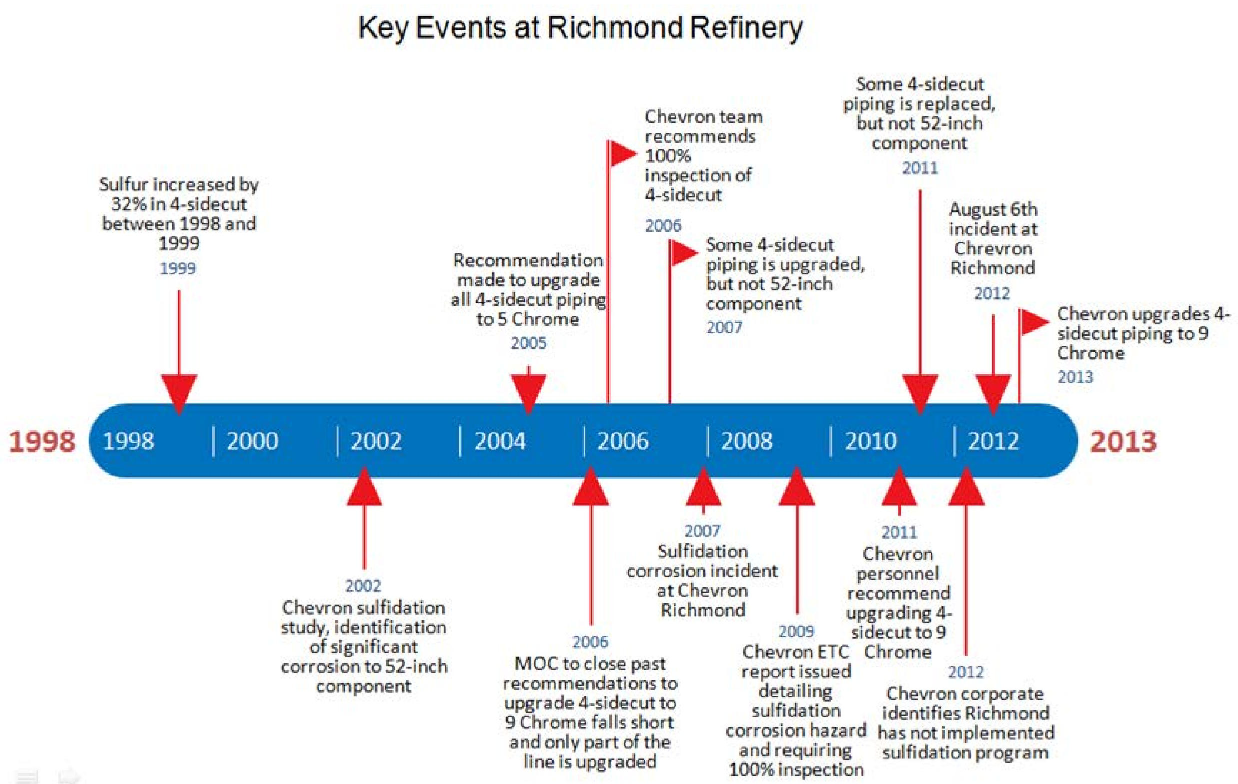


Figure 15. Key events at the Richmond refinery between 1998 and 2013.

[i] Cal/OSHA citations issued January 30, 2013.

45. In August 2002, a Chevron Richmond Refinery employee performed a study analyzing sulfidation corrosion rates in the crude unit and identifying potentially vulnerable areas. The employee discovered that the 4-sidecut operating temperature had been increased and concluded that this increase would cause more hydrogen sulfide to evolve, leading to increased sulfidation corrosion rates. As a result of these findings, the employee recommended increased inspection of the 4-sidecut piping and noted that this piping might need to be upgraded from carbon steel to 5-Chrome, a steel alloy that is more resistant to sulfidation corrosion. In 2002, proactively following up on this study, the crude unit inspector conducted additional piping inspection and identified accelerated corrosion in the 52-inch 4-sidecut component. The inspector recommended upgrading this piping during the next shutdown in 2007. In the inspector's 2002 accomplishments, Chevron management acknowledged this effort to prevent a significant incident; it was characterized as "a save." However, during the 2007 turnaround the recommendation was not implemented, and because a CML was not added to the inspection program, the 52-inch component was not inspected after 2002.

46. In February 2006, a team consisting of a materials and corrosion engineer, an inspector, a process engineer, a metallurgist, and a design engineer issued a Corrosion Mitigation Plan for the Chevron Richmond Refinery crude unit. The report specifically identified the 4-sidecut piping to be at risk for high temperature sulfidation corrosion. The report described that low silicon carbon steel can corrode faster than carbon steel manufactured with higher silicon content, and recommended that 100 percent inspection be performed on the 4-sidecut line using continuous monitoring technology. During the 2007 crude unit turnaround, continuous monitoring probes were only installed on a segment of the 4-sidecut line that did not include the 52-inch component that ultimately failed. The 100 percent inspection recommended in the 2006 Corrosion Mitigation Plan was not performed.

47. During the 2007 turnaround, the crude unit inspector recommended that the refinery upgrade the entire 4-sidecut piping with 5-Chrome. The recommendation was based on findings obtained during the 2002 crude unit turnaround, where the crude unit inspector found that the 52-inch 4-sidecut component had lost one-third of its wall thickness due to corrosion. However, after evaluation, this recommendation was not accepted by the turnaround planning team. Basing its decision on limited inspection data, Chevron determined that the 8-inch portion of the 4-sidecut piping that ran from the atmospheric column to the pump, the portion which included the 52-inch component, had sufficient wall thickness to last to the next turnaround scheduled for Fall 2011.[i] The piping downstream of the pump, which operates at a higher pressure, was determined not to have sufficient wall thickness to last to the next turnaround. This piping was removed and replaced with 9-Chrome, an upgraded and inherently safer metallurgy. The 52-inch component of the 8-inch piping between the atmospheric column and the pump was not replaced during the 2007 turnaround even though it had been identified as thinned in 2002.

[i] This decision was made without reinspecting or evaluating the thickness of the thinned 52-inch component identified in 2002 that prompted the recommendation.

Furthermore, a permanent CML was not placed on the 52-inch component, and it was not entered into the inspection database. As a result, the component was not inspected again.

48. In September 2009, Chevron ETC corrosion experts released a formal technical report discussing sulfidation corrosion and the specific issues associated with carbon steel, including the potential for high corrosion rates in carbon steel piping containing low percentages of silicon. In its report, Chevron ETC issued recommendations for inspection and provided guidelines for prioritizing piping circuits susceptible to sulfidation corrosion so that high-risk lines could be evaluated first. It was recommended that 100 percent component thickness testing be completed on all high priority lines one time to identify thin, low-silicon components to establish a baseline of corrosion rate and risk for failure. Following the release of the report, the Chevron Richmond Refinery materials group completed the risk-ranking of the carbon steel piping in the Richmond Lube Oil Project (RLOP) and in the crude unit, two units known to be susceptible to sulfidation corrosion. The group identified the crude unit 4-sidecut line as a high risk line per the report ranking guidance. Instead of completing the 100 percent component inspection, the 4-sidecut was recommended for replacement with 9-Chrome. However, the replacement recommendation was denied because the available, limited inspection data indicated the piping would last until the next turnaround. Subsequently, the alternative 100 percent component inspection was also never performed.

49. Five months prior to the incident in March 2012, a Chevron corporate review of Richmond identified that inspection of all carbon steel components susceptible to sulfidation corrosion was not being performed at the Richmond refinery. In addition to identifying that CMLs were not in the proper locations, this corporate review found that critical inspection recommendations were being submitted to the shutdown planning process, but were being denied. Chevron corporate identified that Richmond refinery leadership needed to review and implement the 2009 Chevron ETC report recommendations.

50. Chevron conducts “Intensive Process Reviews” prior to turnarounds. This process involves knowledgeable individuals including Business Improvement Network leaders, process engineers, metallurgical engineers, design engineers, and turnaround planners. The purpose of the review is to identify key unit issues that should be addressed and repaired during the unit turnaround. Prior to the 2011 crude unit turnaround, Chevron personnel conducted an Intensive Process Review of the crude unit and specifically recommended that the 4-sidecut carbon steel piping “should be upgraded to 5 Cr [5-Chrome]… due to sulfidation.” Although the Intensive Process Review identified sulfidation problems in the 4-sidecut line, this activity was ineffective. The 4-sidecut piping was not upgraded during the 2011 crude unit turnaround.

51. In preparation of the work list for the 2011 crude unit turnaround, the crude unit inspector and crude unit metallurgist recommended that the 4-sidecut line be replaced with an upgraded metallurgy, 9-chrome, the metallurgy recommended in the Chevron new construction guidelines for piping in high temperature and high sulfur service. The recommendation was based on the

high priority ranking of the 4-sidecut line, corrosion history, and both Chevron and industry recommended best practice. However, the turnaround management team determined that the inspection data available for the 4-sidecut piping, from CMLs on elbow components which are less prone to sulfidation corrosion, did not support a material upgrade during the 2011 turnaround.[i, ii] The lack of data on the more susceptible 4-sidecut straight-run piping components was not considered.

[i] This decision was made without reinspecting or evaluating the thickness of the 52-inch component identified in 2002.

[ii] A portion of the 4-sidecut 12-inch line was replaced during the 2011 turnaround with carbon steel due to thinning caused by sulfidation corrosion.

Inherently Safer Systems

52. The Center for Chemical Process Safety (CCPS) is a corporate membership organization that identifies and addresses process safety needs within the chemical, pharmaceutical, and petroleum industries.[36] Chevron is a corporate member of CCPS.[37] The CCPS book *Inherently* Safer *Chemical Processes, 2nd ed.* defines inherently safer design as the process of identifying and implementing inherent safety in a specific context that is permanent and inseparable.[38] In the book *Guidelines for Engineering Design for Process Safety, 2nd ed.*, CCPS states "inherently safer design solutions eliminate or mitigate the hazard by using materials and process conditions that are less hazardous."[39]

53. Inherently safer technologies are relative; a technology can only be described as inherently safer when compared to a different technology with regard to a specific hazard or risk.[40] A technology may be inherently safer with respect to one risk but not safer from another risk. For this reason, it is important to carry out a comprehensive, documented hazard analysis to determine the individual and overall risks in a process and assess how the risks can be effectively minimized to control hazards. An inherently safer systems review details a list of choices offering various degrees of inherently safer implementation. The review should include risks of personal injury, environmental harm, and lost production, as well as evaluating economic feasibility.[41]

54. It is simpler, less expensive, and more effective to introduce inherently safer features during the design process of a facility rather than after the process is already operating.[42] Process upgrades, rebuilds, and repairs are additional opportunities to implement inherent safety concepts. Conducting a comprehensive hazard review to determine risks and identify ways to eliminate or reduce risks is an important step in implementing an inherently safer process. Chevron training programs on inherently safer systems reflect this approach, stating "we have the greatest opportunity to eliminate or minimize hazards during the development phase of new projects or major revamps of existing facilities."

55. After a 2007 incident caused by a pipe failure in the Richmond refinery crude unit, Chevron implemented an "Inherently Safer Solution" by upgrading the piping to metallurgy that was less susceptible to sulfidation corrosion. However, the change was implemented intuitively without a supporting inherent safety review or failure mechanism hazard review to provide a detailed documented technical rationale for the metallurgy selection. Without such a review, the material selected cannot be analyzed to determine if it is the best inherently safer solution for the process in order to minimize risk.

56. Following the August 6, 2012, incident, the 4-sidecut piping circuit at the Richmond refinery was upgraded from carbon steel to 9-Chrome.[i] However, Chevron did not produce a documented inherently safer hazard review before commencing the rebuild of the crude unit. The crude unit at the Chevron El Segundo refinery is nearly identical in construction and design to the Richmond refinery crude unit. Chevron informed the CSB that piping *downstream* of the 4-sidecut pumps in the 4-sidecut piping circuit at the El Segundo refinery was upgraded in 2001[ii] from carbon steel to stainless steel. As stated previously, after the August 6, 2012, Richmond incident, the 4-sidecut piping *upstream* of the 4-sidecut pumps at the El Segundo refinery was upgraded from carbon steel to 9-Chrome. Had a comprehensive inherently safer systems review been conducted at the Richmond refinery following the August 6th incident, a different metallurgy, such as stainless steel which was installed at the Chevron El Segundo Refinery, may have been identified as inherently safer than 9-Chrome with respect to sulfidation corrosion.

57. An effectiveness ranking of techniques used to control hazards and the risk they represent can be described as a hierarchy of controls. The further up the hierarchy, the more effective the risk reduction achieved (Figure 16). All concepts in the hierarchy of controls should be included in the process of risk assessment and reduction. Upgrading metallurgy to a more corrosion resistant material may be a high ranking, inherently safer choice for certain corrosion mechanisms, such as sulfidation corrosion. Holding other variables constant, upgrading the material of construction may reduce the severity of corrosion and the likelihood of a failure.

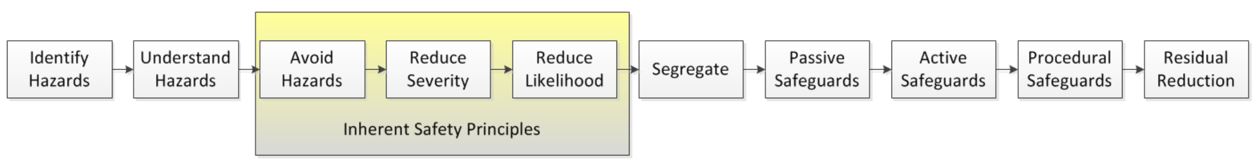


Figure 16. Hierarchy of controls. The boxes reflect inherently safer controls from left to right, based on *Process Plants: A Handbook for Inherently Safer Design Second Edition*; Kletz, Trevor Amyotte, Paul; CRC Press 2010.

58. Chevron employees have recommended implementing inherently safer designs through the MOC process, incident investigations, technical reports, and recommendations from employees in the past. However, the CSB has not identified any documented, thorough analysis of the proposed inherently safer solutions. In addition, Chevron has repeatedly failed to implement proposed inherently safer recommendations. For example, following the discovery of significant 4-sidecut piping sulfidation corrosion in 2002, a Chevron inspector issued the following recommendation to replace the piping in the 2007 turnaround:

[i] After the 2012 incident, the Richmond refinery stated that stainless steel was susceptible to chloride stress corrosion cracking and should not be used.
[ii] Chevron verbal estimate for date of piping installation. No MOC was conducted to review and document this change.

INFORMATION

> The #4 sidecut piping from C-1100 to P-1149/A to E-1113 was RT (x-ray) inspected for hot H2S [sulfidation] corrosion. The piping is actively corroding, particularly on the section on the discharge line from the pumps near the exchanger; the line upstream of the P-1149/A pumps is corroding as well. Corrosion rates indicate that the piping has 4 years of remaining life until the refinery throwaway thickness of 0.14” [inch] is reached. The carbon steel piping is currently running at temperatures between 650 °F on the pump suction line to 641 °F on the line just before E1113; the upper limit for carbon steel piping in this service is 550 °F. A materials upgrade to 5 chrome would raise the upper limit to between 650-750 °F. Additionally, the ABCR piping loop from the same sidecut draw line off of the column to P-1148/A to E-1111 is also carbon steel and operates at the same temperatures, rendering the ABCR piping system to E-1111 susceptible to hot H2S corrosion as well.

Recommendation

> Replace the existing #4 sidecut piping noted above from C-1100 through P-1149/A to E1113 and P-1148/A to E-1111 (approximately 700’[feet] of 12”, 10”, 8” and 6”piping, plus some 4”and 3” at the P-1149/P-1148 suction/discharge headers). Upgrade the pipe material from carbon steel to 5 chrome.

To implement this recommendation, Chevron initiated an MOC in 2006 to replace the piping during the 2007 Turnaround. However, the MOC supporting documents had a narrowed scope to only replace the section of piping from P-1149/A pumps to the E-1113 heat exchanger because Chevron reduced the work scope during the 2007 turnaround planning process. The Description of Change in the MOC stated:

> Existing line is carbon steel in a hot service that operates in the range where high temperature sulfadation [sic] occurs. The line has been ut[i] inspected and found to be nearing tmin[ii] requiring replacement. Due to the higher temperature 9CR [9-Chrome] would be the prefered [sic] material.

Contradicting this Description of Change detailing a replacement of the entire 4-sidecut piping circuit, the MOC Summary Review and attached documentation only authorized replacement of the piping from the P-1149’s to E-1113. The MOC states:

[i] UT is an abbreviation used to indicate ultrasonic thickness testing inspection technique.
[ii] Tmin is an abbreviation used to indicate minimum required piping wall thickness.

> 4 S/C piping has been operating hotter in recent years. The hotter temperatures 550 °F are in the high temperature sulfadation [sic] range. Additionally the section of 4 S/C piping from P-1149' s to E-1113 has been found to be nearing tmin.
>
> The section of pipng [sic] from P-1149's to E-1113 will be replaced with 9 Cr [9-Chrome] piping.

As a result, the portion of the piping containing the 52-inch component that failed on August 6th remained in service. Although the recommendation was intended to more broadly apply inherently safer materials of construction, the final implementation by the MOC limited the application of this more corrosion resistant metallurgy.[i] Again, the inherently safer, more corrosion resistant, metallurgy was not implemented more broadly in crude unit high temperature service. Other examples are discussed above in the section entitled *Chevron Sulfidation Corrosion Inspection and Mitigation*.

59. In 2007, the Chevron Richmond Refinery conducted training to teach employees about the importance of complying with the City of Richmond's Industrial Safety Ordinance (RISO)[ii] inherent safety guidance. The training states "we should always strive to implement inherently safer strategies to the greatest extent feasible." However, Chevron did not regularly or rigorously[iii] apply inherently safer design strategies in opportunities including PHAs, MOCs, incident investigation recommendations, and during turnarounds.[iv]

60. Chevron uses an inherently safer design checklist[v] for PHAs to meet inherently safer systems analysis requirements of the RISO. The checklist, provided by Contra Costa County, is intended to aid identification of opportunities to implement inherently safer design during the PHA process. The checklist was intended to stimulate discussion and analysis of potential opportunities to implement inherently safer design. Contra Costa County's guidance on the IST checklist states that some items may need to be reviewed by a team that is outside the PHA team in order to involve people with the required expertise. Chevron utilized the Contra Costa County inherently safer technologies checklist (IST Checklist) during the 2009 crude unit PHA.

---

[i] As discussed earlier, only the section of piping downstream of the pumps was replaced with 9-Chrome.

[ii] The RISO will be discussed in more detail in the *Regulatory Oversight* section below.

[iii] Chevron does not utilize inherent safety guidewords or checklists during the MOC or incident investigation process. Inherently safer guidewords help direct the inherently safer review process. Examples of guidewords include minimization, substitution, moderation, and simplification. These words may be applied to materials, product inventory, process controls, process piping, and siting, among others. *See* Center for Chemical Process Safety (CCPS). "Inherently Safer Chemical Processes – A Life Cycle Approach." 2nd ed., Table 8.3, 2009.

[iv] As stated in the *Regulatory Oversight* section below, Chevron is only required to conduct inherently safer design strategies during PHAs and for the construction of new processes.

[v] Contra Costa County's guidance document entitled "Attachment C: Inherently Safer Systems Checklist" is provided as a tool for facilities to utilize during the PHA process. The actual use of the checklist is not required. *See* http://cchealth.org/hazmat/pdf/iso/attachment_c.pdf (accessed April 17, 2013).

However, only three permissively worded[i] inherently safer system recommendations were made, none of which addressed sulfidation corrosion or piping metallurgy. In addition, Chevron performed the checklist analysis using the same individuals who conducted the PHA despite Contra Costa County's guidance to involve other personnel with additional expertise. Performing a superficial analysis, Chevron failed to adequately consider inherently safer systems like improved metallurgy for corrosion resistance. For instance, the checklist prompted: "Use corrosion resistant material?" In response, Chevron stated that "vessel specifications and piping classifications include a conservative wall thickness and an appropriate corrosion allowance for each service." No mention is given to improving metallurgy to reduce corrosion. There is also no documented analysis regarding potential materials with enhanced corrosion resistance. There was no documentation of the inherently safer technologies analysis, and no inherently safer alternatives were documented. The checklist as applied by Chevron was a "check-the-box" exercise. Chevron Richmond PHAs were thus not an effective means of driving inherent safety. The table below gives a sample of the IST checklist questions along with the associated Chevron responses.[ii]

Contra Costa County Checklist Question	**Chevron IST Analysis**
Use Corrosion resistant materials?	Vessel specifications and piping classifications include a conservative wall thickness and an appropriate corrosion allowance for each service.
Use smallest diameter piping?	Piping sizes are the smallest possible for the capacity of the unit.
Substitute less hazardous raw materials?	Raw materials in use are of minimal hazard.
Dilute hazardous raw materials?	Raw materials currently dilute where applicable.
Minimize off-site impacts?	#4 Crude Unit is located at a distance from public areas.
Easy operation of valves designed to prevent inadvertent error?	In general, valves are arranged in a logical manner.
Increasing wall strength?	Piping classifications include a conservative wall thickness and an appropriate corrosion allowance for each service.

61. Contra Costa County inspected the Chevron Richmond Refinery in 2011, auditing Chevron's implementation of the county's inherently safer systems analysis requirements in the PHA process. The inspectors determined that Chevron's PHAs "follows the requirements specified by … ISS [inherent safety systems] guidelines." This approval by Contra Costa County

[i] All began with "consider" and two began with "consider evaluating" which does not require any action by Chevron.
[ii] The comprehensive list of IST checklist questions and Chevron's corresponding answers are provided separately on the CSB website.

conveyed to Chevron that the regulator considered that Chevron's minimal analysis of opportunities to implement inherently safer design, its "check-the-box" exercise, was sufficient.

62. Effectively implementing inherently safer technology provides an opportunity for preventing major chemical incidents. The August 6, 2012, incident at Chevron and other incidents[43] throughout the refining industry highlight the difficulty in preventing failure caused by sulfidation corrosion in low silicon carbon steel piping solely through inspection, a procedural safeguard that is low on the hierarchy of controls. Using inherently safer design concepts to avoid issues such as variation in corrosion rate in carbon steel piping due to hard-to-determine silicon content will reduce future similar failures in refineries. Chevron and other process plants' implementation of inherently safer systems to the greatest extent feasible would provide a higher degree of protection from incidents like the one that occurred on August 6, 2012.

63. It is essential that MOCs incorporate hazard analyses and the assessment of opportunities to implement inherently safer systems. This process can be assisted through the use of guidewords to trigger the thought process. CCPS states that "by including inherent safety guidewords in a management of change program, the MOC protocol recognizes inherent safety as both a driving force for - and as an opportunity during - implementation."[44]

64. Layer of Protection Analysis (LOPA) is a well-recognized hazard analysis methodology that is intended to determine if a sufficient number of safeguards or layers of protection exist to protect against a particular hazard or accident scenario.[45] As the potential consequence of a particular scenario increases, the number of safeguards or protection layers must increase to reduce the risk of the scenario to what is considered an acceptable or tolerable level.[46] LOPA can be used to help an organization decide if the risk of a scenario or hazard has been reduced to a level that is "as low as reasonably practicable" (ALARP).[47] ALARP is a risk reduction goal, where risk reduction efforts are continued until the incremental effort to further reduce risk becomes grossly disproportionate to the level of additional risk reduction.[48] By rigorously reviewing accident or hazard scenarios, evaluating the potential consequence of the scenario, and identifying the safeguards or layers of protection necessary to drive risk to as low as reasonably practicable, LOPA becomes an effective organizational tool for implementing a Process Safety Management (PSM) mechanical integrity program.[49] LOPA also helps an organization decide which safeguards to focus on during operation, maintenance, and training.[i, 50] In addition, the LOPA methodology includes provisions allowing an organization to determine the availability[ii] and effectiveness of a safeguard or layer of protection in reducing the risk of a potential scenario.[51]

[i] Chevron is a member of CCPS and peer-reviewed the CCPS LOPA publication. *See* Center for Chemical Process Safety (CCPS). "Layer of Protection Analysis – Simplified Process Risk Assessment," page xiv, 2001.
[ii] The probability that a system will be able to perform its designated function when required for use. Another term frequently used is *Probability of Failure on Demand* (PFD). Availability = 1 - PFD. *See* Center for Chemical Process Safety (CCPS), "Guidelines for Safe Automation of Chemical Processes," page XIX, 1993.

Regulatory Oversight

65. The Contra Costa County Industrial Safety Ordinance (ISO) requires that regulated facilities[i] within the county implement safety programs to prevent chemical incidents. Since the ISO took effect in January 1999, Contra Costa County has continued to make improvements to the implementation of the prevention program's elements.

66. The purpose of the ISO is to "prevent accidental release of hazardous chemicals; improve accident prevention by soliciting participation from industry and the community; require industry to submit a Safety Plan; and conduct audits of the plan and inspections of the industrial plants."[52]

67. Although the City of Richmond is located in Contra Costa County, the county does not have jurisdiction over industrial facilities located within the city limits. Thus, the ISO is not enforceable within the City of Richmond. On December 18, 2001, the City of Richmond adopted its own industrial safety ordinance (RISO), based on the ISO.[ii, 53] The RISO covers the two facilities located within the City of Richmond: Chevron and General Chemical West Richmond Works.[54] Pursuant to an agreement between the two parties, Contra Costa County inspects these two facilities and implements the RISO for the City of Richmond.[55]

68. The ISO and RISO contain identical provisions that address the use of inherent safety concepts. Each defines "inherently safer systems" as "feasible alternative equipment, processes, materials, lay-outs and procedures meant to eliminate, minimize, or reduce the risk of a major chemical accident or release by modifying a process rather than adding external layers of protection."[56] Both regulations also require that:

> For all covered processes, the stationary source shall consider the use of inherently safer systems in the development and analysis of mitigation items resulting from a process hazard analysis and in the design and review of new processes and facilities. The stationary source shall select and implement inherently safer systems to the greatest extent feasible. If a stationary source concludes that an inherently safer system is not feasible, the basis for this conclusion shall be documented in meaningful detail.[57]

---

[i] The ISO applies to oil refineries and chemical plants within the county jurisdiction that are required to submit a Risk Management Plan to EPA and are program level 3 stationary sources as defined by the California Accidental Release Prevention (CalARP) Program. There are seven facilities covered by the ISO, five of which are refineries. *See* http://cchealth.org/hazmat/iso/ (accessed April 17, 2013).

[ii] At the time of the August 6th incident, the RISO did not include amendments made to the ISO in 2006. The 2006 amendments required an expansion of human factors programs, expanded management of organizational change reviews, security vulnerability analyses, and safety culture assessments. These amendments were subsequently adopted by the City of Richmond in February 2013. *See* http://cchealth.org/hazmat/iso/ (accessed on April 9, 2013).

69. The apparent intent of the ISO and RISO regulations is to require companies to evaluate their processes in order to identify opportunities to implement inherently safer systems. However, the plain language contained within these regulations conflicts with this intent. Both regulations contain the following permissive language: "the stationary source *shall consider* the use of inherently safer systems…"[58] This language does not require companies to conduct a comprehensive analysis and implement inherently safer systems even where feasible. It only requires such an analysis be considered. The regulations allow companies to merely engage in an activity contemplating the potential use of inherently safer systems.

70. The language within the ISO and RISO regulations also requires effective action to implement inherently safer systems "to the greatest extent feasible."[59] If an inherently safer system is not implemented, the regulations require that the basis for this decision be "documented in meaningful detail." [60] However, these regulations do not require documentation supporting the adequacy of existing "inherently safer" [61] claims. Chevron's compliance with the RISO is indicative of this deficiency. In its inherently safer systems checklist, Chevron simply concluded that its systems were inherently safer to the extent that no modifications were necessary. However, the company offered no documentation to substantiate these claims. Had the ISO and RISO regulations required analysis of inherently safer systems regardless of what the site already had in place, Chevron may have implemented the inherently safer recommendations made by technical staff to replace the 4-sidecut with an inherently safer metallurgy.

71. The inherently safer systems requirements of the ISO and RISO are only triggered by the conduct of a PHA or the construction of a new process.[62] Rebuilds, repairs, MOCs, and the implementation of incident investigation corrective actions do not require the analysis and application of inherently safer systems.

72. The Contra Costa County PHA guidance document presents four categories of risk reduction:[i] inherent, passive, active, and procedural (Figure 15).[ii] It states that all four categories should be used in the development of recommendations from process hazard analyses.[63] It reiterates the CCPS statement that all may contribute to the overall safety of a process, but that inherent safety is the most effective.[64] It goes on to state "The inherent and passive categories should be implemented when feasible for new processes and facilities and used during the review of Inherently Safer Systems for existing processes if these processes could cause incidents that could result in a Major Chemical Accident or Release."[65] This wording in the guidance

[i] The guidance document uses CCPS definitions for the identified categories of risk reduction.
[ii] Inherent risk reduction involves eliminating the hazard by using materials and process conditions that are non-hazardous. Passive risk reduction is defined as minimizing the hazard through process and equipment design features that reduce the frequency or consequence of the hazard without active functioning of any device. Active risk reduction includes using controls, alarms, safety instrumented systems, and mitigation systems to detect and respond to process deviations from normal operation. Procedural risk reduction achieves the lowest level of risk reduction and involves using policies, operating procedures, training, administrative means, emergency response, and management approaches to prevent incidents and minimize the effects of an incident.

document demonstrates the importance Contra Costa County places on risk reduction and prevention such as metallurgy upgrades; however, as a guidance document, it is non-mandatory.

73. The California Division of Occupational Safety and Health (Cal/OSHA) has jurisdiction over employee safety in California.[66] Cal/OSHA is a division of the California Department of Industrial Relations and has operated a state plan industrial health and safety program since 1973 under a delegation from the U.S. Occupational Safety and Health Administration (OSHA). Cal/OSHA conducts inspections of California workplaces in response to industrial accidents, safety complaints, or as part of an inspection program targeting specific industries.[67] Consideration of inherently safer processes is not currently a required component of any Cal/OSHA (or federal OSHA) standard or regulation.[i]

74. The State of California has promulgated process safety regulations similar to OSHA[68] for the prevention or minimization of the consequences of the accidental release of acutely hazardous chemicals.[69] These regulations require that covered employers perform a PHA to identify, evaluate and control hazards involved in the process using recognized methodologies.[70]

75. California regulations, however, do not provide for a specific review of the effectiveness of the proposed safeguards to control the hazards identified in the PHA using recognized methodologies such as Layers of Protection Analysis (LOPA).[71] Additionally, California regulations do not have any requirements for the use of inherently safer systems analysis and the hierarchy of controls for establishing safeguards for identified process hazards. Cal/OSHA, like federal OSHA, also does not require damage mechanism hazard reviews as part of the PHA process.

76. The Energy Institute, an industry technical working group[ii] organized in the United Kingdom (UK), with contributions from regulators including the UK's Health and Safety Executive (HSE),[iii] as well as other entities,[iv] developed a document in 2008[v] that provides guidance on damage mechanism hazard reviews in the UK's offshore petrochemical industry. The guidance states that effective management of corrosion will contribute to equipment integrity and reduce risk from safety and environmental hazards.[72] In addition, during the design of a process, a corrosion review can be used to eliminate risks and achieve inherent safety.[73] The guidance also

---

[i] This is also the case for US EPA Risk Management Program and the California Accidental Release Prevention Program regulations.

[ii] The Energy Institute is the leading chartered professional membership body supporting individuals and organizations across the energy industry. With a combined membership of over 13,500 individuals and 300 companies in 100 countries, it provides an independent focal point for the energy community and a powerful voice to engage business and industry, government, academia and the public internationally. *See* http://www.energyinst.org/about-us (accessed April 17, 2013).

[iii] HSE is an independent regulator that is tasked with securing the health, safety and welfare of workers within the UK. *See* http://www.hse.gov.uk/aboutus/index.htm (accessed April 17, 2013).

[iv] Chevron Energy Technology Company (ETC) was one of roughly 30 entities recognized in the guidance document as providing contributions to the institute that were "key to the development of this publication…". *See* http://www.energyinstpubs.org.uk/pdfs/815.pdf (accessed April 17, 2013).

[v] *Ibid.*

notes that damage mechanism hazard reviews should provide a structured framework for identifying risks associated with corrosion and developing suitable risk reduction measures.[74] These reviews should cover failure mechanisms including, but not limited to corrosion, environmental cracking, erosion, and mechanical damage, such as vibration induced fatigue.[75] Finally, this guidance states that a formal, documented quantitative and logic based assessment should be used when conducting corrosion reviews.[76]

77. Under a rule issued by the U.S. Environmental Protection Agency (EPA),[77] a facility with a tank, drum, pipe, or other process[i] that contains an extremely hazardous toxic or flammable substance listed at 40 CFR §68.130 in an amount above the "threshold quantity" specified for that substance, is required to conduct a hazard assessment as well as develop a prevention program and an emergency response program. These requirements are documented in a Risk Management Plan (RMP) that is submitted to EPA. Covered facilities must implement the RMP and update their RMPs periodically or when certain changes occur. The goal of EPA's Risk Management Program is to prevent accidental releases of substances that can cause serious harm to the public and the environment from short-term exposures, and to mitigate the severity of releases that do occur.[78]

78. The EPA RMP program provisions build on the planning and preparedness groundwork laid by the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA). EPCRA establishes requirements for federal, state, and local governments, as well as industry, regarding emergency planning and "Community Right-to-Know" reporting on hazardous toxic chemicals. EPCRA "help[s] increase the public's knowledge and access to information on chemicals at individual facilities, their uses, and releases into the environment."[79] According to the U.S. EPA's Chemical Emergency Preparedness and Prevention Office,[ii] transparency between industry and the public will improve community safety:

> Both EPCRA and the CAA [Clean Air Act] section 112(r) Risk Management Program encourage communication between facilities and the surrounding communities about chemical safety and chemical risks. Regulatory requirements, by themselves, will not guarantee safety from chemical accidents. Information about hazards in a community will allow local emergency officials and the public to work with industry to prevent accidents.[80]

[i] "Process" means "any activity involving a regulated substance including any use, storage, manufacturing, handling, or on-site movement of such substances, or combination of these activities…" 40 CFR §68.3 (1997).

[ii] In 2004, the U.S. EPA's Chemical Emergency Preparedness and Prevention Office was merged with the Superfund Emergency Response Program and Oil Spill Prevention Program to form the Office of Emergency Management, or OEM. OEM works with other EPA partners, federal, state, and local agencies, and industry to prevent accidents and maintain and provide superb response capabilities. *See* http://www.epa.gov/oem/about.htm (accessed April 17, 2013).

The CCPS also notes that governments and advocacy organizations have been successful in driving performance improvement by using public disclosure to make safety information available to the public.[81]

79. Under the RMP program's hazard assessment requirement, a facility must prepare a worst-case release scenario analysis[82] and complete a five-year accident history.[83] A covered facility must also develop and implement an emergency response program that includes procedures for informing the public and local agencies about accidental releases and procedures and measures for emergency response after an accidental release.[84] Officials and the public, including local emergency planning committees (LEPCs) can use this information to understand the chemical hazards in the community and then work with industry to address and mitigate those hazards. With both EPCRA and the Risk Management Program, the regulatory purpose and substantive provisions emphasize the importance of transparency, sharing of process safety data, and public participation to prevent chemical accidents. The CSB notes that post-incident, during the decision-making related to piping repairs to the crude unit, the public, worker representatives, regulators, and governmental bodies played a key role driving transparency, accountability, and improved risk reduction.

80. Workforce involvement is a key element of process safety and effective chemical accident prevention. In the Center for Chemical Process Safety publication, *Guidelines for Risk Based Process Safety*, it lists workforce involvement as one of 20 essential management systems necessary to reduce process safety risks and prevent chemical accidents.[85] CCPS states that:

> …workers are potentially the most knowledgeable people with respect to the day-to-day details of operating the process and maintaining the equipment and facilities and may be the sole source for some types of knowledge gained through their unique experiences. Workforce involvement provides management a mechanism for tapping into this valuable expertise.[86]

This CCPS publication discusses general areas of workforce involvement in risk assessments, inspections, audits, and performance reviews. The CCPS notes that participation leads to empowerment, management responsiveness, and process safety performance improvement.[87] The OSHA PSM Standard emphasizes the importance of participation by workers and their representatives. It requires employers to develop a written plan of action, consult with employees, and make available all process safety information.[88] In previous investigation reports, the CSB has identified that workers and their representatives play a very important role in major incident prevention. For example, in the BP Texas City oil refinery investigation report, the CSB recommended that BP and the United Steelworkers International Union (USW) establish a joint program to report incidents and near misses, and to ensure that recommendations made during investigations were implemented. The CSB also recommended that API and the USW work together to develop a safety standard addressing leading and lagging process safety indicators. [i]

81. In July 2012, the CSB held a public hearing on process safety indicators[ii] to explore how companies and regulators use process safety metrics to manage risks and drive continuous safety improvements. During this hearing the CSB stated that, following the 2005 BP Texas City accident, both the CSB and Baker Panel[iii] reports noted the lack of focus by BP on process safety and inadequate performance measurement indicators. The CSB also noted that one goal of process safety indicators is to drive continuous process safety improvement, and that regulators can utilize these indicators to focus inspections, audits, and investigations.

82. Process safety management systems are critical for reducing process safety incidents. Process safety indicators are a significant element of these systems. Indicators measure the strengths and weaknesses of process safety management systems, to achieve and maintain safe and reliable operations. [89] Properly selected and managed indicators will identify the successes and point out the flaws of the system.[90]

83. In 2008, the CCPS published a guidance document for the development of leading[iv] and lagging[v] process safety indicators to assist industry in avoiding catastrophic chemical incidents.[91] While process safety indicators are an important tool for major accident prevention, the simple activity of identifying and recording process safety metrics will not drive process safety improvement. CCPS notes that these metrics must be "collected, analyzed, communicated, understood, and *acted upon."*[92]

84. The UK HSE has published a guidance document to help chemical and major hazard industries develop process safety indicators. HSE states that:

> Most systems and procedures deteriorate over time, and system failures discovered following a major incident frequently surprise senior managers, who sincerely believed that the controls were functioning as designed. Used effectively, process

---

[i] Process safety indicators are also referred to as safety performance indicators, metrics, key process indicators (KPI), performance measures, indicators, etc…

[ii] *See* http://www.csb.gov/assets/1/19/CSB_20Public_20Hearing.pdf (accessed April 17, 2013).

[iii] *See* http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/SP/STAGING/local_assets/assets/pdfs/Baker_panel_report.pdf (accessed April 12, 2013).

[iv] Leading indicators are measurements that predict future performance to ensure that safety protection layers and operating discipline are being maintained, including unsafe behaviors or insufficient operating discipline equipment selection, engineering design, specification of inspection frequency, and technique. *See* Center for Chemical Process Safety (CCPS), *Guidelines for Process Safety Metrics,* Page 20. 2010.

[v] Lagging indicators are facts about previous events, such as process safety incidents, that meet the threshold of severity and should be reported as part of the process safety metric. *See* Center for Chemical Process Safety (CCPS), "Guidelines for Process Safety Metrics," 2010; Page 20.

> safety indicators can provide an early warning, before catastrophic failure, that critical controls have deteriorated to an unacceptable level. [93]

85. The public can play an important role in monitoring safety management systems. In its recent guidelines, the CCPS promoted the sharing of process safety indicators with the public:

> Sharing performance metrics and results broadly can engage the public as a partner in holding the organization accountable for process safety performance. Making metrics and performance public can be an especially powerful way of maintaining upper management commitment since it will likely be the CEO or other senior managers who will be called to account by the public if goals are not met or performance declines. Communicating process safety successes also demonstrates to employees and the public that positive change can be, and are being, made within an organization. [94]

Recommendations

Under 42 U.S.C. 7412(r)(6)(C)(ii), the U.S. Chemical Safety and Hazard Investigation Board is charged with "recommending measures to reduce the likelihood or the consequences of incidental releases and proposing corrective steps to make chemical production, processing, handling and storage as safe and free from risk of injury as possible …." The CSB makes recommendations based on the findings and conclusions of the investigation. Recommendations are made to parties that can affect change to prevent future incidents, which may include the company, contractors, industry organizations responsible for developing good practice guidelines, regulatory bodies, and/or organizations that have the ability to broadly communicate lessons learned from the incident, such as trade associations or professional societies.

Chevron U.S.A (Urgent)

2012-03-I-CA-R1

At all Chevron U.S. refineries, engage a diverse team of qualified personnel to perform a documented damage mechanism hazard review. This review shall be an integral part of the Process Hazard Analysis cycle and shall be conducted on all PSM-covered process piping circuits and process equipment. The damage mechanism hazard review shall identify potential process damage mechanisms and consequences of failure, and shall ensure safeguards are in place to control hazards presented by those damage mechanisms. Analyze and incorporate into this review applicable industry best practices, Chevron Energy Technology Company findings and recommendations, and inherently safer systems to the greatest extent feasible.

2012-03-I-CA-R2

At all California Chevron U.S. refineries, report leading and lagging process safety indicators, such as the action item completion status of recommendations from damage mechanism hazard reviews, to the federal, state, and local regulatory agencies that have chemical release prevention authority.

Mayor and City Council,
City of Richmond, California

2012-03-I-CA-R3

Revise the Industrial Safety Ordinance (ISO) to require that Process Hazard Analyses include documentation of the recognized methodologies, rationale and conclusions used to claim that safeguards intended to control hazards will be effective. This process shall use established qualitative, quantitative, and/or semi-quantitative methods such as Layers of Protection Analysis (LOPA).

2012-03-I-CA-R4

Revise the Industrial Safety Ordinance (ISO) to require the documented use of inherently safer systems analysis and the hierarchy of controls to the greatest extent feasible in establishing safeguards for identified process hazards. The goal shall be to drive the risk of major accidents to As Low As Reasonably Practicable (ALARP). Include requirements for inherently safer systems analysis to be automatically triggered for all Management of Change and Process Hazard Analysis reviews, prior to the construction of new processes, process unit rebuilds, significant process repairs, and in the development of corrective actions from incident investigation recommendations.

2012-03-I-CA-R5

Ensure the effective implementation of the damage mechanism hazard review program (2012-03-I-CA-R1 and 2012-03-I-CA-R2), so that all necessary mechanical integrity work at the Chevron Richmond Refinery is identified and recommendations are completed in a timely way.

Board of Supervisors
Contra Costa County, California

2012-03-I-CA-R6

Revise the Industrial Safety Ordinance (ISO) to require that Process Hazard Analyses include documentation of the recognized methodologies, rationale and conclusions used to claim that safeguards intended to control hazards will be effective. This process shall use established qualitative, quantitative, and/or semi-quantitative methods such as Layers of Protection Analysis (LOPA).

2012-03-I-CA-R7

Revise the Industrial Safety Ordinance (ISO) to require the documented use of inherently safer systems analysis and the hierarchy of controls to the greatest extent feasible in establishing safeguards for identified process hazards. The goal shall be to drive the risk of major accidents to As Low As Reasonably Practicable (ALARP). Include requirements for inherently safer systems analysis to be automatically triggered for all Management of Change and Process Hazard Analysis reviews, prior to the construction of new processes, process unit rebuilds, significant process repairs, and in the development of corrective actions from incident investigation recommendations.

2012-03-I-CA-R8

Monitor and confirm the effective implementation of the damage mechanism hazard review program (2012-03-I-CA-R1 and 2012-03-I-CA-R2), so that all necessary mechanical integrity work at the Chevron Richmond Refinery is identified and recommendations are completed in a timely way.

California State Legislature,
Governor of California

2012-03-I-CA-R9

Revise the California Code of Regulations, Title 8, Section 5189, Process Safety Management of Acutely Hazardous Materials, to require improvements to mechanical integrity and process hazard analysis programs for all California oil refineries. These improvements shall include engaging a diverse team of qualified personnel to perform a documented damage mechanism hazard review. This review shall be an integral part of the Process Hazard Analysis cycle and shall be conducted on all PSM-covered process piping circuits and process equipment. The damage mechanism hazard review shall identify potential process damage mechanisms and consequences of failure, and shall ensure safeguards are in place to control hazards presented by those damage mechanisms. Require the analysis and incorporation of applicable industry best practices and inherently safety systems to the greatest extent feasible into this review.

2012-03-I-CA-R10

For all California oil refineries, identify and require the reporting of leading and lagging process safety indicators, such as the action item completion status of recommendations from damage mechanism hazard reviews, to state and local regulatory agencies that have chemical release prevention authority. These indicators shall be used to ensure that requirements described in 2012-03-I-CA-R9 are effective at improving mechanical integrity and process hazard analysis performance at all California oil refineries and preventing major chemical incidents.

2012-03-I-R11

Establish a multi-agency process safety regulatory program for all California oil refineries to improve the public accountability, transparency, and performance of chemical accident prevention and mechanical integrity programs. This program shall:

1. Establish a system to report to the regulator the recognized methodologies, findings, conclusions and corrective actions related to refinery mechanical integrity inspection and repair work arising from Process Hazard Analyses, California oil refinery turnarounds and maintenance-related shutdowns;
2. Require reporting of information such as damage mechanism hazard reviews, notice of upcoming maintenance-related shutdowns, records related to proposed and completed mechanical integrity work lists, and the technical rationale for any delay in work proposed but not yet completed;

3. Establish procedures for greater workforce and public participation including the public reporting of information; and
4. Provide mechanisms for federal, state and local agency operational coordination, sharing of data (including safety indicator data), and joint accident prevention activities. The California Department of Industrial Relations will be designated as the lead state agency for establishing a repository of joint investigative and inspection data, coordinating the sharing of data and joint accident prevention activities.

2012-03-I-CA-R12

Require that Process Hazard Analyses required under California Code of Regulations, Title 8, Section 5189 Section (e) include documentation of the recognized methodologies, rationale and conclusions used to claim that safeguards intended to control hazards will be effective. This process shall use established qualitative, quantitative, and/or semi-quantitative methods such as Layers of Protection Analysis (LOPA).

2012-03-I-CA-R13

Require the documented use of inherently safer systems analysis and the hierarchy of controls to the greatest extent feasible in establishing safeguards for identified process hazards. The goal shall be to drive the risk of major accidents to As Low As Reasonably Practicable (ALARP). Include requirements for inherently safer systems analysis to be automatically triggered for all Management of Change and Process Hazard Analysis reviews, prior to the construction of new process, process unit rebuilds, significant process repairs and in the development of corrective actions from incident investigation recommendations.

2012-03-I-CA-R14

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.

The U.S. Environmental Protection Agency

2012-03-I-CA-R15

Jointly plan and conduct inspections with Cal/OSHA, California EPA and other state and local regulatory agencies with chemical accident prevention responsibilities to monitor the effective implementation of the damage mechanism hazard review and disclosure requirements under 2012-03-I-CA-R9 and R10 above.

The Board of Supervisors, Contra Costa County, California, 2012-03-I-CA-R16;
The Mayor and City Council, City of Richmond, California, 2012-03-I-CA-R17;
The California Air Quality Management Divisions, 2012-03-I-CA-R18;
The U.S. Environmental Protection Agency, 2012-03-I-CA-R19; and
The California Environmental Protection Agency, 2012-03-I-CA-R20;

Participate in the joint regulatory program described in recommendation 2012-03-I-CA-R11. This participation shall include contributing relevant data to the repository of investigation and inspection data created by the California Department of Industrial Relations and jointly coordinating activities.

Additional Issues Currently Under Investigation

The following section highlights additional issues which the CSB has identified to date in its investigation of the Chevron Richmond Refinery fire and major hydrocarbon release that occurred on August 6, 2012. These issues relate to the ongoing CSB investigation of the management and regulation of health and safety at refineries. The CSB final report will make additional recommendations consistent with this interim report and will present additional detailed findings and analyses in a final report on the incident, to be released later in 2013.

Regulatory Oversight

The CSB noted in its BP Texas City (BPTC) Final Investigation Report (issued in March 2007) the importance of having a well-resourced, competent regulator consisting of individuals with the necessary training, education, and experience to conduct planned comprehensive and robust inspections of facilities with the goal of preventing catastrophic accidents. In a 1992 compliance directive[i] the federal Occupational Safety and Health Administration (OSHA) stated that the primary enforcement model for the Process Safety Management of Highly Hazardous Chemicals (PSM) standard would be planned, comprehensive, and resource-intensive Program Quality Verification (PQV) inspections to help prevent catastrophic accidents.[95] However, the CSB report noted that for the 10-year period prior to the Texas City incident, federal OSHA had conducted no planned PQV inspections in oil refineries. Regular planned inspections appropriately emphasize the prevention of accidents that are potentially catastrophic. Issuing fines and prosecuting companies post-incident are not acceptable substitutes for prevention. As a result, CSB recommended in its report that OSHA strengthen the planned enforcement of the OSHA Process Safety Management (PSM) standard by developing more highly trained and experienced inspectors to conduct more comprehensive inspections similar to those under OSHA's PQV program at facilities presenting the greatest risk of a catastrophic accident.

Spurred in part by the CSB's recommendations, OSHA issued the Petroleum Refinery Process Safety Management National Emphasis Program (NEP) on June 7, 2007.[ii] The NEP was a federal program that established guidelines for inspecting petroleum refineries to assure compliance with the PSM standard, 29 CFR §1910.119.[96] Unlike the PQV approach to inspections, which "employs a broad, open-ended inspection strategy and uses a more global approach to identify compliance deficiencies…,"[97] the NEP "provide[d] a specific tool to evaluate compliance with the [PSM] standard…[which] identifies a particular set of requirements from the PSM standard from which CSHOs [Compliance Safety and Health Officers] are to review documents, interview employees, and verify implementation for specific processes, equipment, and procedures."[98] While the CSB called for an ongoing comprehensive inspection

[i] Compliance directives are the main method OSHA uses to communicate plans, inspection methods, and compliance expectations to their Compliance Safety and Health Officers (CSHOs) for enforcing a new regulation.
[ii] Originally Directive Number CPL 03-00-004. Extended August 18, 2099 as Directive Number CPL 03-00-010 to allow more time to complete NEP inspections under the original CPL 03-00-004.

program, inspections being conducted pursuant to the NEP were terminated in 2011. The CSB recommendation to OSHA remains Open.[i]

OSHA State Plan States[ii] were strongly encouraged but not required to implement the NEP. California's Division of Occupational Safety and Health (Cal/OSHA) did not adopt the NEP "because of its dedicated PSM Unit."[99] Cal/OSHA informed the CSB that federal OSHA approved this decision in 2007. In lieu of conducting NEP inspections, Cal/OSHA's PSM Unit has conducted and continues to conduct a full range of programmed, accident, complaint, and referral inspections of PSM-covered facilities in the state of California pursuant to the California Labor Code, Title 8 regulations, and Cal/OSHA's Policy and Procedures (P&P) Manual C-17 "Process Safety Management,"[iii] to ensure these facilities are complying with PSM requirements.

Between 2006 and August 6, 2012, Cal/OSHA conducted three planned inspections of the Chevron Richmond facility, totaling only 150 inspector hours of effort. None of these inspections resulted in citations or fines. In contrast, according to statistics provided by OSHA, federal NEP refinery inspections conducted between 2007 and the end of 2011 lasted roughly 1,000 inspector hours each and resulted in an average of 11.2 violations and $76,821 in penalties per inspection. OSHA noted that hours spent on a typical federal refinery NEP inspection were 40 times greater than the average OSHA inspection. These numbers indicate a major disparity in thoroughness and comprehensiveness between the planned inspections conducted by Cal/OSHA and the NEP inspections conducted by OSHA and other OSHA State Plan States.

The safety case is a rigorous prescriptive and goal-setting regulatory regime that is highlighted by its adaptability and requirements for continuous improvements in risk reduction for high hazard industrial facilities. The approach is used widely overseas but is not used currently for U.S. process industries. The CSB is currently examining whether the implementation of the safety case regime could be a more effective regulatory tool for Cal/OSHA in its effort to ensure that California refineries are identifying and controlling hazards and ultimately driving risk to as low as reasonably practicable (ALARP). Utilizing the safety case requires effective implementation by an independent, competent, well-funded regulator. Experience and competence of the regulator in technical areas such as chemical engineering, human factors, and process safety are necessary to provide effective auditing and regulatory oversight for prevention. To ensure effective implementation of the safety case, industry standards and guidelines must be rigorous and up-to-date as well. The CSB notes that relevant and applicable industry standards and guidelines – such as API RP 939-C – currently contain voluntary and permissive language. The CSB will be examining the need for more effective good practice standards and guidelines containing the necessary requirements to prevent catastrophic accidents.

---

[i] Open - Awaiting Response or Evaluation/Approval of Response (O - ARE/AR) - The recipient has not submitted a substantive response, or the evaluation by CSB staff of a response is pending, or the Board has not yet acted on staff recommendation of status.

[ii] Section 18 of the Occupational Safety and Health Act of 1970 encourages States to develop and operate their own job safety and health programs, referred to informally as an OSHA State Plan. OSHA approves and monitors State plans and provides up to 50 percent of an approved plan's operating costs.

[iii] Issued June 6, 1994. Revised August 1, 1994 and May 19, 2007.

In addition to the issues discussed above, the CSB will also be examining the need for the reporting of leading and lagging process safety indicators to the regulator; the regulator's effective use of these process safety indicators; workforce and stakeholder involvement in regulatory oversight of refineries; and the thoroughness of Contra Costa County's safety auditing of the Chevron facility.

Emergency Planning and Reporting

According to information provided by Contra Costa Emergency Medical Services, 15,213 individuals sought emergency medical attention between August 6 and August 23, 2012, due to the Chevron refinery major hydrocarbon release and fire.

CSB Investigation Team members visited local hospitals the week of the incident to better understand the impact on the surrounding community. Officials at Doctor's Medical Center (DMC) in San Pablo, California, informed the CSB that in the days following the incident they were inundated with emergency room visits and found it difficult to handle the influx due to a lack of funding and staffing. Officials at both DMC and Kaiser Permanente Hospital (KP) in Richmond told the CSB that they lacked specific knowledge of the chemicals released as a result of the incident, complicating efforts to evaluate and treat individuals.

The California Code of Regulations (CCR) requires that owners and operators of hazardous waste facilities make "arrangements to familiarize local hospitals with the properties of hazardous waste handled at the facility and the types of injuries or illnesses which could results from fires, explosions, or releases at the facility."[100] The CSB is currently evaluating ways to ensure that hospitals have the information necessary to properly evaluate and treat individuals that may be exposed to releases from facilities in Contra Costa County.

Following the incident, Contra Costa County's Community Warning System (CWS) notified the surrounding community of a hazardous material incident and ordered a shelter-in-place (SIP). The CWS uses sirens, the news media, and phone calls to residents in order to initiate the SIP. Contra Costa County issued the SIP on August 6, 2012, at 6:38 pm for the cities of Richmond, San Pablo, and North Richmond, California, and lifted the SIP later that evening at 11:12 pm. However, the CSB has learned that some phone calls notifying residents of the SIP did not occur until over four hours after the release.

It is essential that responders, community residents, and hospitals in the areas surrounding industrial facilities be aware of what hazardous materials exist at these facilities, what specific chemicals are released into the community in the event of an incident, and what is known about the potential acute and chronic health impacts. The CSB will be analyzing ways to strengthen current regulations and policies to ensure there is proper emergency planning and reporting for industrial facilities in Contra Costa County and the state of California.

Emergency Response

OSHA provides guidance on emergency response in its *Hazardous Waste Operations and Emergency Response* standard, known as HAZWOPER, under 29 CFR §1910.120 (p) and (q). Under 29 CFR §1910.120(q)(6), the HAZWOPER standard contains requirements for training and qualification of all individuals involved in emergency response related to their roles and responsibilities.

Good safety practice dictates that individuals responding to emergencies should have the technical knowledge to give input into shutdown decisions, set up an incident command structure, establish boundary limits, and evaluate the "hot zone." Access to the hot zone must be strictly limited to personnel with higher degrees of specific training, experience, and appropriate personal protective equipment; all others must be removed to a safe location away from chemical hazards. Hot zone boundaries must be established to anticipate the possible escalation of releases and the positioning of firefighting equipment such as fire trucks.

The CSB will be looking at the sufficiency of regulatory requirements, industry standards, and good practices, in addition to evaluating emergency response decision-making following the leak and subsequent pipe rupture (including the training and qualification of responders) to determine whether improvements are needed in these areas.

Safety Culture

The Center for Chemical Process Safety (CCPS) defines process safety culture as the "combination of group values and behaviors that determines the manner in which process safety is managed."[101] As the CSB noted in its BP Texas City Report, safety culture can be influenced by management changes, historical events, and economic pressures. After reviewing evidence and decisions made relating to materials of construction and mechanical integrity within the crude unit at the Chevron refinery, as well as the response to the leak on August 6, 2012, the CSB has determined that issues relating to safety culture are relevant to this incident. The CSB will examine the Chevron Richmond Refinery's approach to safety, its safety culture and any organizational deficiencies, to determine how to best prevent future incidents.

The CSB notes that on August 6, 2012, following discovery of the leak on the 4-sidecut piping, Chevron hoped to forestall a shutdown by installing a leak repair clamp.[i] Chevron's mechanical integrity management system has not been fully successful in detecting and replacing deteriorated piping components prior to failure, resulting in the company's frequent use of leak repair clamps[ii] to externally stop process fluid leaks. Chevron's reliance on such clamps to mitigate process piping component leaks identifies serious questions about its mechanical integrity program. The CSB determined that Chevron

[i] Chevron's leak repair clamp vendor was called out to the scene of the leak to help determine potential clamping options.

[ii] Leak repair clamps are mechanical devices designed and installed to stop a leak from a piping component such as piping, valves, flanges, and instrumentation. These devices are typically intended to provide a temporary repair while a process continues operation until a plant shutdown takes place and a permanent repair can be made.

has more than 100 clamps on hydrocarbon and other process piping components at the Richmond refinery. The leak repair clamp is typically relied upon to prevent further leaking until the next unit turnaround, when the deteriorated piping component can be repaired. However, Cal/OSHA citations following the August 6, 2012, fire in the crude unit identified that Chevron has not always replaced these clamps during unit turnarounds and these devices then remain in service significantly longer than originally intended. The CSB determined that Chevron has leak repair clamps in place on piping components containing hazardous flammable process fluids including applications where the process material is above the autoignition temperature. Some of these leak repair clamp applications are in locations where a permanent repair would not have required a unit shutdown. The CSB will further evaluate the frequent use of leak repair clamps by Chevron and the potential that the deviance of a weak mechanical integrity management system has been normalized.[i]

[i] Normalization of deviance is a long-term phenomenon in which individuals or work teams gradually accept a lower standard of performance until the lower standard becomes the norm. It is typically the result of conditions slowly changing and eroding over time. *See* Center for Chemical Process Safety (CCPS), Recognizing Catastrophic Incident Warning Signs in the Process Industries, Page 4. 2012.

BY THE

U.S. Chemical Safety and Hazard Investigation Board

Rafael Moure-Eraso
Chair

Mark Griffon
Member

Beth Rosenberg
Member

Date of Approval April __, 2013.

References

1. Chevron U.S.A. Inc. "30 Day Follow-Up Notification Report." September 5th, 2012.

2. KTVU roof cam footage. *See* http://www.ktvu.com/videos/news/ktvu-timelapse-exclusive-timelapse-video-of-smoke/vdCJ7/ (accessed April 10, 2013).

3. Anamet, Inc. "Metallurgical Evaluation of Samples from the Chevron U.S.A. Inc., Richmond #4 Crude Unit 8-Inch and 12-Inch 4-Sidecut Piping Involved in the August 6, 2012, Hydrocarbon Release and Fire." Prepared for: The Chemical Safety and Hazard Investigation Board (CSB), February 11, 2013.

4. API RP 939-C. "Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries." 1st ed., Section 4, May 2009.

5. *Ibid* at Section 3.1.6.

6. *Ibid* at Section 6.2.2.1.

7. NACE International Task Group 176. "Overview of Sulfidic Corrosion in Petroleum Refining." *NACE International Publication 34103.* Item No. 24222, 2004.

8. API RP 939-C. "Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries." 1st ed., May 2009.

9. *Ibid.*

10. ASTM Standard A53/A53M-12. "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless." 2012.

11. Niccolls, E. H., J. M. Stankiewicz, J. E. McLaughlin, and K. Yamamoto. "High Temperature Sulfidation Corrosion in Refining." *17th International Corrosion Congress.* Las Vegas: NACE International, 2008.

12. API RP 939-C. "Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries." 1st ed., Section 6.2.3.2, May 2009.

13. API Publication 943. "High-Temperature Crude Oil Corrosivity Studies." September 1974.

14. ASTM Standard A53/A53M-12. "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless." 2012.

15. ASTM Standard A106/A106M–11."Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service." 2011.

16. API Specification 5L. "Specification for Line Pipe." 45th ed., December 2012.

17. ASTM Standard A53/A53M-12. "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless." 2012.

18. http://www.eia.gov/tools/faqs/faq.cfm?id=29&t=6 (accessed February 14, 2013).

19. Anamet, Inc. "Metallurgical Evaluation of Samples from the Chevron U.S.A. Inc., Richmond #4 Crude Unit 8-Inch and 12-Inch 4-Sidecut Piping Involved in the August 6, 2012, Hydrocarbon Release and Fire." Prepared for: The Chemical Safety and Hazard Investigation Board (CSB), February 11, 2013.

20. API RP 939-C. "Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries." 1st ed., Section 7.1.5, May 2009.

21. *Ibid.*

22. *Ibid.*

23. *Ibid.*

24. *Ibid* at Section 9.

25. *Ibid* at Section 7.1.5.

26. *Ibid* at Section 6.2.3.2.

27. *Ibid* at Section 7.1.5.

28. *Ibid* at Section 9.

29. *Ibid* at Section 9.

30. API RP 571. "Damage Mechanisms Affecting Fixed Equipment in the Refining Industry." 2nd ed., April 2011.

31. Center for Chemical Process Safety (CCPS). "Layer of Protection Analysis – Simplified Process Risk Assessment." 2001.

32. Division of Occupational Safety and Health, State of California, Citation of Notification of Penalty, Inspection Number 314331877, CSHO ID A0572, Citation 4 Item 1, January 30, 2013.

33. http://www.opportunitycrudes.com/marketupdates/index.php?topics=opcrudetypes (accessed February 14, 2013).

34. API RP 939-C. "Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries." 1st ed., Section 4, May 2009.

35. API 570. "Piping Inspection Code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems." 3rd ed., Section 4.3.1.2, November 2009.

36. www.aiche.org/ccps/about (accessed February 14, 2013).

37. www.aiche.org/ccps/community/members (accessed February 14, 2013).

38. Center for Chemical Process Safety (CCPS). "Inherently Safer Chemical Processes – A Life Cycle Approach." 2nd ed., Section 2.2, 2009.

39. *Ibid* at Section 5.1.1.

40. *Ibid* at Section 5.2.

41. *Ibid* at Page 184.

42. Kletz, Trevor, and Paul Amyotte. "Process Plants: A Handbook for Inherently Safer Design." 2nd ed., Section 1.1, Page 14, 2010.

43. API RP 939-C. "Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries." 1st ed., May 2009.

44. Center for Chemical Process Safety (CCPS). "Inherently Safer Chemical Processes – A Life Cycle Approach." 2nd ed., Page 21, 2009.

45. *Ibid* at Page 11.

46. *Ibid.*

47. *Ibid* at Page 26.

48. *Ibid* at Page 46.

49. *Ibid* at Page 27.

50. *Ibid* at Page 26.

51. *Ibid* at Page 80

52. http://cchealth.org/hazmat/iso/faq.php (accessed February 14, 2013).

53. City of Richmond Municipal Code Chapter 6.43, RISO. December 18, 2001. http://www.ci.richmond.ca.us/archives/66/113%20N.S.%20amending%20Richmond%20Municipal%20Code%20Chapter%206.43%20to%20improve%20industrial%20safety-conformed.pdf (accessed April 11, 2013).

54. http://cchealth.org/hazmat/iso/ (accessed April 11, 2013).

55. City of Richmond Municipal Code Chapter 6.43, RISO. Section 6.43.060 "Administration" December 18, 2001. http://www.ci.richmond.ca.us/archives/66/113%20N.S.%20amending%20Richmond%20Municipal%20Code%20Chapter%206.43%20to%20improve%20industrial%20safety-conformed.pdf (accessed April 11, 2013).

56. Contra Costa County, California, Ordinance Code. Title 4 – Health and Safety. Division 450 – Hazardous Materials and Wastes. Chapter 450-8: Risk Management. Section 450-8.014 "Definitions" (2010). http://library.municode.com/index.aspx?clientId=16286 (accessed February 15, 2013). *See also* City of Richmond Municipal Code §6.43.050(g) (February 5, 2013).

57. *Ibid* at Section 450-8.016 subpart (d)(3) "Process Hazard Analysis/Action Items." *See also* City of Richmond Municipal Code §6.43.090(d)(3) (February 5, 2013).

58. *Ibid*.

59. *Ibid*.

60. *Ibid*.

61. *Ibid*.

62. *Ibid*.

63. Contra Costa County Industrial Safety Ordinance Guidance Document. Section D: Process Hazard Analysis / Action Items. Subpart D.1.3. Process Hazard Analysis Recommendations and Mitigations. Published June 15, 2011. http://cchealth.org/hazmat/pdf/iso/section_d.pdf (accessed March 20, 2013).

64. *Ibid* at Subpart D.1. Inherently Safer Systems.

65. *Ibid.*

66. http://www.dir.ca.gov/dosh/enforcementpage.htm (accessed February 15, 2013).

67. *Ibid.*

68. 29 CFR §1910.119 – Process Safety Management of Highly Hazardous Chemicals (2002).

69. California Code of Regulations. Title 8. Section 5189 - Process Safety Management of Acutely Hazardous Materials http://www.dir.ca.gov/title8/5189.html (accessed February 15, 2013).

70. *Ibid* at (e)(1).

71. Layer of Protection Analysis: Simplified Process Risk Assessment. Center for Chemical Process Safety of the American Institute of Chemical Engineers. 2001.

72. Energy Institute. "Guidance for Corrosion Management in Oil and Gas Production and Processing." Section 1.1, May 2008.

73. *Ibid* at Section 4.2.

74. *Ibid.*

75. *Ibid* at Section 1.2.3.

76. *Ibid* at Section 4.3.

77. 40 CFR Part 68, known as the "Chemical Accident Prevention Provisions."

78. U.S. Environmental Protection Agency, "General Guidance on Risk Management Programs for Chemical Accident Prevention (40 CFR Part 68)." Page i. March 2009. http://www.epa.gov/oem/docs/chem/Intro_final.pdf (accessed April 3, 2013).

79. http://www.epa.gov/oem/content/lawsregs/epcraover.htm (accessed April 3, 2013).

80. Chemical Emergency Preparedness and Prevention Office, "RMPs Are on the Way! How LEPCs and Other Local Agencies Can Include Information from Risk Management Plans in Their Ongoing Work." November 1999. http://www.epa.gov/osweroe1/docs/chem/lepc-rmp.pdf (accessed April 17, 2013).

81. Center for Chemical Process Safety (CCPS), Guidelines for Process Safety Metrics, Page 103. 2010.

82. 40 CFR §68.25. 1999.

83. 40 CFR §68.42. 1999.

84. 40 CFR §68.95(a)(1) 1996.

85. Center for Chemical Process Safety (CCPS). "Guidelines for Risk Based Process Safety." Page liv. 2007.

86. *Ibid* at Page 124.

87. *Ibid* at Page 125.

88. 29 CFR §1910.119 (c) 2012.

89. Center for Chemical Process Safety (CCPS), Guidelines for Process Safety Metrics, Page 109. 2010.

90. *Ibid.*

91. Process Safety Leading and Lagging Metrics …You Don't Improve What You Don't Measure, http://www.aiche.org/ccps/resources/overview/process-safety-metrics/recommended-process-safety-metrics (accessed April 12, 2013).

92.Center for Chemical Process Safety (CCPS), Guidelines for Process Safety Metrics, Page 97. 2010.

93.Health and Safety Executive (HSE), Developing Process Safety Indicators a Step-by-Step Guide for Chemical and Major Hazard Industries, HSE Guidance Series/HSG Series, HSG254, Page 4. 2006.

94.Center for Chemical Process Safety (CCPS), Guidelines for Process Safety Metrics, Page 109. 2010.

95. OSHA Instruction CPL 02-02-045 (1992). Updated in 1994.

96. CPL 03-00-004, Section VII. Federal Program Change. 2007.

97. *Ibid* at Section X(D)(1).

98. *Ibid.*

99. Department of Industrial Relations, Division of Occupational Safety and Health, California, Process Safety Management District Office. "Mission Statement: Goals Reached in 2011 & Strategic Plan for 2012."

100. 22 CCR §66265.32(a)(4)(2004).

101. Center for Chemical Process Safety (CCPS). "Guidelines for Risk Based Process Safety." 2007.

Steve Wildman
Manager

Process Safety Management & Operational Excellence
Chevron Products Company
P. O. Box 1272
Richmond, CA 94802-0272
Tel 510 242 3887
Fax 510 242 5353
STDW@chevron.com

April 12, 2013

Randall L. Sawyer
Hazardous Materials Program Director
Contra Costa Health Services
4333 Pacheco Boulevard
Martinez, CA 94553-2229

RE: Seventh Update to the 30-Day Report for the CWS Level 3 Event of August 6, 2012

Dear Mr. Sawyer:

In accordance with the December 14, 2004 Contra Costa Health Services ("CCHS") Hazardous Materials Incident Notification Policy, Chevron U.S.A. Inc. ("CUSA") is providing an update to the 30-Day Report for the Community Warning System ("CWS") Level 3 Event that occurred at the Richmond Refinery on August 6, 2012. The attached "Update to 30-Day Follow-Up Notification Report Form" updates sections IX and X to reflect that CUSA has now completed its investigation into the August 6 CWS Level 3 Event and is submitting its report summarizing the investigation results to the CCHS. This letter provides a brief summary of the investigation report findings and recommendations, as well as an update on the actions CUSA is taking to prevent a similar incident in the future.

Incident Investigation

CUSA's investigation was conducted by a team that included external scientific and engineering experts, members of the United Steelworkers Union, and CUSA's technical experts. The team gathered and reviewed historic information and data, interviewed relevant personnel, visually inspected the damaged portions of the No. 4 Crude Unit ("Crude Unit") where the incident occurred, collected samples, and observed testing of the failed pipe section performed by Anamet Inc. ("Anamet"), a testing laboratory.

Based on this investigation, the report concludes a failure occurred in a five-foot long piping component of the 8" carbon steel atmospheric gas-oil pipe line from the atmospheric distillation tower (known as the "4-sidecut") in the Crude Unit, resulting in a hydrocarbon leak. Subsequently, a fire erupted in the area of the failure. Consistent with the metallurgy evaluation report on the failed piping component prepared by Anamet, our investigation found that the five-foot carbon steel component where the leak occurred failed due to thinning caused by sulfidation corrosion, which was accelerated by the low-silicon content of the failed component. Individual carbon steel piping components with low-silicon can, and here did, corrode at an accelerated rate not readily detectable by multiple corrosion monitoring locations.

Causal Factors, Additional Considerations, and Recommendations

CUSA's investigation team identified four "causal factors"[1] of the August 6 incident:

- The response and assessment after discovery of the leak did not recognize the risk of piping rupture and the possibility of auto-ignition.
- A measurement performed in 2002 showed one-third wall loss in the failed pipe component just downstream of a corrosion monitoring location ("CML"). This information was only captured as a comment in the inspection management software tool and not elsewhere in the inspection management system. Documenting wall thickness information in a comment without adding it to the inspection management software database limited the ability for future decision-makers to utilize the data.
- Relevant information regarding carbon steel sulfidation corrosion – including the understanding that components with low-silicon are especially susceptible to sulfidation corrosion and the recommendation to perform 100% component-by-component inspection – was not transferred to the Refinery inspection management system. The 2009 Reliability Opportunity Identification/Intensive Process Review ("ROI/IPR") did not identify the need for 100% component-by-component inspection or the replacement of the 4-sidecut piping.
- Inspection during the 2011 Turnaround did not include every component in the 4-sidecut piping circuit because the recommendation to identify and inspect every component was not built into the inspection plans for the Crude Unit. A 100% component-by-component inspection would have required the inspection of the pipe component that failed in August 2012, which could have alerted the Refinery to the component's accelerated metal loss.

To address these causal factors, the investigation team made the following recommendations:

- Revise Refinery policies and checklists to ensure appropriate information – including process safety and inspection information – is considered when evaluating leaks and addressing the issue of whether to shut down or continue operation of equipment.

[1] Based on the methodology used to perform the investigation, a "causal factor" iws a mistake or failure that, if corrected, could have prevented the incident from occurring or would have significantly mitigated its consequences..

- Enhance the Refinery's mechanical integrity program to ensure the Refinery properly identifies and monitors piping circuits for appropriate damage mechanisms using a standardized methodology and documentation system.

- Implement certain improvements concerning inspector training and competency, oversight of mechanical integrity, inspection plans and escalation procedures. Develop and implement a process to review and act upon mechanical integrity-related recommendations from industry alerts, Chevron Energy Technology Company ("ETC"), and other subject-matter experts. Inspect Crude Unit piping that falls under the ETC Sulfidation Inspection Guidelines criteria for sulfidation corrosion prior to restarting the Crude Unit, and implement the ETC Sulfidation Inspection Guidelines for the remainder of the Refinery.

- Ensure relevant technical studies and inspection data are considered for the Refinery's equipment reliability plans and incorporated into the ROI/IPR process.

In addition to the four causal factors of the incident, the investigation report also found six "additional consideration" which, while not considered a direct cause of the August 6 incident, represent opportunities to prevent a similar incident from recurring (with specific additional recommendations noted):

- The Chevron Fire Department did not complete a Hazard Material Data Sheet and positioned Engine Foam 60 too close to the leak source when responding to the Incident.
  - Review the Pre-Fire Plan to ensure sufficient guidance is provided on equipment positioning.

- The leaking line could not be isolated on the upstream side to mitigate loss of containment.
  - Review company/industry loss history on large fractionating towers to determine if internal Engineering Standard FRS-DU-5267 (Emergency Isolation and Depressuring Valves) adequately addresses mitigation of accidental releases from these systems. Revise the standard as warranted by the findings of this review.

- The ETC Sulfidation Inspection Guidelines were not fully implemented and action items were not tracked to completion.
  - Ensure Refinery business plans provide for the appropriate implementation of process safety recommendations.

- The minimum thicknesses calculated for the 4-sidecut washout spool piping did not include safety factors considered in the Refinery Piping Inspection Guideline and American Petroleum Institute Recommended Practice 574, which may have triggered a Fitness for Service analysis and led to additional inspections and resulting data.

- Ensure sufficient organizational capacity and competency for minimum thickness Fitness for Service determinations.

- The June 2012 inspection of the P-1149/A suction piping was not entered in the inspection management system.

  - Consider additional training on expectations under the "Richmond Refinery Piping Inspection Guidelines" and "RFMS Piping Data Entry (Reliability Focused Maintenance System) and ACD (Add/Change/Delete) Guideline."

- The Crude Unit Process Hazard Analyses did not consider the potential for sulfidation corrosion.

  - Review and modify the Process Hazard Analysis ("PHA") procedures to ensure that teams consider known corrosion threats/mechanisms.

  - Consider a project to evaluate the purpose and methods of various process safety management ("PSM") reviews to determine if these activities can be combined or better sequenced to improve risk understanding across the various functions and promote better process safety outcomes.

Actions to Address Report Findings and Recommendations, and To Prevent Recurrence

In our Fourth Update to the 30-Day Report for the CWS Level 3 Event of August 6, 2012, submitted January 28, 2013, we summarized the measures the Refinery is implementing to prevent a recurrence of the incident. We are providing CCHS a further update of those measures, and the status of their implementation. In addition to previously sharing these measures with CCHS, we have previewed these actions with Cal/OSHA and the CSB in order to ensure alignment with their understanding of the causes of the incident.

Low-Silicon Carbon Steel and Piping Component Inspections

- The Refinery has inspected every piping component in the Crude Unit potentially susceptible to sulfidation corrosion. Of the approximately 4,600 piping components inspected, we replaced four carbon steel piping components that appeared to have higher corrosion rates than other piping components in the system.

- Our enhanced inspection programs are being implemented throughout the Refinery, and we are replacing every component found as indicated by the results of these inspections. Over the longer-term, we will conduct 100 percent piping component inspections throughout our refining network.

Mechanical Integrity Program

- We are strengthening the Refinery's reliability program for piping and equipment to ensure it covers potential damage mechanisms applicable to those systems. As part of this effort, CUSA has begun implementing an enhanced process for regular damage mechanism reviews for each unit and piping circuit so as to formalize the evaluation of known damage mechanisms, the consequences of a failure, and the safeguards necessary to mitigate failures and other potential risks from those damage mechanisms.

- We also are reviewing and modifying our PHA procedures to ensure that known corrosion threats/mechanisms have been appropriately considered.

- The Refinery is implementing an enhanced process to better review, prioritize, and act upon mechanical integrity-related recommendations from internal and external technical experts, including industry standards and alerts, to ensure that the right information gets into the hands of the right people at the right time so the right decisions can be made.

Assessment, Decision-Making, and Oversight

- The Refinery is implementing a process for additional oversight of mechanical integrity-related recommendations, inspection plans, and turnaround work lists.

- We are reviewing and improving our mechanical integrity training as a way to further support our leaders, inspectors, operating groups, and engineers. We are also making certain that the appropriate technical resources are readily available to assist any evaluation of the fitness of equipment for service.

Leak Response

- We have implemented a new protocol for evaluating leaks with simple guidance for making sometimes necessary rapid decisions around leak response and further enhancing situational awareness skills. We recently shared our new leak response protocol with CCHS, Cal/OSHA, and the CSB, as well as other refineries and industrial facilities in Contra Costa County.

Process Safety Focus

- We are reemphasizing our expectations around process safety and the responsibility of all personnel for process safety performance, including the importance of incorporating process safety into decision-making.

With the submission of its investigation report, CUSA believes that, absent new information coming to light or a request for additional information from CCHS, this will be the final update to the 30-Day Report.

If you have questions or comments, please feel to contact me directly at the number above, or Karen Draper of my staff at (510) 242-1547.

Sincerely,

Steve Wildman

For CCHS Use Only:
Received By: ____________
Date Received: ____________
Incident Number: ____________
Copied To: ____________
Event Classification Level: ____________

ATTENTION: Randall L. Sawyer
Hazardous Materials Program Director
Contra Costa Health Services Department
4333 Pacheco Boulevard
Martinez, CA 94553

INCIDENT DATE: August 6, 2012
INCIDENT TIME: 6:30 PM
FACILITY: Chevron U.S.A. Inc. Richmond Refinery

PERSON TO CONTACT FOR ADDITIONAL INFORMATION: Karen Draper
Phone Number: (510) 242-1547

PROVIDE ANY ADDITIONAL INFORMATION THAT WAS NOT INCLUDED IN THE 30-DAY REPORT WHEN THE 30-DAY REPORT WAS SUBMITTED, INCLUDING MATERIAL RELEASED AND ESTIMATED OR KNOWN QUANTITIES, COMMUNITY IMPACT, INJURIES, ETC.:

I. SUMMARY OF EVENT

On August 6, 2012, a piping failure occurred in the #4 Crude Unit at the Chevron U.S.A. Inc. refinery in Richmond, CA, and subsequently a fire ignited in the area of the failure. The rupture involved an 8" carbon-steel atmospheric gas-oil pipe line from the atmospheric distillation tower.

The primary location of the fire was near P-1149 (C-1100 Atmospheric Column No. 4 Sidecut pump). At the time of the fire, Operations personnel were in the process of evaluating a reported leak with the assistance of Chevron Fire Department personnel.

The #4 Crude Unit distills crude oil into various fractions of different boiling ranges, each of which is then processed further in the other refinery processing units. The #4 Crude Unit at Richmond Refinery has both an Atmospheric Distillation column and a Vacuum Distillation column. This incident involved equipment associated with the Atmospheric Distillation column.

The company's investigation into this incident is now complete, and is included with this Update. The information below has been updated accordingly.

II. AGENCIES NOTIFIED, INCLUDING TIME OF NOTIFICATION

Primary: Community Warning System (CWS):

- Level 3 CWS (shelter in place) activated at approximately 6:35 PM (which served as the initial notification to most of the agencies below)
- The shelter in place was lifted by Contra Costa County Hazardous Materials Programs (CCHMP) at 11:30 PM

Secondary: Subsequent notifications via telephone to the agencies below:

State of Emergency Services	Bob McRae	800-852-7550 or 916-845-8911	6:53 PM
National Response Center (NRC)	Garther	800-424-8802	6:59 PM
Contra Costa Hazardous Materials Program (CCHMP)	Melissa Hagen	925-335-3200	7:28 PM
Bay Area Air Quality Management District (BAAQMD)	Mr. Scott	415-749-4979	7:33 PM
Richmond Fire/ Police Central Dispatch	Dispatch	510-620-6933	7:40 PM
California Division of Occupational Safety and Health (Cal/OSHA)	Clyde Trombettas	925-602-6517	10:09 PM

III. AGENCIES RESPONDING, INCLUDING CONTACT NAMES AND PHONE NUMBERS:

The list below does not include all representatives from the respective agencies

Cal/OSHA	Clyde Trombettas	925-602-2665
CCHMP	Trisha Asuncion	925-335-3200
BAAQMD	Jackie Huynh	415-749-4979
OSPR– Dept. Fish & Game	Bob Chedsey	707-864-4975
U.S. EPA	Scott Adair	415-947-4549
Richmond Police Department	Responding Officers	510-233-1214
U. S. Chemical Safety and Hazard Investigation Board (CSB)	Dan Tillema	303-236-8703

IV. EMERGENCY RESPONSE ACTION:

At or around 3:48 PM on August 6, 2012, an operator noticed a small leak from insulated piping on the C-1100 Atmospheric Distillation Column of the 4 Crude Unit. The operator immediately notified the Head Operator and Supervisor for the unit and initiated a dialogue regarding next steps and how to isolate the leak.

The standard practice of the Chevron Fire Department (CFD) is to respond to leaks, spills, and releases. In this instance, the CFD was notified at 4:02 PM that a leak had been discovered at the 4 Crude Unit. The CFD was asked to deploy a crew to the location as a precaution. The CFD arrived at the location between 4:07 PM and 4:09 PM and initiated air monitoring and assessment.

From 4:09 PM to 4:19 PM the rate of feed to the unit was reduced. Then, from 4:20 PM to 6:24 PM, Operations personnel, in conjunction with the CFD, investigated and assessed options. While the leak was being assessed, the CFD set up an engine and had two hose teams in place, one directed at the potential source of the leak and one directed at the personnel assessing the leak. At approximately 6:22PM, a small flash fire occurred on the insulated piping going to P-1149/A. The CFD and Plant Operators activated water spray and extinguished the small flash fire. At some point shortly before 6:25 PM, the size of the release abruptly increased. Between 6:25 PM and 6:28 PM, the order was given to shut down the unit. Around this time a white cloud was visible. At or around 6:32 PM, the fire that is the subject of this report and ongoing investigation ignited.

At 6:38 PM, a Community Warning System Level 3 alert was initiated by Chevron U.S.A. Inc. and the CWS alarm sounded. At or around this timeframe, both Petro-Chem Mutual Aid and Municipal Mutual Aid were called in for support. This included: Richmond Fire, El Cerrito Fire, Berkeley Fire, Contra Costa County Fire, Moraga/Orinda Fire, Hercules/Rodeo Fire, Phillips 66, Valero, Shell, Tesoro and Dow Fire. Also at or around this timeframe, a shelter-in-place order was issued for Richmond, San Pablo, and North Richmond. The shelter-in-place order advised residents to remain indoors until the fire was controlled. At 11:12 PM, the shelter-in-place order was lifted by CCHMP.

V. IDENTITY OF MATERIAL RELEASED AND ESTIMATED OR KNOWN QUANTITIES:

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Emergency Planning and Community Right-To-Know Act (EPCRA) require reporting when a facility releases more than a "reportable quantity" of a hazardous substance. The reportable release thresholds are based upon EPCRA & CERCLA reporting requirements. There was a reportable quantity of sulfur dioxide released from the fire and the flaring associated with the fire.

As a result of our continuing investigation, emission calculations from flaring associated with the event have been refined and summarized below.

Flare emissions (8/6 – 8/10)*	
Material Release	**Quantity Released**
Vent Gas Volume	8,021,389 SCF
Sulfur Dioxide (SO_2)	8,772 pounds
Methane	1,713 pounds
Non-Methane Hydrocarbon	3,794 pounds
Hydrogen Sulfide (H2S)	46 pounds
Nitric Oxides (NOx)	270 pounds

* Flare emission data includes emissions from the initial release and from depressuring the unit through August 10, 2012

As a result of our continuing investigation, emissions calculations from the fire that were in excess of a reportable quantity have been refined and summarized below:

Fire Emissions		
Material Released	**Quantity Released**	**Reportable Release Thresholds**
Sulfur Dioxide (SO_2)	2,017 pounds	500 pounds

Emission estimates herein are based on currently available data and are subject to change based on further investigation and analysis.

VI. METEROLOGICAL CONDITIONS AT TIME OF EVENT:

Wind Speed	11.5 MPH
Wind Direction	134° (SE)
Precipitation	None
Temperature (F)	75°

VII. DESCRIPTION OF INJURIES:

The following employee injuries were associated with this incident (all were part of the emergency response):

1) Employee received minor burn to small area of the left ear
2) Employee received minor burn to left wrist
3) Employee suffered abdominal discomfort
4) Employee suffered respiratory irritation
5) Employee suffered blister to lower leg from boot wear
6) Employee suffered bruise to a finger

All employees received first aid onsite by the Chevron Fire Department and/or the onsite clinic. All employees returned to work on the same shift. There were no injuries to contractor personnel associated with this incident.

VIII. COMMUNITY IMPACT:

A shelter-in-place order was issued for Richmond, San Pablo, and North Richmond, which advised residents to remain indoors until the fire was controlled. According to the Contra Costa Health Services website, a large number of people sought medical attention at local emergency rooms (three individuals were admitted to the hospital). Most cases have been minor complaints of nose, throat or eye irritation or respiratory issues.

a) Chevron U.S.A. Inc. established a claims process to compensate community members for medical and property expenses incurred as a result of the incident. As of January 21, 2013, approximately 23,900 claims have been initiated, and Chevron U.S.A. Inc. has spent approximately $10 million to compensate area hospitals, affected community members with valid claims, and local government agencies in Richmond and West Contra Costa County.

b) On August 6, 2012, seventeen (17) direct-reading samples were taken using an Industrial Scientific MX6 iBrid multi-gas monitor. The data from these samples confirms that concentrations for Hydrogen Sulfide (H2S), Sulfur Dioxide (SO2) and Carbon Monoxide (CO) were below detectable limits (<0.1ppm, <0.1ppm, and <1ppm respectively). Additionally, nineteen (19) grab samples were collected in Tedlar bags in various downwind locations in Richmond, California, El Sobrante, California, and El Cerrito, California. These samples were sent for analysis of sulfur compounds and hydrocarbons to Air Toxics Ltd., a laboratory specializing in the analysis of air using a wide variety of methods. All results from these samples were well below both the California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA) Reference Exposure Levels and California Occupational Safety and Health Administration (Cal/OSHA) Permissible Exposure Limits.

Follow-up community monitoring was conducted by Chevron U.S.A. Inc. at various locations throughout Richmond, California on August 7-8, 2012. Twenty (20) direct-reading air samples were taken during this timeframe using an Industrial Scientific MX6 iBrid multi-gas monitor. The data from these samples also confirms that concentrations of Hydrogen Sulfide (H2S), Sulfur Dioxide (SO2) and Carbon Monoxide (CO) were below detection limits (<0.1ppm, <0.1ppm, and <1ppm respectively). In addition, six (6) grab samples were collected in Tedlar bags during this timeframe at various locations in Richmond, California and were sent to Air Toxics Ltd Laboratory for analysis of sulfur compounds and hydrocarbons. Consistent with the above-referenced findings, all results from these samples were well below the OEHHA Reference Exposure Levels and Cal/OSHA Permissible Exposure Limits. Please note, however, that the laboratory detection limit for Acrolein is higher than the OEHHA Reference Exposure Limit.

c) Fence-line monitoring: Continuous monitoring data is gathered around the clock from instrumentation located at Chevron's Office Hill, Castro Street and Gertrude Street monitoring stations. A data point, close to or prior to the incident, is employed as a reference. The following maximum readings were recorded between the times the fire ignited and the time all-clear was called by CCHMP (between 6:30 PM and 11:31 PM on August 6, 2012). As reflected in the table below, none of the maximum readings exceeded Cal/OSHA's Permissible Exposure Limits (PELs).

Permissible Exposure Limits (PELs). Maximum Concentration Readings

	Cal/OSHA PEL	Castro Street	Office Hill	Gertrude Street
H2S (ppb) Background at 3:00 PM	10,000 ppb	3.04 ppb	3.99 ppb	2.09 ppb
H2S (ppb) Max.	10,000 ppb	3.27 ppb	5.41 ppb	2.51 ppb
SO2 (ppm) Background at 3:00 PM	2 ppm	0.006 ppm	0.003 ppm	0.002 ppm
SO2 (ppm) Max.	2 ppm	0.007 ppm	0.006 ppm	0.002 ppm

Note: The Cal/OSHA PEL are concentrations averaged over an 8-hour period.

IX. INCIDENT INVESTIGATION RESULTS:

Following the incident, Chevron U.S.A. Inc. promptly initiated an investigation of the incident using the TapRooT® methodology. The investigation is now complete. The investigation was conducted by a team that included external scientific and engineering experts, members of the Unites Steelworkers Union, and the company's technical experts. The team gathered and reviewed historic information and data, interviewed relevant personnel, visually inspected the damaged portions of the No. 4 Crude Unit ("Crude Unit") where the incident occurred, collected samples, and observed testing of the failed pipe section performed by Anamet Inc. ("Anamet"), an independent laboratory.

The investigation report concludes a failure occurred in a five-foot long piping component of the 8" carbon steel atmospheric gas-oil pipe line from the atmospheric distillation tower (known as the "4-sidecut") in the Crude Unit, resulting in a hydrocarbon leak. Subsequently, a fire erupted in the area of the failure. Consistent with the metallurgy evaluation report on the failed piping component prepared by Anamet, the investigation found that the five-foot carbon steel component where the leak occurred failed due to thinning caused by sulfidation corrosion, which was accelerated by the low-silicon content of the failed component. Individual carbon steel piping components with low-silicon can, and here did, corrode at an accelerated rate not readily detectable by multiple corrosion monitoring locations. A copy of the final investigation report is included with this Update.

X. SUMMARIZE INVESTIGATION RESULTS BELOW OR ATTACH COPY OF REPORT:

The investigation is now complete and the final report included with this Update.

XI. SUMMARIZE PREVENTABLE MEASURES TO BE TAKEN TO PREVENT RECURRENCE INCLUDING MILESTONE AND COMPLETION DATES FOR IMPLEMENTATION

Actions to Address The Investigation Report Findings and Recommendations, and To Prevent Recurrence

In its Fourth Update to the 30-Day Report for the CWS Level 3 Event of August 6, 2012, submitted January 28, 2013, the company summarized the measures the Refinery is implementing to prevent a recurrence of the incident. Chevron U.S.A. is providing CCHS a further update of those measures, and the status of their implementation. In addition to previously sharing these measures with CCHS, the company previewed these actions with Cal/OSHA and the CSB in order to ensure alignment with their understanding of the causes of the incident.

Low-Silicon Carbon Steel and Piping Component Inspections

- The Refinery has inspected every piping component in the Crude Unit potentially susceptible to sulfidation corrosion. Of the approximately 4,600 piping components inspected, the Refinery replaced four carbon steel piping components that appeared to have higher corrosion rates than other piping components in the system.

- Enhanced inspection programs are being implemented throughout the Refinery, and the Refinery will replace every component found as indicated by the results of these inspections.

Mechanical Integrity Program

- The company is strengthening the Refinery's reliability program for piping and equipment to ensure it covers potential damage mechanisms applicable to those systems. As part of this effort, Chevron U.S.A. has begun implementing an enhanced process for regular damage mechanism reviews for each unit and piping circuit so as to formalize the evaluation of known damage mechanisms, the consequences of a failure, and the safeguards necessary to mitigate failures and other potential risks from those damage mechanisms.

- The Refinery also is reviewing and modifying its Process Hazard Analysis procedures to ensure that known corrosion threats/mechanisms have been appropriately considered.

- The Refinery is implementing an enhanced process to better review, prioritize, and act upon mechanical integrity-related recommendations from internal and external technical experts, including industry standards and alerts, to ensure that the right information gets into the hands of the right people at the right time so the right decisions can be made.

Assessment, Decision-Making, and Oversight

- The Refinery is implementing a process for additional oversight of mechanical integrity-related recommendations, inspection plans, and turnaround work lists.

- The Refinery is reviewing and improving its mechanical integrity training as a way to further support leaders, inspectors, operating groups, and engineers. The company is also making certain that the appropriate technical resources are readily available to assist any evaluation of the fitness of equipment for service.

Leak Response

- The Company has implemented a new protocol for evaluating leaks with simple guidance for making sometimes necessary rapid decisions around leak response and further enhancing situational awareness skills. The Refinery recently shared its new leak response protocol with CCHS, Cal/OSHA, and the CSB, as well as other refineries and industrial facilities in Contra Costa County.

Process Safety Focus

- The Refinery is reemphasizing our expectations around process safety and the responsibility of all personnel for process safety performance, including the importance of incorporating process safety into decision-making.

XII. ADDITIONAL INFORMATION. DETAILED EVENT TIMELINE, CORRESPONDENCE, RELEVANT HISTORY OF INCIDENTS WITH SIMILAR EQUIPMENT OR PROCEDURES:

The detailed event timeline is included in the final investigation report, which is included with this Update.

Richmond Refinery 4 Crude Unit Incident

August 6, 2012

Prepared by the CUSA Richmond Investigation Team

April 12, 2013

Event Title: Richmond Refinery 4 Crude Unit Leak and Fire

IMPACT ERM Record Number(s): #43094

PSM Related Event: Yes | **PSM Related Near Miss: No**

RISO MCAR Event: Yes | **RISO MCAR Near Miss: No**

Contents

List of Figures

Glossary

Term	Description
4CU	4 Crude Unit
4SC	4 sidecut
ABCR	Atmospheric Bottom Circulating Reflux – drawn off the light gas oil collection tray – plays an important role in heat balance of the Atmospheric Distillation Column
AOA	Alarm Objective Analysis
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	ASTM International, an organization that develops and distributes international consensus technical standards
CBO	Control Board Operator
CCHS	Contra Costa Health Services
CFD	CUSA Fire Department
CFR	Code of Federal Regulations
CML	Corrosion Monitoring Location – also known as Thickness Monitoring Location (TML) – locations where inspection is periodically conducted
COA	Control Objectives Analysis
Condition Manager	Meridium's database of CML measurements
CSB	U.S. Chemical Safety and Hazard Investigation Board
CUSA	Chevron U.S.A. Inc.
CWS	Community Warning System
Distillation	Process to separate a mixture into its component parts by boiling point
EPA	U.S. Environmental Protection Agency
ETC	Energy Technology Company
Flag Thickness	A wall thickness value used for triggering the need for quantitative minimum thickness and half-life assessment
HO	Head Operator
LGO	Light Gas Oil
MCC	Motor Control Center
Meridium	Inspection management software tool
MSDS	Material Safety Data Sheet

Term	Description
OA	Operations Assistant – an exempt position outside of the chain of command between refinery management and the Head Operator and Operators
PHA	Process Hazard Analysis
PO	Plant Operator
PPE	Personal Protective Equipment
PSM	Process Safety Management
RBI	Risk Based Inspection
Reflux	Portion of the overhead liquid product from a Distillation Column that is returned to the Column to cool and condense vapors in the Column
ROI/IPR	Reliability Opportunity Identification/Intensive Process Review – reliability study that seeks to identify opportunities for improvement in the plant being reviewed
RP	Recommended Practice
RSC	Reliability Steering Committee
RSL	Refinery Shift Leader
RT	Radiographic Testing – inspection technique used for non-destructively measuring wall thickness
SC	Sidecut
SCBA	Self-Contained Breathing Apparatus
Si	Silicon
sRCM	streamlined Reliability Centered Maintenance – reliability study used to identify equipment criticality, failure modes, and strategies for maintaining the equipment
STL	Shift Team Leader – Richmond Refinery operations first line supervisor
TML	Thickness Monitoring Location (see CML)
UT	Ultrasonic Testing – inspection technique used for non-destructive measuring wall thickness

Executive Summary

On August 6, 2012 at approximately 1548 hours, a leak was discovered by an operator in an 8-inch diameter pipe carrying light gas oil (LGO) in the 4 Crude Unit (4CU) at the Chevron U.S.A. Inc. (CUSA) Refinery in Richmond, California (Refinery). At approximately 1830 hours, the hydrocarbon release from the pipe resulted in the formation of a white cloud, a subsequent fire, and a black smoke plume (collectively, the Incident). A shelter-in-place order was issued for the cities of Richmond, San Pablo, and North Richmond, which advised residents to remain indoors until the fire was controlled. The CUSA Fire Department (CFD), with assistance from Petrochemical Mutual Aid Organization and Municipal Mutual Aid, brought the fire under control and the shelter-in-place was lifted at 2312 hours on the same day. Six responders were treated for first aid injuries and the 4CU and a cooling tower sustained damage.

Immediately after the Incident, CUSA's management formed an investigation team, consisting of CUSA employees and technical consultants (Investigation Team). On August 7, 2012, the Investigation Team met on-site and began its investigation, which included gathering historical information and data, interviewing relevant personnel, visually inspecting the damaged portion of the 4CU, collecting samples, and observing testing of the ruptured pipe section at an outside laboratory. The Investigation Team also performed literature and standards reviews, analytical calculations, computational simulations, and experiments to gather additional information. The Investigation Team performed detailed technical analyses on the gathered information to determine the causes of the Incident.

The Investigation Team concluded that the 4 sidecut (4SC) carbon steel pipe in the 4CU failed due to thinning caused by sulfidation corrosion in a component that had low silicon content. The failed pipe component was part of the 4SC piping circuit with a total length of approximately 215 feet and consisting of 67 components, including fittings, elbows, and straight pipe runs. The Investigation Team determined that the components of the circuit had corroded at varying rates due to the different silicon content of the carbon steel components. The silicon content of the failed component was ten times lower than the adjacent component where corrosion was monitored [corrosion monitoring location (CML) #3].

The Investigation Team identified the following four Causal Factors[1] of the Incident:

1. The response and assessment after the discovery of the leak did not fully recognize the risk of piping rupture and the possibility of auto-ignition.

2. A measurement performed in 2002 showed one-third wall loss in the failed pipe component just downstream of CML #3. This information was only captured as a comment in the inspection management software tool (Meridium) and not elsewhere in the inspection management system. Documenting wall thickness information in a comment without adding it to the inspection management software database (Condition Manager) limited the ability for future decision-makers to utilize the data.

[1] Defined by the TapRooT® analysis method as: "A mistake or failure that, if corrected, could have prevented the incident from occurring or would have significantly mitigated its consequences."

3. Relevant information regarding carbon steel sulfidation corrosion—including the understanding that components with low silicon content are especially susceptible to sulfidation corrosion and the recommendation to perform 100% component-by-component inspection—was not transferred to the refinery inspection management system. The 2009 Reliability Opportunity Identification/Intensive Process Review (ROI/IPR) did not identify the need for 100% component-by-component inspection.

4. Inspection during the 2011 Turnaround did not include every component in the 4SC piping because the recommendation to identify and inspect every component was not built into the inspection plans for the 4CU. A 100% component-by-component inspection would have required the inspection of the pipe component that failed in August 2012, which could have alerted the Refinery to the component's accelerated metal loss.

The Investigation Team makes the following recommendations to prevent future recurrences of these Causal Factors:

1. Revise Refinery policies and checklists to ensure appropriate information—including Process Safety and Inspection information—is considered when evaluating leaks and addressing the issue of whether to shut down or continue operation of equipment.

2. Enhance the Refinery's Mechanical Integrity program to ensure the Refinery properly identifies and monitors piping circuits for appropriate damage mechanisms using a standardized methodology and documentation system.

3. Implement certain improvements concerning inspector training and competency, oversight of mechanical integrity, inspection plans and escalation procedures. Develop and implement a process to review and act upon mechanical integrity-related recommendations from industry alerts, ETC and other subject-matter experts. Inspect 4CU piping that falls under the ETC Sulfidation Inspection Guidelines criteria for sulfidation corrosion prior to restarting the 4CU, and implement the ETC Sulfidation Inspection Guidelines for the remainder of the Refinery.

4. Ensure relevant technical studies and inspection data are considered for the Refinery's equipment reliability plans and incorporated into the ROI/IPR process.

The Investigation Team also identified six Additional Considerations.[2]

The findings presented in this report are made to a reasonable degree of scientific and engineering certainty based on the information possessed by the Investigation Team as of the date of this report.

---

[2] A mistake or failure that contributed to the incident, but that did not rise to the level of a Causal Factor.

1. Introduction

On August 6, 2012 at approximately 1548 hours, a leak was discovered by an operator in an 8-inch diameter pipe carrying light gas oil (LGO) in the 4 Crude Unit (4CU) at the Chevron U.S.A. Inc. (CUSA) Refinery in Richmond, California (Refinery). At approximately 1830 hours, the hydrocarbon release from the pipe resulted in the formation of a white cloud, a subsequent fire, and a black smoke plume (collectively, the Incident). A shelter-in-place order was issued for the cities of Richmond, San Pablo, and North Richmond, which advised residents to remain indoors until the fire was controlled. The CUSA Fire Department (CFD), with assistance from Petrochemical Mutual Aid Organization and Municipal Mutual Aid, brought the fire under control and the shelter-in-place was lifted at 2312 hours on the same day. Six responders were treated for first-aid injuries (Appendix 1). The 4CU and a cooling tower sustained damage. The general location of the Incident is shown in Figure 1.

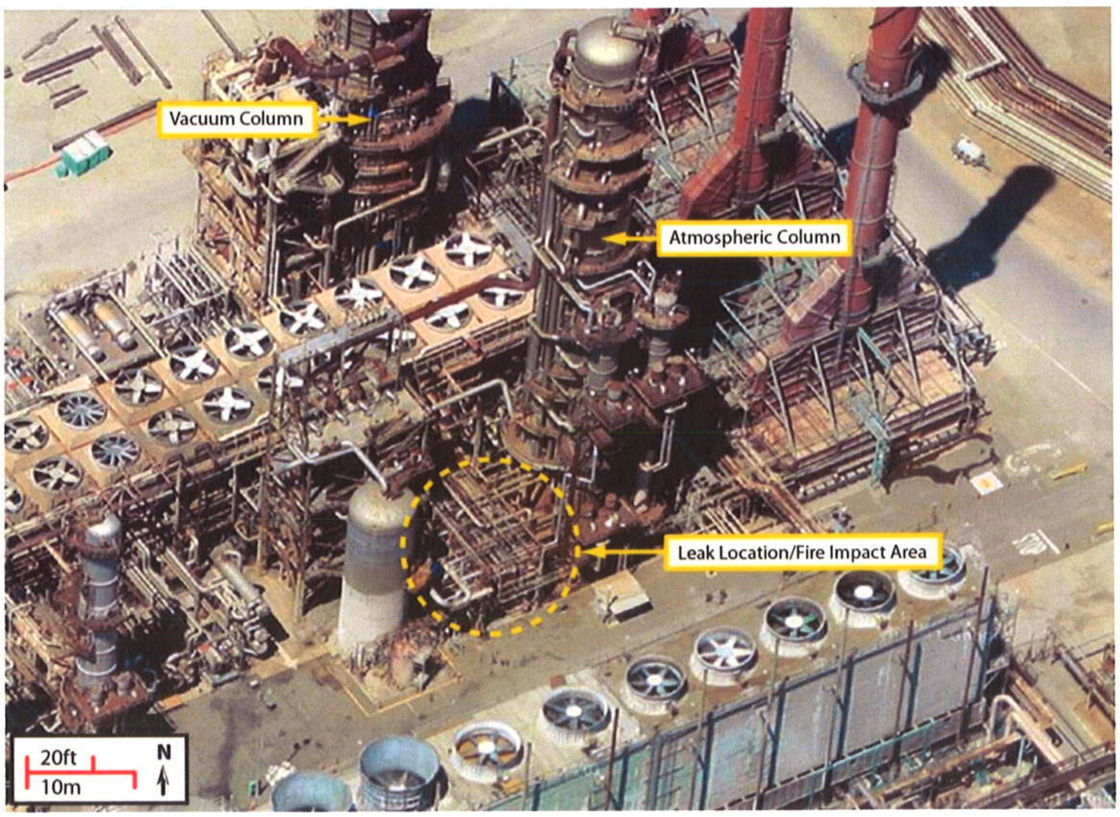


Figure 1. Overhead view of the 4CU prior to the Incident with the location of the rupture circled in yellow (image from Google Maps®).

CUSA formed an investigation team of selected CUSA personnel, both from the Richmond Refinery and elsewhere in the corporation, and outside technical consultants to investigate the Incident (Investigation Team). The charter of the Investigation Team was to establish a timeline of the events leading to the Incident until the Community Warning System (CWS) was activated, to determine the causes of the Incident and make recommendations to prevent a recurrence. The Investigation Team met on August 7, 2012 and began the investigation. The Investigation Team immediately began gathering historical information and data, interviewing relevant personnel, and collecting samples.

Numerous federal, state, and local government agencies also responded to the Incident, including the U.S. Chemical Safety and Hazard Investigation Board (CSB), U.S. Environmental Protection Agency (EPA), California Department of Industrial Relations-Division of Occupational Safety and Health (Cal/OSHA), Bay Area Air Quality Management District, and Contra Costa Health Services (CCHS). Following the fire, Cal/OSHA issued a preservation order and an order prohibiting use related to the immediate fire-damaged area of the 4CU due to concerns over the integrity of various overhead structures. In addition, the CSB and Cal/OSHA requested that all evidence be preserved in its as-found condition. An agreed upon third-party consultant (BakerRisk) assisted with evidence collection, documentation, and storage. After the Investigation Team and other interested parties visually inspected the ruptured 4SC pipe, it was removed and taken into evidence by BakerRisk and transported to Anamet, Inc. (Anamet), an outside laboratory in Hayward, California for subsequent testing and analysis, which the Investigation Team observed.

The Investigation Team also performed literature and standards reviews, analytical calculations, computational simulations, and experiments to gather additional information. The Investigation Team performed detailed technical analyses on the gathered information to determine the causes of the Incident. In performing the analyses, the Investigation Team employed various techniques based on the scientific method, including the TapRooT® root cause analysis method, which is a structured technique that facilitates the identification of Causal Factors and Additional Considerations, all of which are identified in the body of the report and discussed in more detail in Section 6 and Section □.

This report summarizes the findings and recommendations of the Investigation Team. The purpose of these findings and recommendations is to assist CUSA in understanding the causes of the Incident to prevent a recurrence. The consideration of off-site impacts was beyond the scope of this investigation.[3]

1.1 4CU Process Description and 4SC Design

The 4CU distills crude oil to produce various product streams (sidecuts or SCs), atmospheric overheads, and vacuum residuum. The crude oil is heated, desalted and split into different product streams, which then are sent to intermediate storage tanks or to downstream processing units as feed.

The 4CU was put into service in 1976. All crude oil processed in the Refinery passes through the 4CU, which has two distillation columns: (1) the Atmospheric Distillation Column (C-

[3] *See* the sixth "Update to the 30 Day Follow-Up Notification Report Form" for the CWS Level 3 Event of August 6, 2012, dated March 29, 2013.

1100), which is fed with heated crude oil; and (2) the Vacuum Column, which is fed with the heated bottoms stream from the C-1100. Figure 2 shows a simplified flow diagram for the 4CU.

The 4SC and the Atmospheric Bottom Circulating Reflux (ABCR) are drawn via a 20-inch nozzle from the C-1100 (Figure 3). The piping branches to a 12-inch ABCR pipe and a separate 8-inch 4SC pipe. Post-Incident inspection showed that there were 67 components, including straight pipe and fittings (elbows, tees, flanges, etc.) in the 4SC piping between the piping branch and the 4SC stripper pumps.

All of the 4SC and the ABCR piping was specified as carbon steel piping with Schedule 40 thickness for sizes 6-inch to 16-inch. In the past, the industry followed carbon steel piping specifications in ASTM International (ASTM) A53, which did not include minimum silicon content.

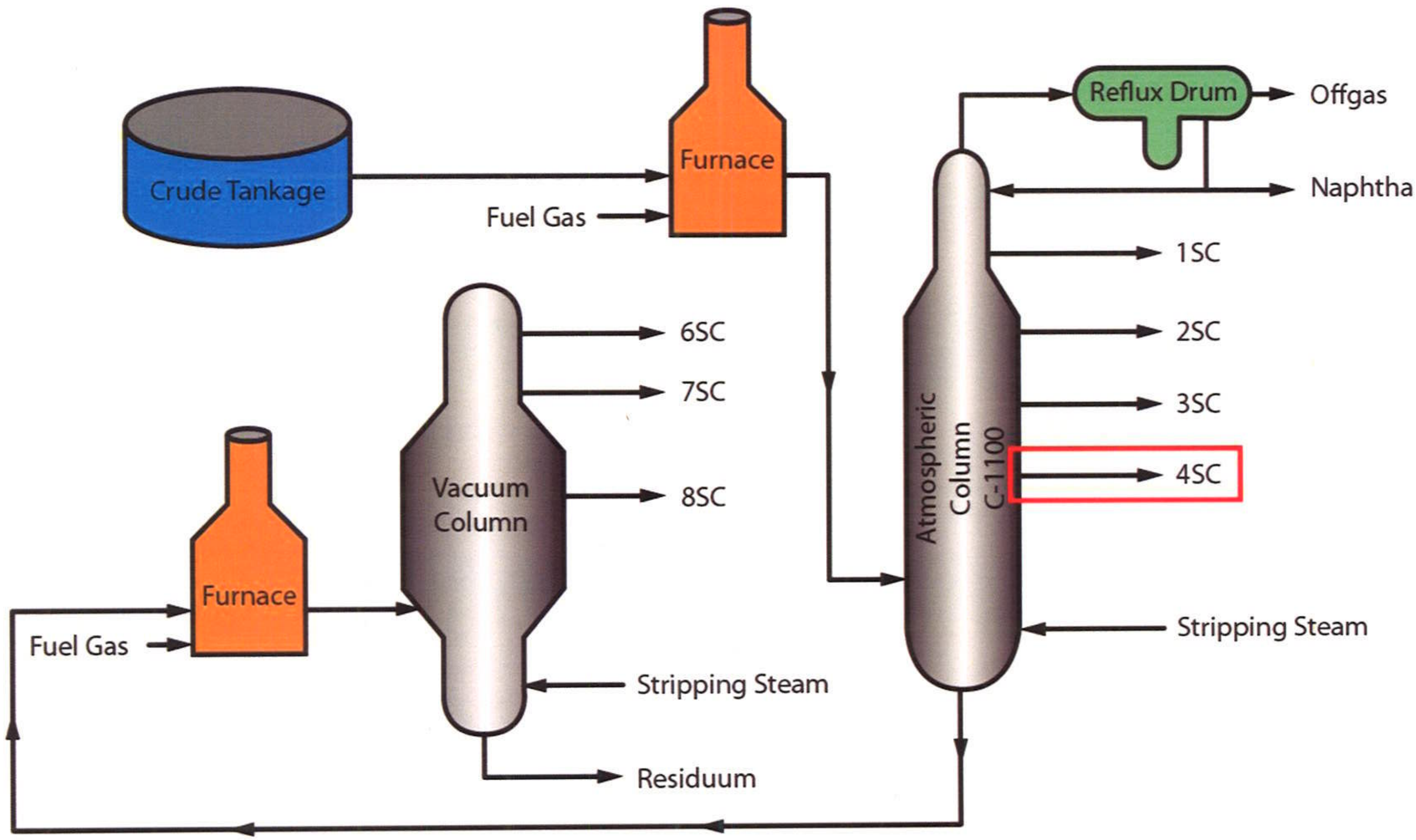


Figure 2. Simplified 4CU flow diagram. The failure occurred in the 4SC piping of the C-1100 (marked in red).

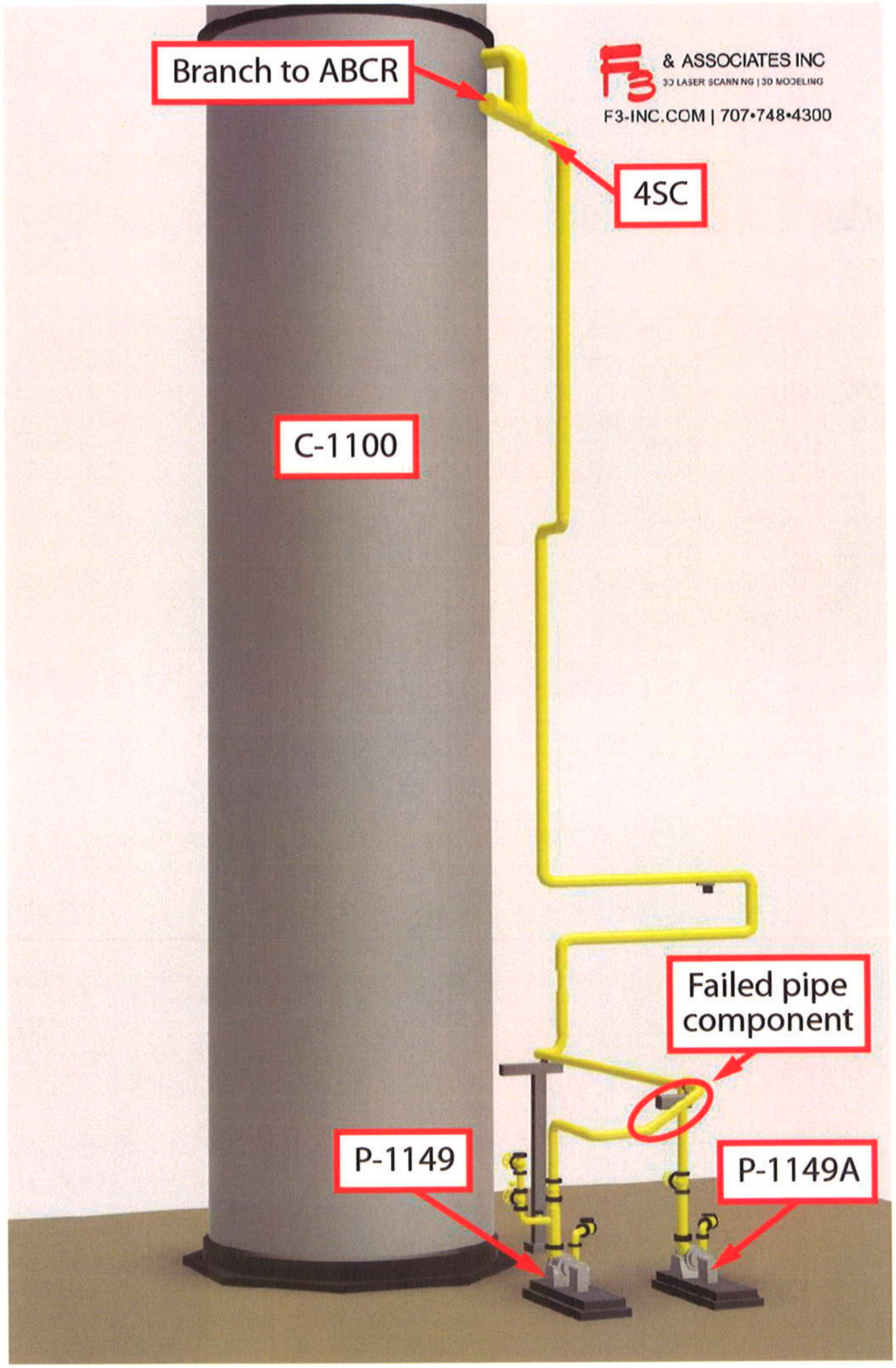


Figure 3. Three-dimensional model showing the 4SC and the ABCR drawn via a 20-inch nozzle from the C-1100. Note: the ABCR piping is not shown beyond the initial branch.

2. Incident Summary

This section provides an overview of the Incident and the response. A detailed timeline of events is attached as Appendix 2. The Incident began with the development of a small leak on the 4SC stream emanating from the C-1100. This initial, small leak was detected by a Plant Operator (PO1) at approximately 1548 hours on August 6, 2012. Prior to this time, the 4CU was in stable condition and running at approximately 250,000 barrels of feed per day.

2.1 Response to the Leak

At 1548 hours, the PO1 notified the Head Operator (HO1) and together they reportedly determined that the leak was coming from the insulated 8-inch suction piping to the 4SC stripper pump (P-1149) and its spare (P-1149A).[4] Figure 4 shows the relevant portion of the 4SC piping after the leak was discovered. The exact location of the leak was not visible due to the insulation and weather jacketing on the piping. When the leak was first discovered, the leak rate was estimated at 20-40 drips per minute.

The Shift Team Leader (STL1) was notified at 1553 hours and went to the 4CU. At 1602 hours, the CFD was also called and went to the 4CU with two monitor trucks and Engine Foam 60. Upon arrival, CFD personnel performed gas testing and determined that the atmosphere around the leak was not flammable based upon a Lower Explosive Limit (LEL) reading of 2%. CFD personnel completed a Scene Safety and Action Plan form, but they did not complete a Hazard Material Data Sheet for this leak as directed by the Scene Safety and Action Plan form. Based upon the perception that they were responding to a minor leak, CFD personnel positioned Engine Foam 60 close to the cooling tower. Responding CFD personnel did not consider the risk of pipe rupture or fire in the area when they positioned Engine Foam 60.

<u>Additional Consideration 1</u>: **The CFD did not complete a Hazard Material Data Sheet and positioned Engine Foam 60 too close to the leak source when responding to the Incident.**

At 1619 hours, Operations personnel reportedly confirmed that the leaking section of the 4SC could not be isolated on the upstream side.

<u>Additional Consideration 2</u>: **The leaking line could not be isolated on the upstream side to mitigate loss of containment.**

[4] Pumps P-1149 and P-1149A together are referred to as P-1149/A in this report.

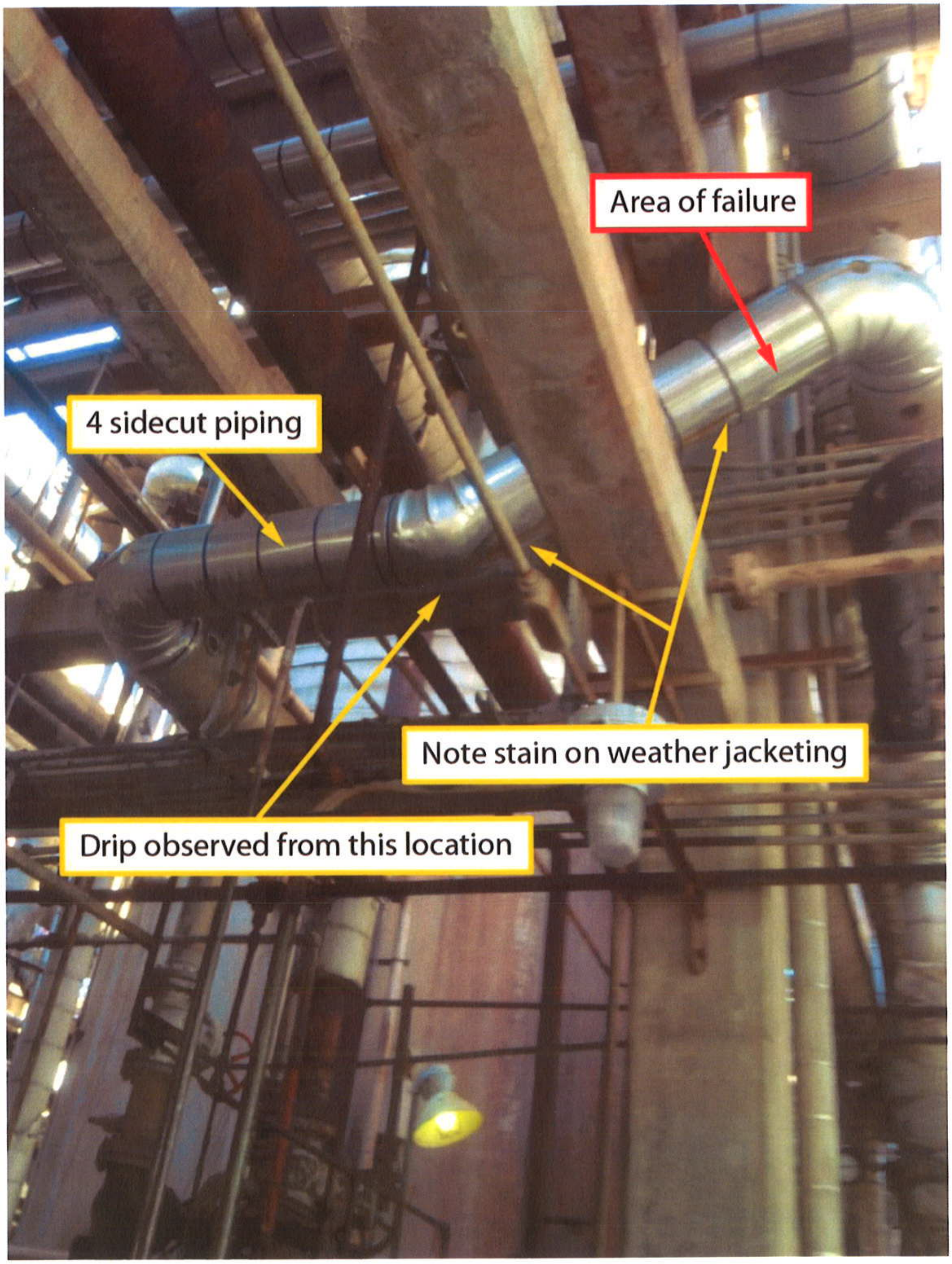


Figure 4. Photograph taken by STL2 during the initial response to the leak, but before the pipe rupture. The area where the rupture subsequently occurred (indicated by a red arrow) is approximately 16 feet from the ground.

2.2 Options to Address the Leak

Operations personnel consulted Maintenance, Reliability (Inspection), and Process Engineering personnel to assess options for addressing the leak. Because isolating the leak from the C-1100 was not possible, the assembled Operations and Operations Management personnel considered three options for addressing the leak: online repair potentially involving an engineered clamp, a routine shutdown, and an emergency shutdown. To further assess the online repair option, it was concluded that the weather jacketing and piping insulation needed to be removed so the leak could be visually assessed.

In the meantime, due to the inability to isolate the leak and the uncertainty about the option for online repair, Operations personnel directed a routine shutdown of the 4CU. At 1609 hours, the Control Board Operator (CBO) began reducing the 4CU feed rate per No. 4CU Shutdown procedure 4CUXN3000.[5]

Field personnel (Operations and the CFD) attempted to remove the insulation, starting downstream of the stained weather jacketing (Figure 5: top). From the ground, they attempted to grab onto and pull down the bands of the aluminum weather jacketing along the horizontal section of the pipe using a 10-foot fiberglass pike pole. However, due to the location and elevation of the horizontal section of pipe, approximately 13 feet above grade, this attempt was unsuccessful. The HO1, STL1, Battalion Chief (BC1), Operations Assistant (OA), and Section Head (SH) then developed a plan to remove the insulation, which involved erecting scaffolding below the leaking pipe to allow better access. This plan was communicated separately to both the Refinery Shift Leader (RSL) and to the acting Operations Manager sometime between 1630 to 1700 hours.

After addressing specific staging requirements—such as two points of egress—the scaffold contractor completed a hazard assessment form, which included personal protective equipment (PPE) requirements. In addition, the requirements for CFD monitoring and backup during the work were discussed before the scaffold builders began their work. Planning and erection of the scaffolding reportedly took approximately one hour to accomplish.

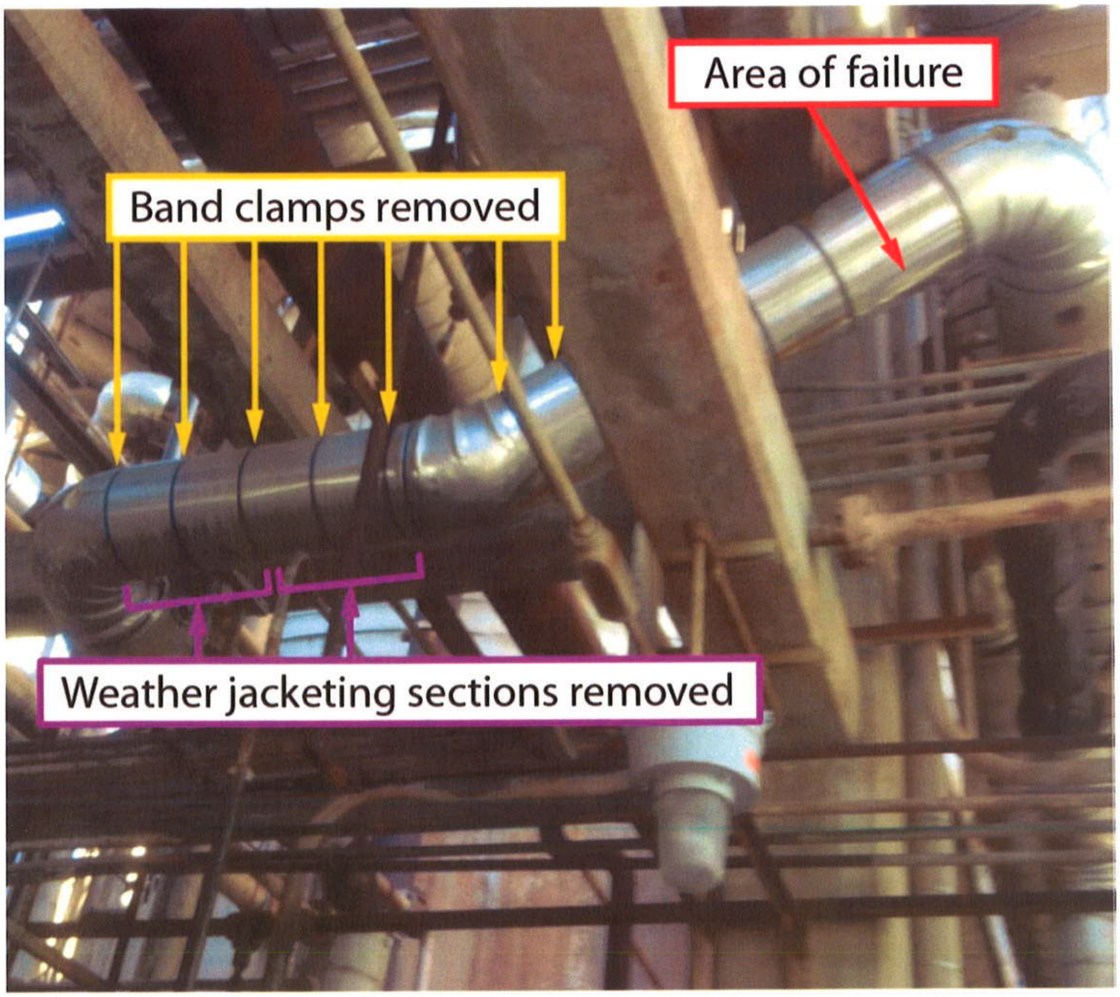
While the scaffolding was being erected, CFD and Operations personnel developed a plan for removing the weather jacketing and insulation from the leaking pipe. The plan called for two firefighters to climb the scaffold and use hand tools to first remove the weather jacketing and then the underlying insulation. Figure 5 (top) shows the band clamps that were cut with pliers, the area where the weather jacketing was removed, and the location of the failed pipe component.

As a standard precaution against a flash fire resulting from exposing oil-soaked insulation to the air, the insulation removal team wore full PPE (e.g. turnouts, self-contained breathing apparatus [SCBA], etc.) and two 1½-inch hose teams were on standby. Firefighters also performed

[5] A routine shutdown of the 4CU involves feed rate reductions of approximately 5,000 barrels per day every 30 minutes, with proportionate reductions in the sidecut draw rates. After a feed rate of 110,000 barrels per day is reached, the furnace temperatures and C-1100 overhead pressure are reduced. Vessels and lines are flushed with wash oil, water washed, and then steamed out. A routine shutdown of the 4CU takes roughly three days.

continuous air monitoring of the area to confirm that conditions did not change. While Operations understood that the 4SC stream was near its auto-ignition temperature, some CFD personnel thought the temperature of the 4SC stream was near or below its flash point.[6]

[6] The material safety data sheet (MSDS) for LGO indicates a flash point of less than 200°F and an auto-ignition temperature of 640°F. A thermocouple upstream of the failure location indicated temperatures between 614°F and 630°F during the period between initial discovery and escalation of the leak.



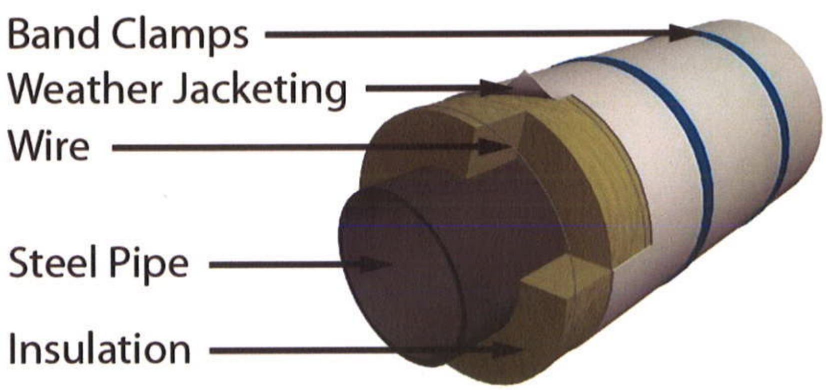


Figure 5. The steel pipe was encapsulated by insulation held in place by wire, which was covered by aluminum weather jacketing held in place with band clamps (bottom). The firefighters cut several band clamps (marked with yellow arrows) with pliers and removed two sections of the weather jacketing from the piping (marked with purple brackets).

During the erection of the scaffolding, multiple field turnovers were performed at approximately 1700 hours between the outgoing and oncoming Operations and CFD crews. Most of the dayshift personnel remained to assist if needed. Due to the shift change, personnel from the oncoming crews supported and performed the insulation removal tasks. There was not a single meeting where all parties could collectively consider the potential risks and outcomes. In addition, with the benefit of hindsight, the lack of full recognition of the risk of piping rupture led to a large number of personnel being present at the Incident location.

Causal Factor 1: The response and assessment after the discovery of the leak did not fully recognize the risk of piping rupture and the possibility of auto-ignition.

2.3 Initial Flash Fire

Two firefighters reportedly cut the bands holding the weather jacketing in place on the horizontal piping and the first two bands on the sloping pipe above the elbow (Figure 5: top). They then began to remove the weather jacketing on the horizontal portion of the pipe.

When the second sheet of weather jacketing was removed, a small flash fire ignited at 1822 hours. This fire was quickly extinguished by the supporting hose teams. In response to the flash fire, the firefighters descended the scaffolding, leaving the oil-soaked insulation in place.[7] These firefighters were then instructed to set up and start a portable monitor (Blitz) for additional firewater coverage.

CFD hose teams maintained a stream of water on the piping insulation that had ignited, switching from power cone to straight stream nozzle patterns in order to knock away the oil-soaked insulation from the piping where the weather jacketing had been removed. After briefly shutting the water off to assess the insulation removal, the firefighters observed that the volume of material from the leak was increasing and that the released material was beginning to smoke.

At this point (1827 hours), the HO2 gave the order for an emergency shutdown of the 4CU and supporting field personnel began to move out of the area. A radio transmission instructed the CBO to "start making preparations to bring this plant down." Additionally, at 1828 hours, the RSL was informed that the 4CU was being shut down. At 1829 hours, the CBO activated the hand switches for an emergency shutdown of the 4CU.

2.4 White Cloud and Fire

At approximately 1830 hours, the leak rapidly worsened, as confirmed by a radio transmission and video footage (Figure 6). As a result, a large white cloud formed and quickly enveloped the 4CU and downwind processing plants. Consequently, the CFD hose teams shut off the hose nozzles and withdrew from the area. Water application via the portable Blitz monitor continued and water flow from Engine Foam 60's deck monitor was activated and directed toward the general area of the leak.

[7] As shown in Figure 5, wire was used to hold the insulation in place during its installation and remained after the weather jacketing was removed on the day of the Incident. The wire would need to be cut to fully remove the insulation.

A fire ignited approximately 2 minutes and 30 seconds after the leak escalated, resulting in the formation of a black smoke plume[8] (Figure 6: bottom). Multiple personnel told the Investigation Team that they saw flames originating near the location of the ruptured pipe component. At the time the fire ignited, the weather conditions were clear, with the temperature recorded at 75°F and 11.5 mph winds coming out of the southeast (134°).

Following ignition, witnesses in the vicinity reported hearing several "popping" sounds at the location of the Incident. The Investigation Team cannot be certain of the cause of the sounds, but likely possibilities include: the lifting of one or more pressure safety valves; the rupture of fire-impacted piping; the rupture of a gas cylinder; the rupture of tires from Engine Foam 60; or arcing in the Motor Control Center (MCC).

After the fire was brought under control at 2215 hours on August 6, 2012, CUSA's Emergency Services Manager recommended to CCHS that it cancel the shelter-in-place order and deactivate the Warning Sirens. CCHS lifted the shelter-in-place order at 2312 hours that day.

[8] CUSA has reported separately on the black smoke plume in the sixth "Update to the 30 Day Follow-Up Notification Report Form" for CCHS (Appendix 1).

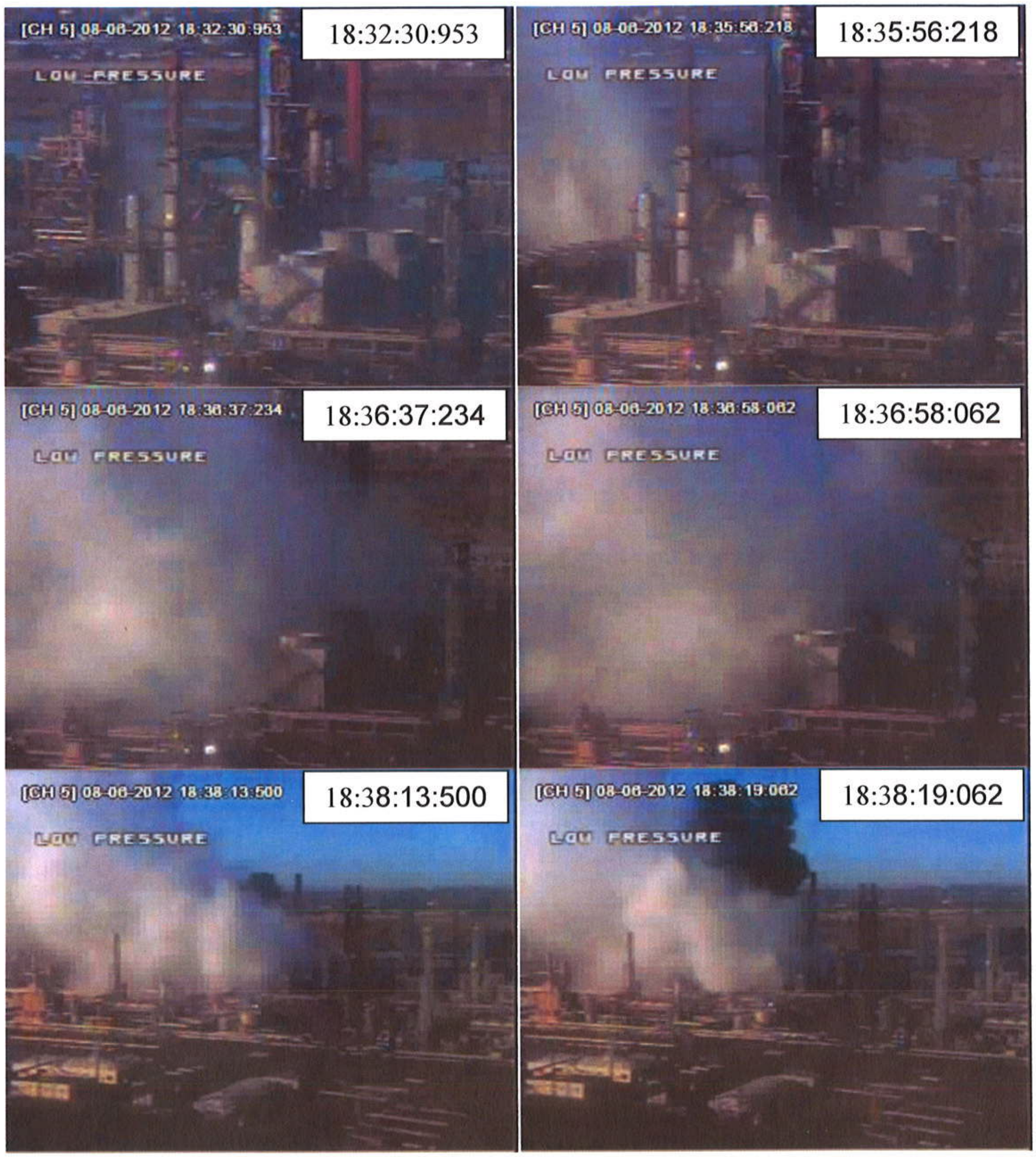


Figure 6. CUSA surveillance camera showing the 4CU (top left). A white cloud is shown forming (top-right and middle-right/left) for approximately 2 minutes and 30 seconds after the leak escalated and before the fire ignited (bottom, camera had been zoomed out). (The clock in these images is approximately 5-7 minutes ahead of actual time.)

3. Analysis of the Pipe and the White Cloud

The Investigation Team concluded that the 4SC pipe component failed due to thinning caused by sulfidation corrosion that was accelerated by the lower silicon content of the failed pipe component.

This section describes the details of the mechanism of sulfidation corrosion and the factors that affect the rate of sulfidation corrosion. This section also provides a summary of analyses performed by the Investigation Team to evaluate the properties of the ensuing white cloud and a discussion of plausible ignition mechanisms that initiated the fire.

3.1 Sulfidation Corrosion of Carbon Steel

While sulfidation corrosion for a given alloy is generally dependent on the temperature and sulfur content of the product stream, the sulfidation corrosion rate for carbon steel is highly dependent on the steel's silicon content. Carbon steel with a silicon content of less than 0.10 weight percent (wt%) can exhibit higher sulfidation corrosion rates than carbon steel with higher levels of silicon. This can result in wide variations in corrosion rates in a single carbon steel piping system composed of individual components with different silicon contents even if the components are exposed to the same process conditions.[9]

At the time of the Incident, the temperature of the 4SC was around 620°F and the historic data shows that the LGO within the 4SC contained between 0.8 and 1.6 wt% sulfur. Although the operating temperature and sulfur could have increased the corrosion rate of the piping, the historical recorded measurements at the corrosion monitoring locations (CMLs) did not show significant changes in wall thickness until 2002 (see Section 4).

[9] As noted earlier in this report, in the past, the refining industry used carbon steel piping specifications that did not include minimum silicon content (ASTM A53). Since late 2009, CUSA has used specifications that require a minimum silicon content of 0.10 wt% as specified in ASTM A106.

3.2 Evidence of Sulfidation Corrosion in the Ruptured Pipe

The ruptured pipe is shown in Figure 7 and Figure 8.

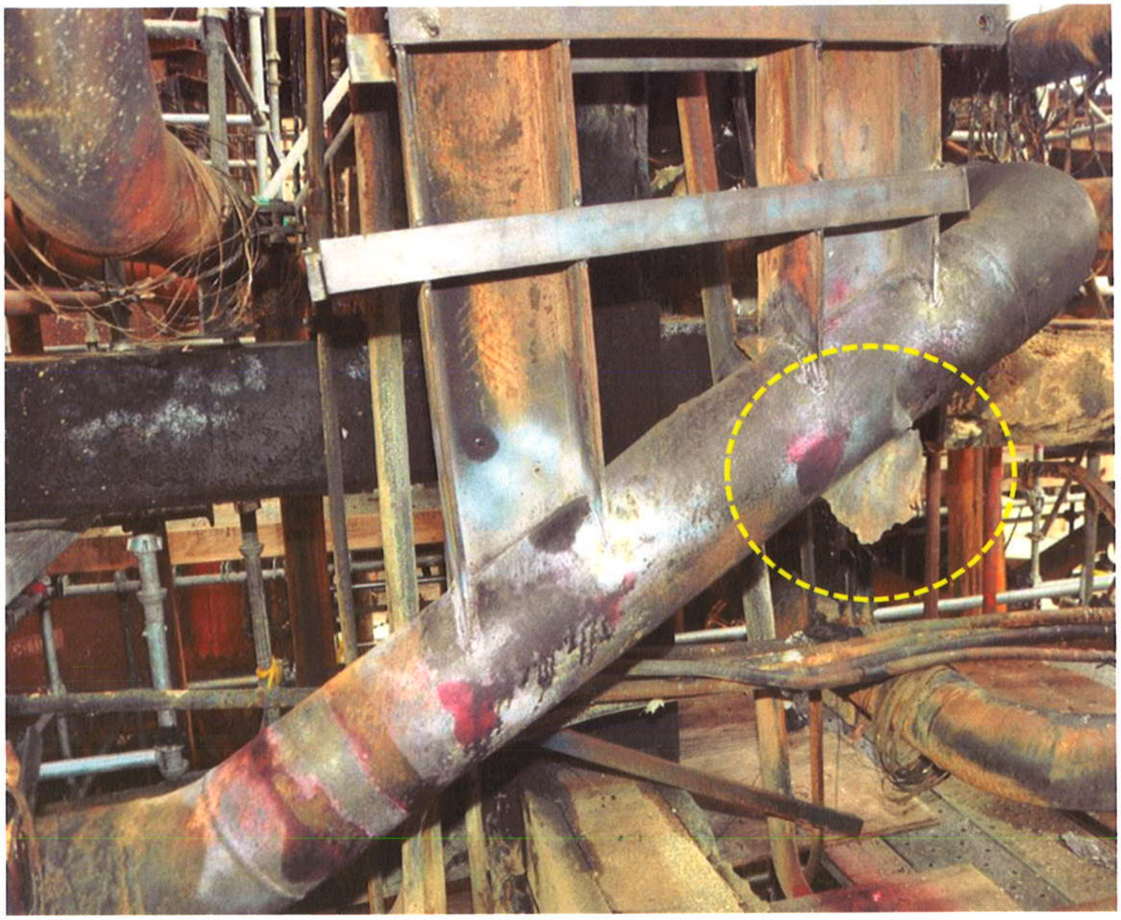


Figure 7. Photograph of the ruptured pipe component during inspection prior to removal. Area of the rupture is circled in yellow. (This photograph shows the same sloped portion of the pipe component shown in Figure 5.)

Figure 8. Close-up photograph of the ruptured pipe component taken during the inspection prior to removal.

During the laboratory analysis at Anamet, thickness measurements were taken on the ruptured pipe component on a grid layout, as shown in Figure 9. Virtually the entire 27-inch circumference and 44-inch length of the ruptured pipe component had thinned to less than 0.10 inches, with only a few readings in the vicinity of the welded pipe guide attachments showing higher values.[10] An ASME Code B31.3[11] analysis conducted by the Investigation Team determined that, in the area where the 4SC pipe ruptured, the minimum wall thickness required for containment is approximately 0.072 inches. The measured wall thicknesses of the ruptured pipe component were less than 0.072 inches (Figure 9).

In addition, many tiny perforations were visible at or near the main fracture surfaces. Several such perforations in one of the metal flaps are shown in Figure 10. It is likely that the source of the initial leak, shown in Figure 4, was these tiny holes, which grew and multiplied during the Incident, causing the leak to worsen. Eventually, cracks or tears linked the perforations,

---

[10] The guides serve as heat sinks, lowering the local temperature of the pipe and, therefore, the rate of corrosion.

[11] *Process Piping: ASME Code for Pressure Piping, B31.* American Society of Mechanical Engineers, ASME B31.3, New York, 2008.

resulting in rupture. The corrosion pattern observed is considered "uniform thinning," and is consistent with sulfidation corrosion.

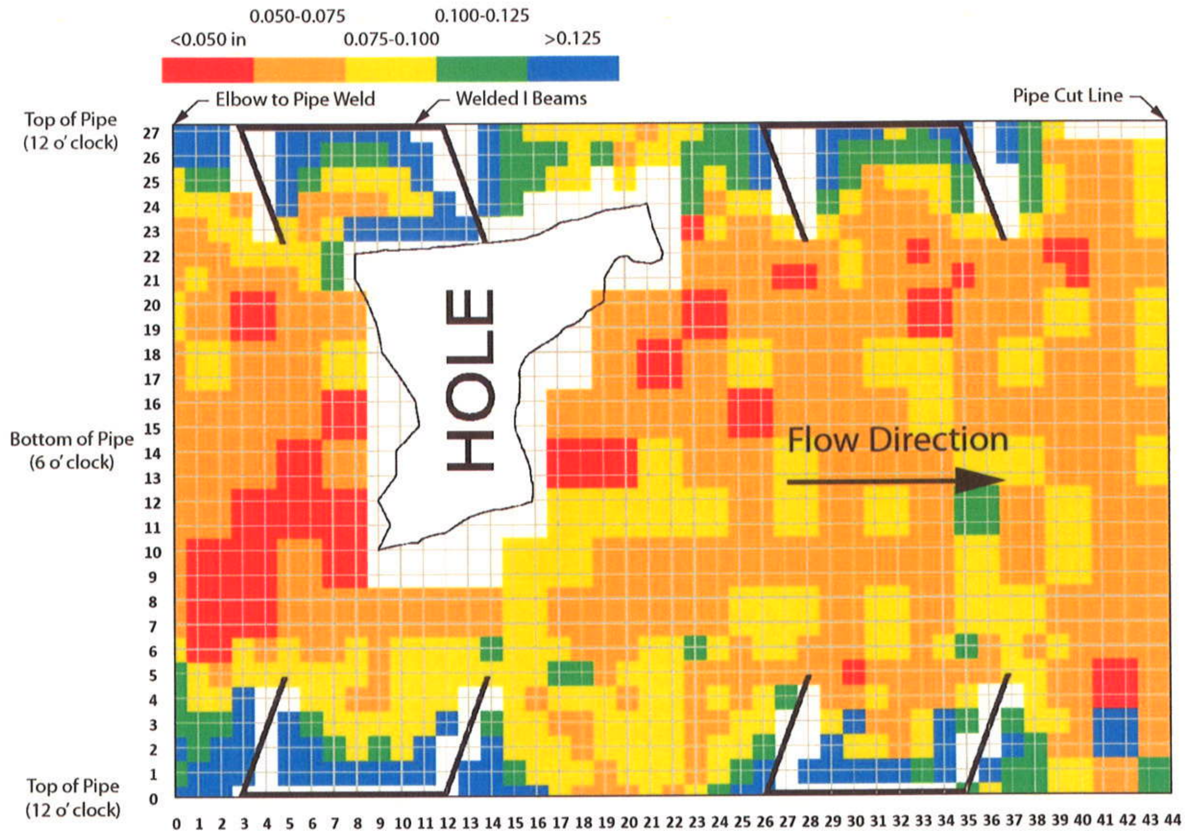


Figure 9. Thickness measurement results from the ruptured pipe component. Virtually the entire 27-inch circumference and 44-inch length of the ruptured pipe component had thinned to less than 0.10 inches, consistent with sulfidation corrosion. The graphic represents the pipe as sliced longitudinally at the top of the pipe (12 o'clock) and rolled out flat. The areas in white could not be measured.

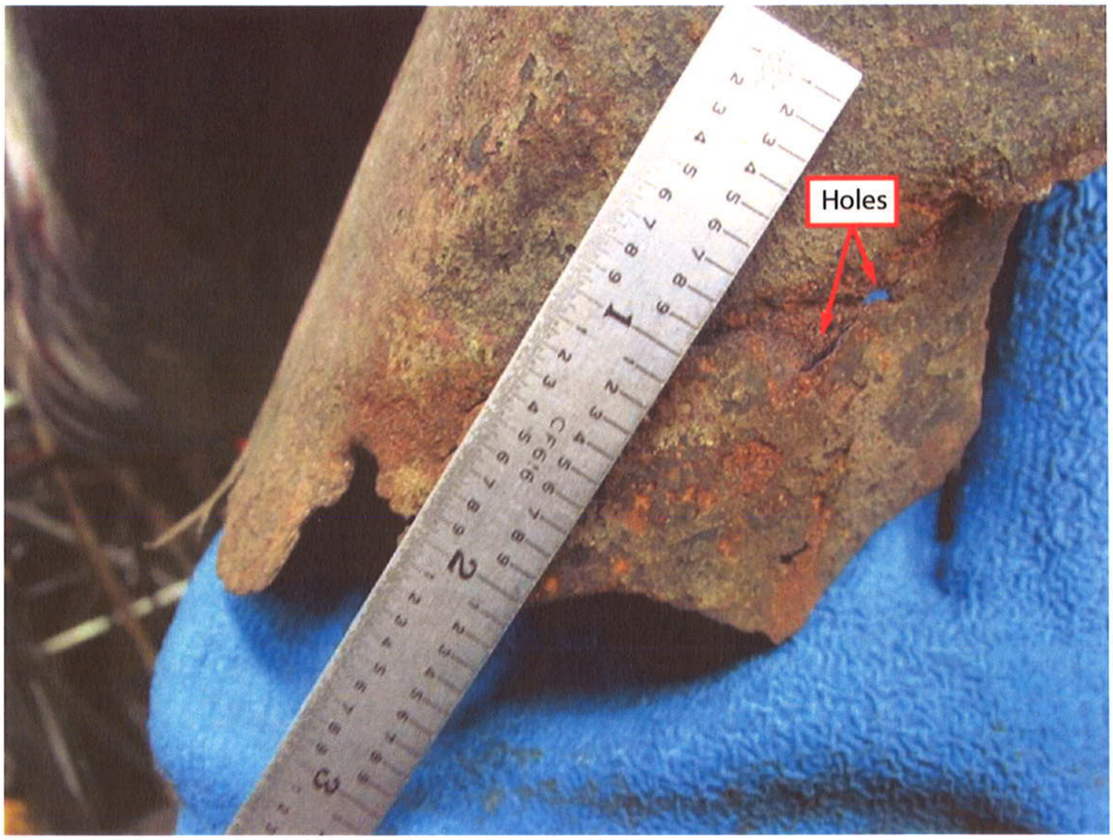


Figure 10. Photograph of one of the metal flaps associated with the 4SC rupture. Small perforations are visible in the flap.

Figure 11 shows a cross section of the ruptured pipe, the adjacent elbow, and the weld between the two. Figure 12 shows the location where the sectioned sample was removed from the ruptured pipe. The ruptured component is clearly thinner than the adjacent elbow. The results of the chemical analysis indicate that the ruptured pipe component had a silicon content of approximately 0.01 wt% and the adjacent elbow had a silicon content of 0.16 wt%. As noted earlier, carbon steel with less than 0.10 wt% silicon content can exhibit higher sulfidation corrosion rates than carbon steel with higher levels of silicon. The impact of these differing corrosion rates is discussed in Section 4.

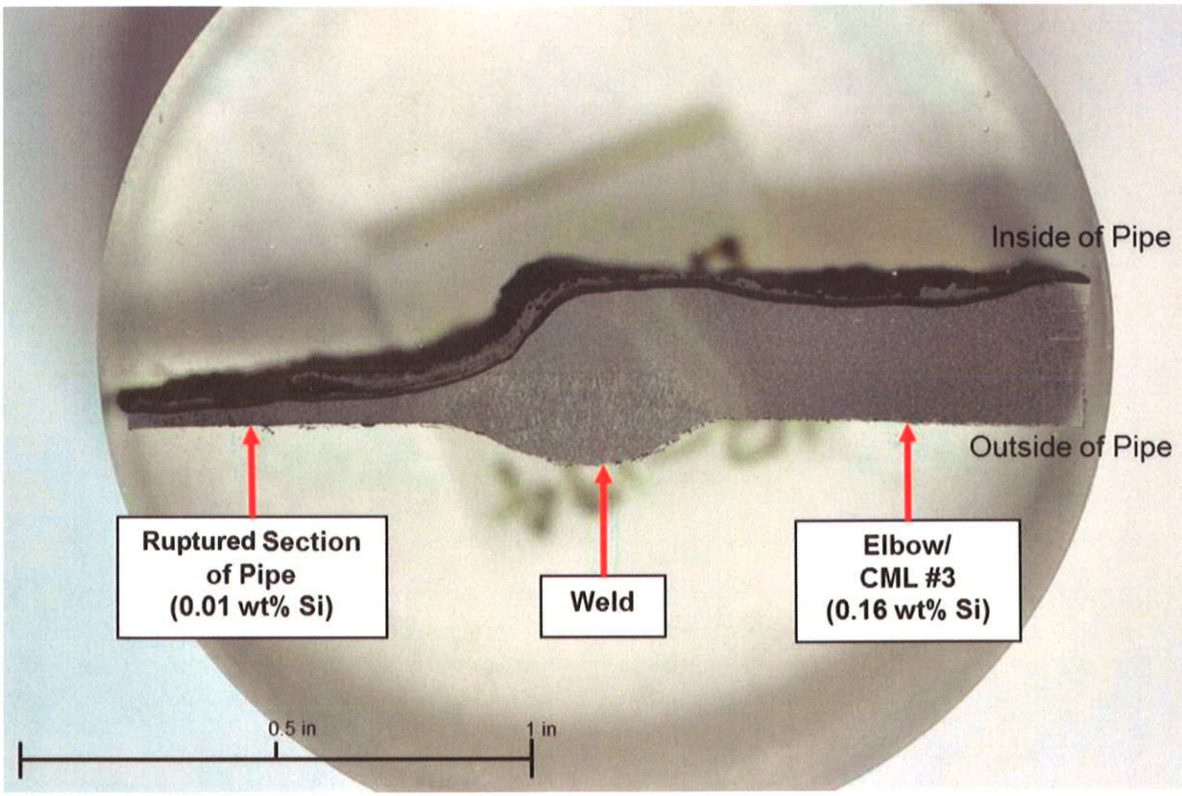


Figure 11. Cross section through the weld of the subject pipe showing thicknesses of the ruptured section (left) and the adjacent elbow, where CML #3 is located.

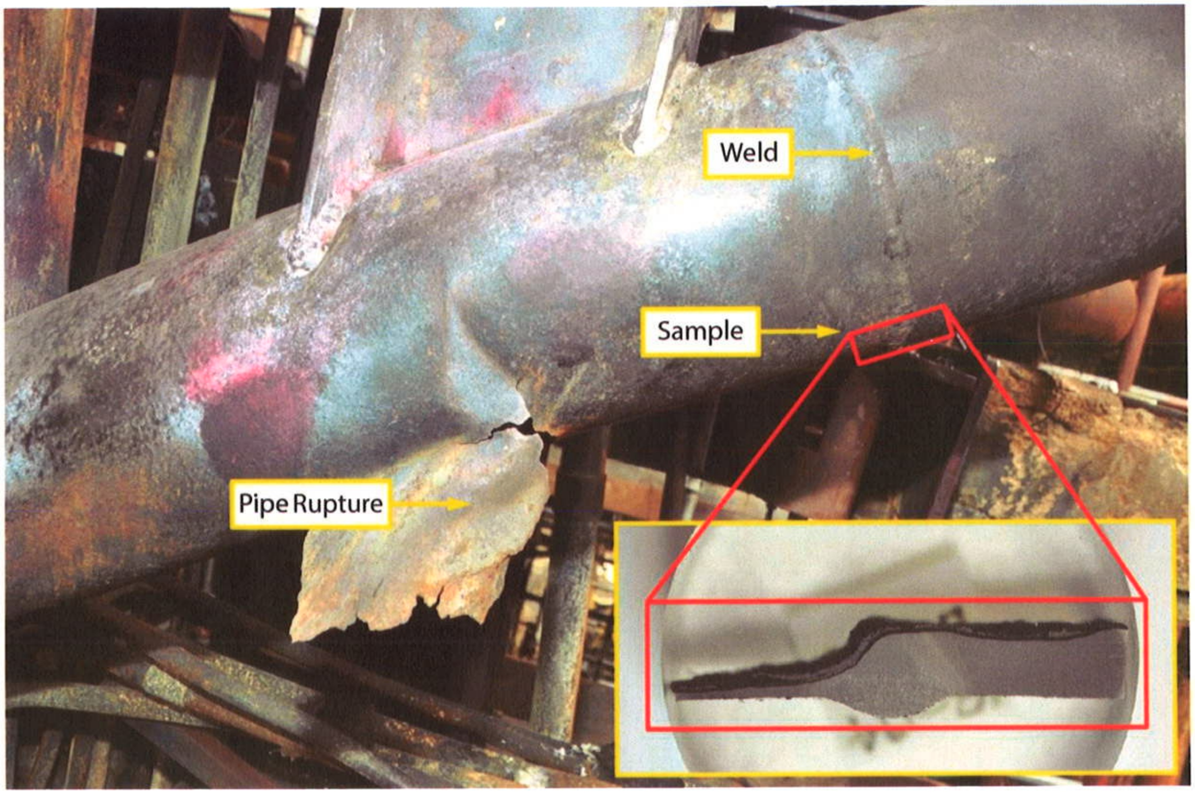


Figure 12. Image showing the location where the sectioned sample was removed from the ruptured pipe component.

Scale samples were scraped from the interior surface of each of the ten pipe components removed from non-failed portions of the 4SC and the ABCR piping systems (five from each system), and analyzed visually, and using X-ray diffraction, X-ray spectroscopy, and metallography. The results showed that all samples primarily contained iron sulfides, while three contained minor phases of iron oxides. The presence of iron sulfides is consistent with sulfidation corrosion. It has also been established that iron sulfides can be converted into oxides in the presence of air and moisture. This could account for the minor oxide phases.

The general thinning and scale measurements indicate sulfidation corrosion. The chemical analysis confirms that the ruptured pipe component corroded faster than surrounding components because of its low silicon content. None of the other data reported by Anamet contradicts this conclusion.

3.3 Leak Escalation

As discussed in Section 2.3, the rate of material flowing from the leak increased during the insulation removal activities. Given the previously identified generalized thinning of the failed pipe component, it is possible that external forces during these activities contributed to the increased leak rate by causing tearing or crack growth within the thinned carbon steel, or the expansion/linking of the small perforations that were already leaking. These external forces may have included: forces applied during weather jacketing removal, forces due to the straight stream firewater contacting the insulation and pipe, or the force from tool impact. Anamet concluded that certain physical evidence suggests that there may have been contact between the tip of a pike pole and the failed piping component. None of the witnesses interviewed by the Investigation Team, however, stated that there was contact with the insulation-covered sloping section of pipe, which includes the area of failure, after the flash fire. One witness recalled that a pike pole was used after the flash fire in an attempt to dislodge insulation from the elbow area, but this location was several feet away from the area where Anamet suggests pike tip impact may have occurred.

3.4 White Cloud Formation and Properties

A large white cloud formed after the rapid escalation of the leak. In order to better understand the potential consequences of the release (e.g., flammability/ignitability) and the impact to those exposed to the white cloud, an analysis of the white cloud was performed. In conducting this analysis, the Investigation Team was purposely conservative in its assumptions (e.g., in estimating the initial flow rate of hydrocarbons at the time of initial cloud formation). These worst case assumptions likely overestimate the amount and concentration of hydrocarbons actually present in the white cloud.

The leak rate at the time of the initial formation of the white cloud was estimated in order to understand the composition, size, flammability properties, and health effects of this cloud. The analysis utilizing the actual hydrocarbon properties, the measured hole geometry, and the measured pipe surface roughness predicts that the initial flow through the ruptured pipe component after the white cloud began to form was approximately 19,000 lb/min (144 kg/s).

3.4.1 Composition, Properties, and Size of the White Cloud

Just after ignition, a freelance photographer at Pier 39 in San Francisco and video footage shot from Marine View Avenue in Point Richmond captured the white cloud. Analysis was performed to estimate the size of the white cloud at the time witnesses reported the fire started. The largest dimensions of the white cloud were approximately 1,100 feet wide (in the east-west direction) and approximately 1,200 feet high, as shown in Figure 13.

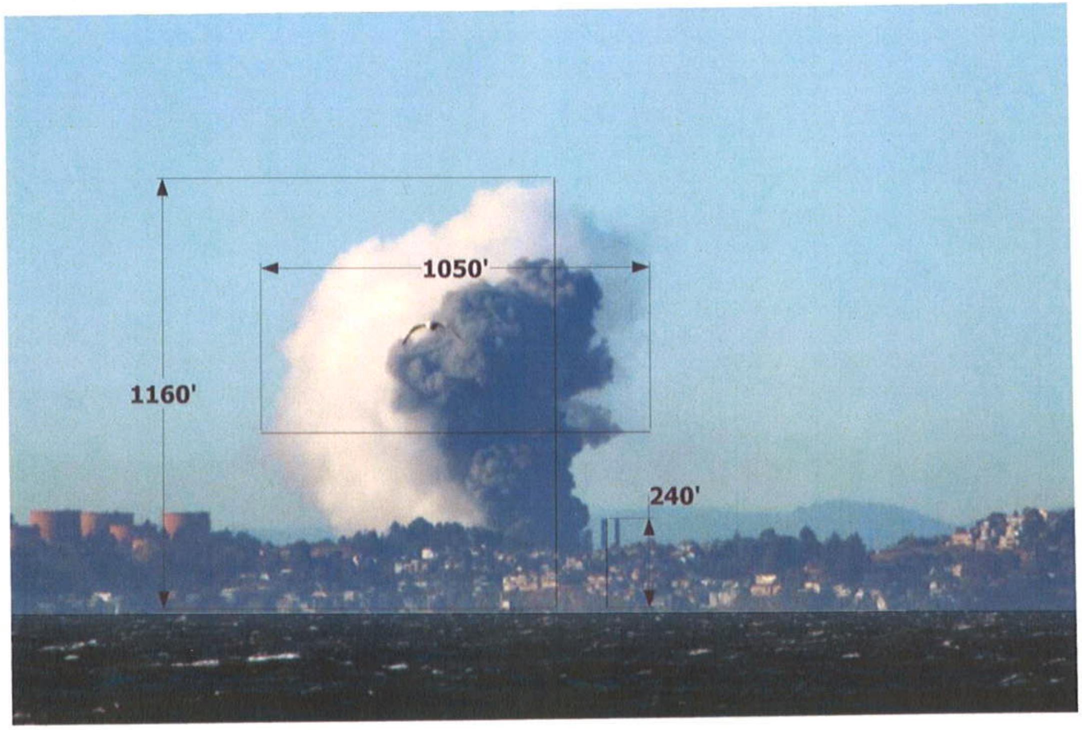


Figure 13. Estimated size of the white cloud utilizing a photograph taken at Pier 39 in San Francisco. The 240 foot dimension shows the height of the 4CU furnace stacks.

The white cloud that formed prior to ignition of the fire consisted of air mixed with vapor and droplets of both hydrocarbons and water. Initially, the composition of the release was LGO. As the leak progressed, the boiling point of the released material decreased and approximated the combination of the 1SC, the 2SC, the 3SC, and the 4SC.

As the hot LGO exited the pipe, approximately 20% (by mass) flashed to vapor and mixed with air. Prior to and during escalation of the release rate, the CFD applied water to the rupture location. Some of the firefighting water contacted the released hot liquid and other hot surfaces. The mixing of cold water and hot surfaces and liquids vaporized a fraction of the water, which then mixed with air. As the mixture of air, water vapor, and LGO vapor cooled, some of the water and LGO vapor condensed, forming a fine mist/fog that appeared as a white cloud.

White clouds can be formed by heating hydrocarbon oils sufficiently to form vapor and then rapidly cooling the vapor by mixing it with air. These white clouds, also known as "fog oil" or "smoke screen," consist of small droplets (~1 micron diameter) of condensed oil. Fog oils are stable and can persist for long periods in the atmosphere. The properties of some hydrocarbon oils used in smoke generators[12] are similar to the properties of the fluid in the 4SC (LGO). The process of creating smoke screens is similar to what occurred when the 4SC piping ruptured.

[12] Smoke generators are used by the military to screen or obscure troop movements.

3.4.2 Flammability of the White Cloud

Adding inert diluting agents, such as water vapor/droplets, can decrease the ignition hazards of fuel-air mixtures. The amount of diluent (e.g. water vapor, carbon dioxide) required to inert mixtures is equivalent or less for mists as compared to vapors of the same material.

Incident site inspections, witness observations, and video footage show that the vast majority of the white cloud did not ignite. According to witnesses, ignition occurred near the pipe rupture, resulting in a black smoke plume. A clear demarcation was observed between the black smoke plume and the white cloud, as shown in Figure 14. Flames were visible in the video footage, providing a competent ignition source for the white cloud. However, the white cloud persisted for several minutes in the immediate vicinity of the black smoke plume even after the ignition. No flames were observed propagating through the white cloud and no signs of overpressure were observed.

The literature review and analysis also supports the observation that the white cloud could not explode. The literature suggests that even an optically dense and opaque fog/mist is substantially below the lower flammability limit (LFL). Analysis of the size of the cloud, the release rate from the ruptured pipe, and the flammability limits of LGO show that the amount of LGO that leaked through the ruptured pipe component was orders of magnitude below the amount required to form a flammable mixture in the entirety of the cloud. Furthermore, fire water was added to the region of the rupture prior to and during escalation of the material release rate. The water vapor and subsequent droplets that formed from the evaporating firewater reduced the ignition hazard of the fuel-air mixture that formed as a result of the leak. In addition, the white cloud drifted past Refinery furnaces without igniting.

Figure 14. Stills from video footage taken from Marine View Avenue in Point Richmond that shows the formation of the black plume shortly after ignition of the fire (top), and after continued burning (bottom).

3.4.3 Health Effects of the White Cloud

For personnel in the white cloud, the primary route of exposure would be through inhalation. Personnel in the immediate area did not cite symptoms associated with exposure to the white cloud. While approximately half of the people in the immediate vicinity of the white cloud were wearing SCBAs, there was no difference in health effects reported between the personnel who wore SCBAs and those who did not.

CUSA industrial hygienists and toxicologists assessed the potential health effects of the white cloud. The white cloud was a spatially- and temporally-varying mixture of air with vapor and droplets of both hydrocarbons and water. The properties of the hydrocarbons (LGO) are described in the Material Safety Data Sheet, which is attached as Appendix 3.

Short-term inhalation overexposure of LGO vapor/aerosol has the potential to produce respiratory irritation and depress the central nervous system. No such effects were reported.

On-site personnel were not exposed to the black smoke plume. As such, consideration of any health effects of the black smoke plume is beyond the scope of this investigation.

3.5 Ignition

The Investigation Team sought information from responding personnel, examined video footage to estimate the location of the ignition, and attempted to identify the ignition source for the fire. Numerous ignition sources and scenarios were considered as potential candidates and evaluated based on the physical evidence, data obtained, and observations of witnesses. Evaluated ignition sources included: the auto-ignition of materials flowing from the ruptured pipe, a failed light fixture, hot surface ignition, open flames, static electric discharge, Engine Foam 60 (diesel engine), the scaffolding contractor's truck (gasoline engine), and pyrophoric iron sulfide. While most of these ignition scenarios are unlikely based on the available information, two viable candidates remain, as summarized in the following sections.

3.5.1 Auto-Ignition

Auto-ignition is the process by which a fuel-air mixture ignites in the absence of an external ignition source due to its temperature. The temperature of the liquid and pipe at the time of leak discovery was reportedly near the auto-ignition temperature of the 4SC. The flash fire experienced during the removal of the second sheet of weather jacketing likely resulted from auto-ignition of hot hydrocarbon vapors mixing with air.

Following the flash fire and before the white cloud formed, an emergency shutdown of the 4CU was initiated. This includes cutting fuel to the furnaces (F-1100A and F-1100B), which substantially reduces the vapor formation and upward flow through the C-1100. This process is commonly referred to as "slumping" of the C-1100. Slumping causes liquid held in trays above the 4SC collection tray to flow downward to the 4SC collection tray and through the 4SC line.

The composition of the liquid flowing from the 4SC collection tray to the area of rupture changed as the 4SC liquid was depleted and the 3SC, 2SC, and 1SC materials flowed down to the 4SC collection tray through the 4SC line and the ruptured pipe. The 2 minute and 30 seconds delay between the formation of the white cloud and ignition of the fire is approximately the time required to deplete the 4SC material available in the C-1100.

The 4SC, 3SC, and 2SC materials have auto-ignition temperatures of 640°F, 494°F, and 410°F, respectively. The measured temperature of the material upstream of the rupture was approximately 620°F at the time of the ignition. The auto-ignition temperature of the material released likely decreased during the Incident as a result of its changing composition. Thus, auto-ignition of the leaking material remains a viable cause of the ignition.

3.5.2 Failed Light Fixture

A photo taken after the discovery of the leak (but prior to the erection of the scaffolding) shows two light fixtures in the immediate vicinity of the failed pipe, as shown in Figure 15. The light in the upper portion (foreground) of the photograph is not energized. This light is controlled by a photocell on the north side of the MCC located approximately 280 feet west of the failed pipe. After the Incident, the light fixture was missing, but the electrical conduit remained, as shown in Figure 15.

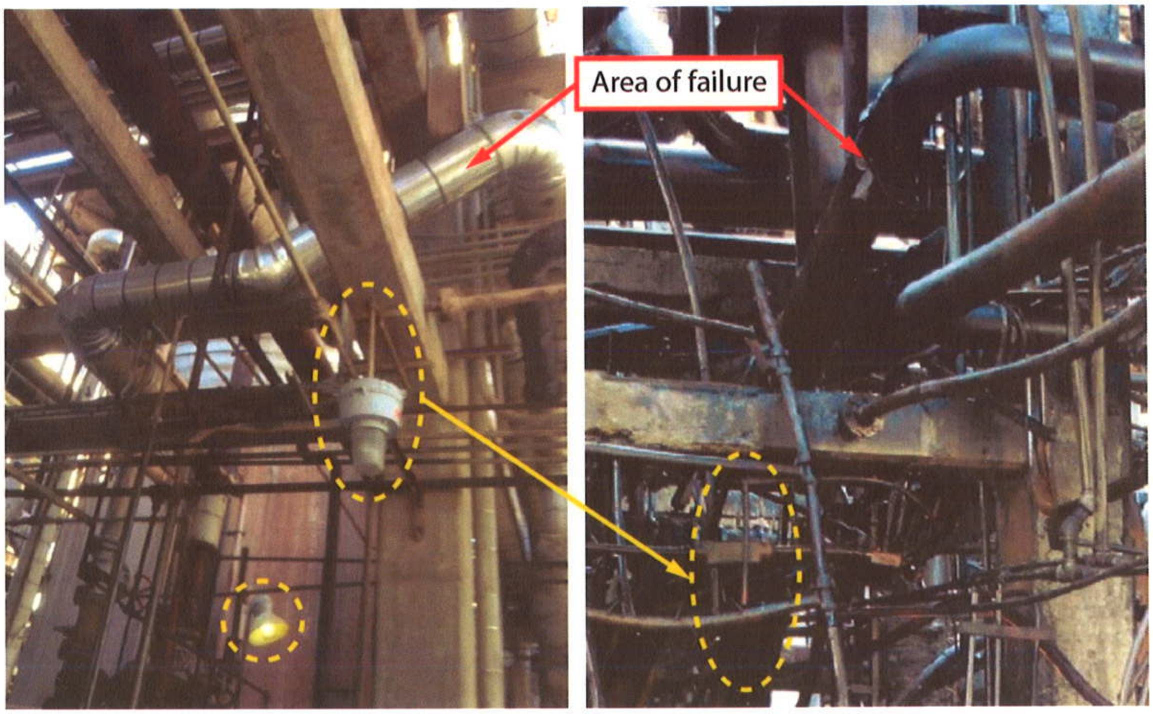


Figure 15. Lighting fixtures at the time the leak was discovered (photograph taken during the initial response) (left); and missing light after the Incident (right).

It is possible that the flow of hot liquid from the rupture location caused the lighting fixture to dislodge, exposing the wiring that provided power. After the white cloud formed and obscured the photo cell that controls the light, the lighting circuit may have energized. This photo cell was inspected and tested post-Incident. Testing showed that the photo cell activated at low light levels. With the circuit energized and wires exposed, this fixture could have provided an ignition source for the fire. This scenario also is possible if the bulb was burned out pre-Incident. Similarly, the photo shows the lower light fixture energized; this too could have provided an ignition source if the light fixture was dislodged by the flow of hot liquid.

4. 4SC Condition Monitoring History

This section briefly describes the corrosion management system and provides an overview of the inspections performed for reliability assessment of the 4SC piping.

4.1 Corrosion Management System

Equipment reliability is a key expectation of CUSA's Operational Excellence Management System. As a result, the term "Reliability" is often used interchangeably with "Mechanical Integrity," the more common process safety term.

The Reliability function is responsible for collecting information on the condition of equipment and for analyzing that information to confirm mechanical integrity and Fitness for Service. For a complex facility like the Richmond Refinery, this involves monitoring thousands of pieces of equipment and thousands of miles of piping. The condition of equipment is typically inspected using non-destructive testing and analyzed on a periodic basis corresponding to equipment damage mechanisms and rates. Threats to mechanical integrity are reviewed by Operations, Reliability, and Engineering personnel to assign priorities and develop work plans to address them. The Operational Excellence and Reliability Information website includes information on the status of planned equipment inspections to enable management oversight of these activities. Additionally, higher priority threats are periodically reviewed by the Refinery's Reliability Steering Committee (RSC) to ensure that they are being appropriately addressed.

Inspectors manage the collection and analysis of equipment and piping inspection data. In addition to American Petroleum Institute (API), National Boiler Inspection Code, and state certifications, Inspectors receive training particular to the type of plant in which they work. For example, crude unit Inspectors are trained on damage mechanisms found in crude units, inspection techniques relevant to these mechanisms, and expectations for the contents of the inspection plans developed for their particular unit.

Thickness gauging is performed on selected CMLs.[13] There are more than 8,800 CMLs on the 4CU piping. When an inspection comes due, each of these CML inspections may consist of four or more thickness measurements. The data from these CML inspections is entered into Meridium.

Meridium utilizes its database of CML measurements (Condition Manager) to calculate the corrosion rates at the CMLs and predict future thicknesses. Additional information can be entered into the Meridium system as comments, known as Meridium History Briefs (History Briefs). While History Briefs can be manually reviewed, the Condition Manager does not use the History Briefs for computations, predictions, or triggers. CUSA uses the Condition Manager's calculations to assist in scheduling re-inspections and the replacement of components.

[13] CMLs were originally referred to as TMLs (thickness monitoring locations).

4.2 4SC Inspection History

The 4SC inspection plan was to periodically measure thickness at CMLs considered representative of the piping circuit between the C-1100 and P-1149/A (see Appendix 2). The nearest CML to the failed pipe component was CML #3, which is located at the elbow directly upstream of the failure location, as shown in Figure 16.

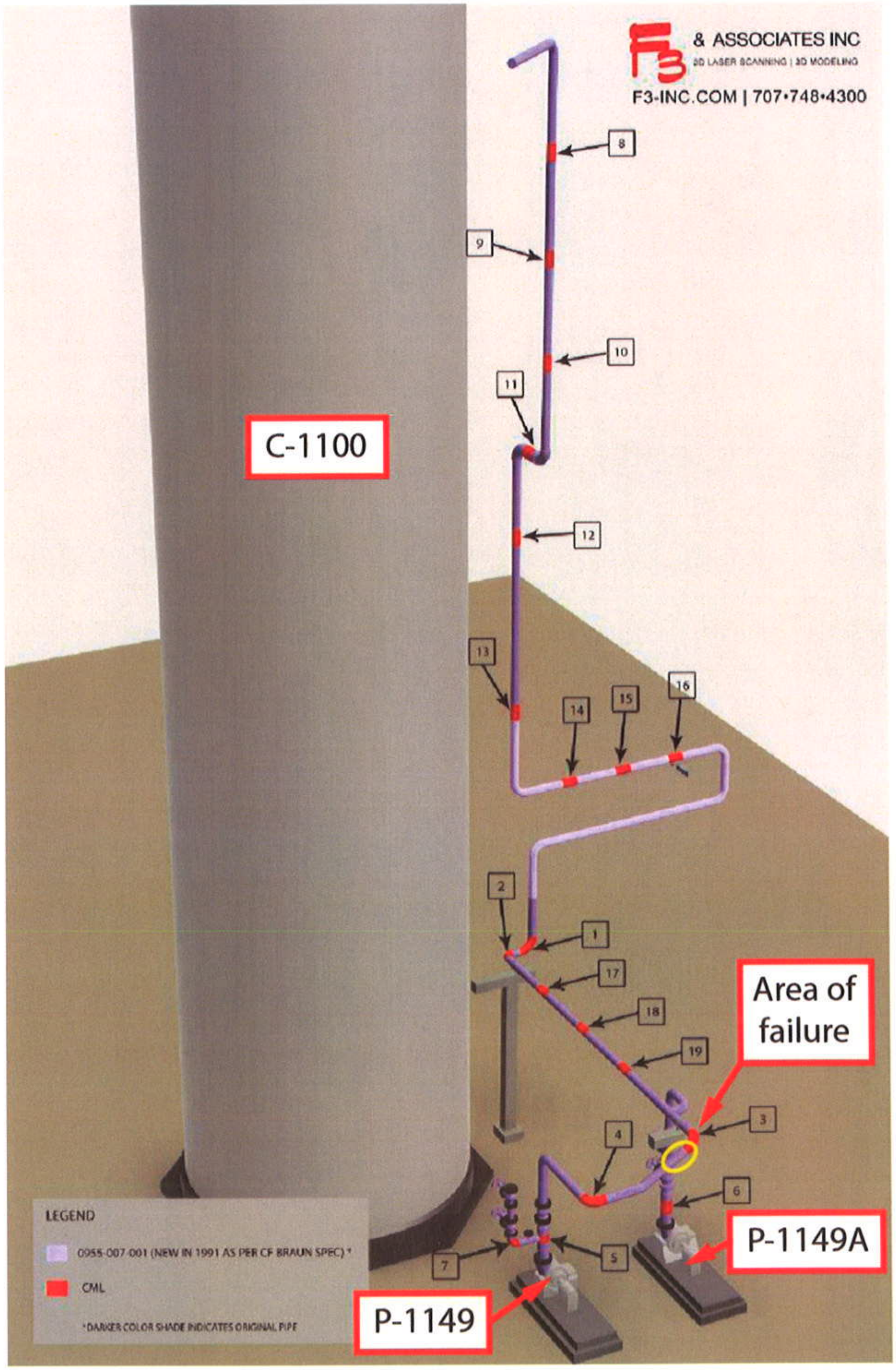


Figure 16. Three-dimensional model of the 8-inch 4SC line showing the CML locations. CMLs 1-6 were original, CML 7 was added in 2002, and CMLs 8-19 were added in 2011.

4.2.1 2002 Radiographic Testing Inspection of the 4SC

In 2002, the 4CU Inspector expanded the on-the-run inspection of the 4SC to include a one-time Radiographic Testing (RT) inspection of straight piping components by including a portion of the piping components adjacent to each CML. Normally, the findings for the existing CMLs were captured in the Condition Manager, but these expanded findings were summarized in a History Brief. This History Brief noted that one section of piping downstream of CML #3 had lost one-third of its original thickness (using the nominal thickness of 0.322 inches, the estimated thickness of the failed pipe component would have been approximately 0.21 inches in 2002) due to corrosion. The 4CU Inspector recommended the replacement of this pipe during the next turnaround, which was scheduled for 2007.

In 2006, as preparation for the 2007 Turnaround, the Turnaround Core Team[14] reviewed the worklist items submitted by the 4CU Inspector requesting replacement of the 4SC piping. The Turnaround Core Team, including the 4CU Inspector who had inspected the line in 2002, concluded that the piping downstream of P-1149/A needed to be replaced with 9-chromium steel[15] to better resist sulfidation corrosion. They also concluded that the piping upstream of P-1149/A could operate safely at least until the 2011 Turnaround, when the piping would be re-inspected to determine whether it should be replaced based on its predicted remaining life. It appears that the History Brief from 2002, noting thinning on the piping downstream of CML #3, was not used in reaching this decision.

<u>Causal Factor 2</u>: **Documenting wall thickness information in a History Brief in Meridium without adding it to the Condition Manager limited the ability for future decision-makers to utilize the data.**

A 2006 review of the metallurgy and corrosion of all equipment in the 4CU noted that the 4SC piping was operating above 600°F and that replacement of the discharge piping for P-1149/A was planned for the 2007 Turnaround. The review recognized that pipe components with lower silicon content could corrode faster than components with higher silicon content and recommended the installation of Guided Wave ultrasonic testing (UT) sensors on the remainder of the 4SC piping to determine if there were pipe components that may be thinner than indicated by the CML measurements. The Turnaround Core Team agreed to install the Guided Wave UT sensors as recommended by the metallurgical review.

During the first quarter 2007 Turnaround of the 4CU, the piping downstream of P-1149/A was replaced and 16 Guided Wave UT sensors were installed as planned. Three sensors were installed on the pipe between the C-1100 and P-1149/A. However, none were installed on the failed piping component. By the end of 2009, the data captured by the Guided Wave UT sensors was considered unreliable and the 4CU Inspector continued traditional UT and RT techniques for measuring wall thickness.

---

[14] The Turnaround Core Team typically consists of representatives from Maintenance, Operations, and Capital Projects, the Design and Process Engineers, and the Inspector.

[15] Increasing the chromium content in steel increases the resistance to sulfidation corrosion. The industry typically uses 9-chromium steel as the optimal alloy when resistance to sulfidation corrosion is needed.

In approximately 2007, CUSA training for crude unit inspectors was updated to include a recommendation to inspect individual components in carbon steel systems subject to sulfidation corrosion. Richmond Refinery crude unit inspectors attended this training in September 2007.

4.2.2 Recommendations for 100% Component-by-Component Inspection

In September 2009, CUSA's Energy Technology Company (ETC) issued "Updated Inspection Strategies for Preventing Sulfidation Corrosion Failures in Chevron Refineries" (ETC Sulfidation Inspection Guidelines). These guidelines noted that different carbon steel components can experience different rates of sulfidation corrosion due to varying silicon content. The ETC Sulfidation Inspection Guidelines recommended that "*For Priority 1-3 piping circuits* inspect every component once to ensure none are corroding exceptionally fast or are near failure." Based on carbon steel operating above 600°F, the 4SC and the ABCR lines would be considered Priority 1. Hence, each component in carbon steel piping systems should be inspected at least once to document any relative differences in thickness that may suggest low silicon content. In June 2010, a Refinery materials engineer presented an overview of the new guidelines to the Refinery's RSC. Following this presentation, it does not appear that there was a specific understanding on a path forward.

In preparation for the 2011 Turnaround, the Turnaround Core Team reviewed the work requests recommending replacement of the 4SC piping. The Core Team concluded that the data reviewed did not warrant replacement of the suction piping for P-1149/A or the ABCR piping. Instead, the Core Team agreed to inspect the piping during the 2011 Turnaround. There was no indication that the ETC Sulfidation Inspection Guidelines' recommendation to conduct a 100% component-by-component inspection was considered.

<u>Additional Consideration 3</u>: **The ETC Sulfidation Inspection Guidelines were not fully implemented and action items were not tracked to completion.**

4.2.3 2011 Turnaround Inspections

During the 2011 Turnaround, the inspection of the 4SC piping, the ABCR piping, and suction piping for the P-1149/A was conducted as planned.

CML inspections of the ABCR piping showed wall thicknesses as low as 0.10 inches, indicating that the pipe could be too close to minimum thickness before the next Turnaround, scheduled for 2016, to leave it in service. Hence, portions of the ABCR piping were replaced with carbon steel piping during the 2011 Turnaround (see Figure 17).

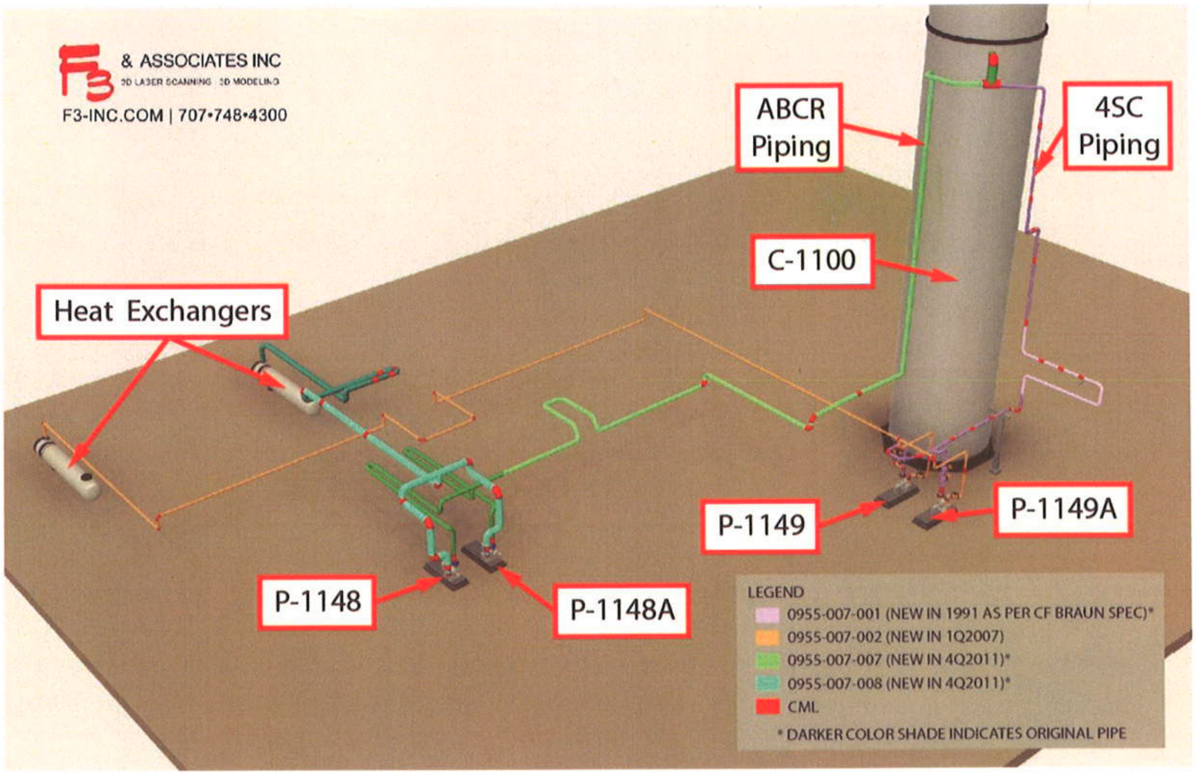


Figure 17. Three-dimensional model showing the locations of the CMLs in the 4SC and the ABCR piping within the 4CU.

Inspection of the 4SC suction piping for P-1149/A included the seven historical CMLs (CML #1 through #7 shown in Figure 16) as well as the twelve new CMLs (CML #8 through #19). The new CMLs were chosen to include a variety of straight piping components supplementing the previous CMLs on fittings (elbows and tees). However, the 19 total CMLs did not cover all 67 components. None of the CMLs were on the failed piping component near CML #3.

__Causal Factor 3__: Inspection during the 2011 Turnaround did not include every component of the 4SC piping.

In the 2011 Turnaround, the thickness at CML #3 was 0.17 inches. When the Inspector reviewed this and similar data for the rest of the CMLs, he apparently concluded that the pipe would reach the 0.14 inch Flag Thickness in three years. However, a calculated minimum thickness for a particular spool piece on the 8-inch line was determined by Engineering to be 0.036 inches, as discussed in more detail below. It appears that this calculated minimum thickness prompted the Inspector to decrease the Flag Thickness to 0.10 inches. Using a 0.01 inch per year corrosion rate, the Inspector apparently concluded that the pipe would reach the 0.10 inch Flag Thickness in approximately seven years. The P-1149/A suction piping was left in service since the data suggested that the piping would still be above the 0.10 inch Flag Thickness in 2016.

The small spool at CML #5 (shown in Figure 16) was recommended for replacement. When the Turnaround Core Team recognized that the spool could be replaced on-the-run during P-1149 maintenance, it asked Refinery Designs Engineering to calculate a minimum allowable wall thickness. The calculated 0.036 inches minimum thickness was based on simple hoop stress and deadweight stress calculations for the 8-inch pipe. Based on the estimated remaining life, the Core Team deferred replacing the washout spool. Although a Management of Change analysis was completed for this decision, other instructions in the Refinery Piping Inspection Guideline on completing Fitness for Service evaluations on pipe below Flag Thickness were not followed.

<u>Additional Consideration 4</u>: The minimum thickness calculated for the 4SC washout spool piping (0.036 inches) did not include safety factors considered in the Refinery Piping Inspection Guideline and API RP 574, which may have triggered a Fitness for Service analysis and led to additional inspections and resulting data.

Following the November 2011 Turnaround, the washout spool and the rest of the P-1149/A suction piping was re-inspected twice before the Incident using RT. One objective was to monitor the washout spool to ensure there was no significant reduction in thickness before it could be replaced on-the-run.

Concurrently with the above, data was gathered to establish current corrosion rates for the entire piping circuit. Measurements taken in February 2012 did not show significant changes and they were entered into the Condition Manager. The measurements taken in June 2012 showed primarily higher thickness than the previous readings. Most of the readings were within the tolerance for the inspection methods being used on hot, insulated pipe; however, some readings were outside the tolerance. Per the Refinery Piping Inspection Guideline, testing on the CMLs with out-of-tolerance readings should have been repeated, but was not. The readings also were not entered into the Condition Manager.

<u>Additional Consideration 5</u>: The June 2012 inspection of the P-1149/A suction piping was not entered into the Condition Manager.

5. Sulfidation Corrosion Threat and Risk Assessment

CUSA uses various methods to assess process hazards associated with unit operation and prioritize actions that are needed to control these hazards. Two methods that are relevant to the threat of sulfidation corrosion are the Reliability Opportunity Identification/Intensive Process Review (ROI/IPR) and the Process Hazard Analysis (PHA).

The ROI/IPR is conducted as part of turnaround planning in order to identify opportunities or reliability threats that can be resolved during turnaround execution. The PHA is conducted on a five-year cycle and is used to broadly assess the safety and operability risks of plant operations.

The ROI/IPR for the 2011 4CU Turnaround was conducted in 2009 (prior to the release of the ETC Sulfidation Inspection Guidelines). Documentation related to the 2009 ROI/IPR references potential upgrades for some portions of the 4SC, but does not identify any specific circuits. It further suggests the need for additional information to evaluate potential upgrade recommendations. The final ROI/IPR report, however, does not include a recommendation for 100% component-by-component inspection or any other increased inspection of the 4SC circuits.

<u>Causal Factor 4</u>: **The 2009 ROI/IPR recommendations did not include 100% component-by-component inspection.**

The most recent PHA for the 4CU was conducted in 2009. It does not appear from the 2009 PHA or any of the previous PHAs that the various study teams recognized sulfidation corrosion as a specific hazard associated with the 4SC composition, operating temperature, and piping metallurgy.

<u>Additional Consideration 6</u>: **The 4CU PHAs did not consider the potential for sulfidation corrosion.**

6. Root Causes and Recommendations

The TapRooT® root cause analysis method defines Causal Factors as a "Mistake or failure that, if corrected, could have prevented the incident from occurring or would have significantly mitigated its consequences."[16]

After identifying the Causal Factors for an incident, the TapRooT® method calls for analyzing the Root Causes for each Causal Factor before developing Corrective Actions for each Root Cause. This is done using a structured methodology (TapRooT® Root Cause Tree®), which guides an investigation team in identifying Basic Cause categories (such as "Procedures" or "Communications") and then analyzing further to categorize the Root Cause. In the TapRooT® system, a Causal Factor may have multiple Root Causes. As an example, a Causal Factor may have the following root causes: "Communication" (Basic Cause Category), "Misunderstood Verbal Communication" (Near Root Cause Category), or "Standard Terminology Not Used" (Root Cause Category). The following analysis lists the TapRooT® Root Cause categories for each Causal Factor of the Incident.

<u>Causal Factor 1</u>: **The response and assessment after the discovery of the leak did not fully recognize the risk of piping rupture and the possibility of auto-ignition**, as covered in Sections 2.1 and 2.2 of this report.

The risk assessment performed upon leak discovery was informal and corresponded with the perception of a small, stable leak. There was not a single meeting where all parties could collectively consider the potential risks and outcomes. This gave rise to communication problems (e.g., some CFD personnel misunderstanding the line temperature in relationship to flash point). Additionally, not all pertinent information (e.g., an overall understanding of the potential corrosion mechanisms and their particular failure modes – see Section 2.2) was brought into the decision-making process. If all the relevant information had been included, it is likely that one or more parties would have decided not to proceed with the removal of the aluminum weather jacketing or the use of firefighting equipment to remove the insulation.

The Investigation Team identified four root causes for this Causal Factor. These were:

- Misunderstood oral communication.
- No communication or untimely communication.
- Standards, Policies or Administrative Controls were confusing or incomplete.
- There were no Standards, Policies or Administrative Control.

[16] TapRooT® Changing the Way the World Solves Problems by Mark Paradies & Linda Unger, 2008.

Recommendation:

- Revise Refinery policies and checklists to ensure appropriate information—including Process Safety and Inspection information—is considered when evaluating leaks and addressing the issue of whether to shut down or continue operation of equipment.

__Causal Factor 2__: **Documenting wall thickness information in a History Brief in Meridium without adding it to the Condition Manager limited the ability for future decision-makers to utilize the data,** as covered in Section 4.2.1 of this report.

The Meridium 2002 Inspection History Brief notes one-third wall loss downstream of CML #3 on the drawing of the P-1149/A suction piping. This is the area where the failure occurred. This was only noted as text in the History Brief and not elsewhere (see Section 4.2.1 of this report). As documented in Section 4.1 of this report, the Meridium tool does not use information entered as text in a History Brief for computations, predictions, or triggers.

The Investigation Team identified three root causes for this Causal Factor. These were:

- Standards, Policies or Administrative Controls were confusing or incomplete.
- Complex system – knowledge-based decision required.
- Complex system – monitoring too many items.

Recommendation:

- Enhance the Refinery's Mechanical Integrity program to ensure the Refinery properly identifies and monitors piping circuits for appropriate damage mechanisms using a standardized methodology and documentation system.

__Causal Factor 3__: **The inspection during the 2011 Turnaround did not include every component in the 4SC piping**, as covered in Section 4.2.3 of this report.

In 2006, a metallurgy review for the 4CU recommended increased inspection coverage of the 4SC piping to identify components that had a higher susceptibility to sulfidation corrosion. In September 2007, Richmond Refinery inspectors attended crude unit subject matter expert training that included a recommendation to inspect individual carbon steel components subject to sulfidation corrosion. The ETC Sulfidation Inspection Guidelines recommended that "*For Priority 1-3 piping circuits* inspect every component once to ensure none are corroding exceptionally fast or are near failure." Based on carbon steel operating above 600°F, the 4SC and the ABCR lines would be considered Priority 1. However, the recommendation to identify and inspect every component was not built into the inspection plans for these piping circuits. A 100% component-by-component inspection would have required inspection of the pipe component that failed in August 2012, which could have alerted the Refinery to the component's accelerated metal loss. Section 4.2.2 of this report covers the decision-making process in preparation for the 2011 Turnaround and the lack of any indication that the need to conduct a 100% component-by-component analysis of the 4SC piping was considered.

The Investigation Team identified three root causes for this Causal Factor. These were:

- Continuing training needs improvement.
- Work package/permit needs improvement.
- Communication of Standards, Policies, or Administrative Controls needs improvement.

Recommendations:

- Review and enhance the requirements for inspector training and competency.
- Develop and implement a process for additional oversight of mechanical integrity-related recommendations and inspection plans, and the escalation of recommendations.
- Develop and implement a process to review and act upon mechanical integrity-related recommendations from industry alerts, ETC, and other subject-matter experts.
- Inspect 4CU piping that falls under the ETC Sulfidation Inspection Guidelines criteria for sulfidation corrosion prior to restarting the 4CU.
- Implement the ETC Sulfidation Inspection Guidelines for the remainder of the Refinery.

<u>Causal Factor 4</u>: **The 2009 ROI/IPR recommendations did not include a 100% component-by-component inspection**, as documented in Section 5 of this report.

Prior to the ROI/IPR study:

- In 2002, a thinning area was found downstream of CML #3 on the P-1149/A suction piping as documented in Section 4.2.1 of this report.
- A 4CU Metallurgical Review study completed in 2006 highlighted the need for increased inspection coverage of the 4SC piping and recommended the installation of Guided Wave sensors, but the data gathered by the Guided Wave technology was ultimately considered unreliable, as documented in Section 4.2.1 of this report.
- In 2007, piping downstream of P-1149/A was replaced with 9-chromium steel due to thinning, as documented in Section 4.2.1 of this report.
- In approximately 2007, CUSA training for crude unit inspectors was updated to include a recommendation to inspect individual components in carbon steel systems subject to sulfidation corrosion, as documented in Section 4.2.1 of this report.

While documentation related to the 2009 ROI/IPR references potential upgrades for some portions of the 4SC, it does not identify any specific circuits. It further suggests the need for additional information to evaluate potential upgrade recommendations. The final ROI/IPR report, however, does not include a recommendation for 100% component-by-component inspection or any other increased inspection of the 4SC circuits. Relevant information related to 100% component-by-component inspection was not transferred to the Refinery inspection management system.

The Investigation Team identified two root causes for this Causal Factor. These were:

- Corrective Action needs improvement.
- Standards, Policies, or Administrative Controls were confusing or incomplete.

Recommendation:

- Ensure relevant technical studies and inspection data are considered for the Refinery's equipment reliability plans and incorporated into the ROI/IPR process.

7. Additional Considerations

In the judgment of the Investigation Team, there are additional issues that did not directly cause the Incident, but represent an opportunity to prevent similar events. The Investigation Team identified six Additional Considerations, as follows:

Additional Consideration 1: **The CFD did not complete a Hazard Material Data Sheet and positioned Engine Foam 60 too close to the leak source when responding to the Incident**, as covered in Section 2.1 of this report.

Recommendation:

- See recommendation for Causal Factor 1.
- Review the Pre-Fire Plan to ensure sufficient guidance is provided on equipment positioning.

Additional Consideration 2: **The leaking line could not be isolated on the upstream side to mitigate loss of containment**, as described in Section 2.1 of this report.

Recommendation:

- Review company/industry loss history on large fractionating towers to determine if internal Engineering Standard FRS-DU-5267 (Emergency Isolation and Depressuring Valves) adequately addresses mitigation of accidental releases from these systems. Revise the standard as warranted by the findings of this review.

Additional Consideration 3: **The ETC Sulfidation Inspection Guidelines were not fully implemented and action items were not tracked to completion**, as discussed in Section 4.2.2 of this report.

Recommendation:

- See recommendation for Causal Factor 3.
- Ensure Refinery business plans provide for the appropriate implementation of Process Safety recommendations (such as the ETC Sulfidation Inspection Guidelines).

Additional Consideration 4: **The minimum thicknesses calculated for the 4SC washout spool piping (0.036 inches) did not include safety factors considered in the Refinery Piping Inspection Guideline and API RP 574, which may have triggered a Fitness for Service analysis and led to additional inspections and resulting data,** as described in Section 4.2.3 of this report.

Recommendation:

- Ensure sufficient organizational capacity and competency for minimum thickness Fitness for Service determinations.

<u>**Additional Consideration 5**</u>**: The June 2012 inspection of the P-1149/A suction piping was uot entered iuto the Condition Manager**, as described in Section 4.2.3 of this report. The CMLs with out-of-tolerance readings should have been re-inspected, but were not.

Recommendation:

- See recommendation for Causal Factor 2.

- Consider additional training on expectations under the "Richmond Refinery Piping Inspection Guidelines" and "RFMS Piping Data Entry (Reliability Focused Maintenance System) and ACD (Add/Change/Delete) Guideline."

<u>**Additional Consideration 6**</u>**: The 4CU PHAs did not consider the potential for sulfidation corrosion**, as described in Section 5 of this report.

Recommendations:

- Review and modify the PHA procedures to ensure that teams consider known corrosion threats/mechanisms.

- Consider a project to evaluate the purpose and methods of various process safety management (PSM) reviews (PHA, ROI/IPR, AOA, COA, sRCM, RBI, etc.) to determine if these activities can be combined or better sequenced to improve risk understanding across the various functions and promote better process safety outcomes.

Investigation Team

Name	Discipline/Role	Current Position
Doug Pottenger	Team Lead	Technical Manager, El Segundo
Michael Baer	Team Facilitator	Senior Safety Specialist, Manufacturing OE/HES
Meaghan Horton	Trainee Facilitator	Safety Specialist – Incident Investigation & Reporting
Steve Bruce	Process Safety	ETC Risk Management & Fire Protection Team Lead
Chris Buehler	Technical	Exponent Thermal Sciences Practice
Bharat Chavda	Operations/Technical	Business Improvement Coordinator
Sean Clark	Operations	USW Health and Safety representative
Dave Cooke	Technical	ETC Consulting Materials Engineer
Carol-Ann Laughlin	Reliability	Reliability Consultant Manufacturing PSM, Reliability, and Energy
Dan Mattison	Technical	Exponent Thermal Sciences Practice
Dan Quinonez	Operations	Shift Team Leader
Mike Smith	Operations	USW Health and Safety representative

Appendix 1: Major Chemical Accidents or Releases Report[17]

ATTACHMENT C
Update to the 30 DAY FOLLOW-UP NOTIFICATION REPORT FORM
CONTRA COSTA HEALTH SERVICES
Page 1 of 8

For CCHS Use Only:
Received By: ______________
Date Received: ______________
Incident Number: ______________
Copied To: ______________
Event Classification Level: ______________

ATTENTION: Randall L. Sawyer
Hazardous Materials Program Director
Contra Costa Health Services Department
4333 Pacheco Boulevard
Martinez, CA 94553

INCIDENT DATE: August 6, 2012
INCIDENT TIME: 6:30 PM
FACILITY: Chevron U.S.A. Inc. Richmond Refinery

PERSON TO CONTACT FOR ADDITIONAL INFORMATION: Karen Draper
Phone Number: (510) 242-1547

PROVIDE ANY ADDITIONAL INFORMATION THAT WAS NOT INCLUDED IN THE 30-DAY REPORT WHEN THE 30-DAY REPORT WAS SUBMITTED, INCLUDING MATERIAL RELEASED AND ESTIMATED OR KNOWN QUANTITIES, COMMUNITY IMPACT, INJURIES, ETC.:

I. SUMMARY OF EVENT

On August 6, 2012, a piping rupture occurred in the #4 Crude Unit at the Chevron U.S.A. Inc. refinery in Richmond, CA, and subsequently a fire ignited in the area of the rupture. The rupture involved an 8" carbon-steel atmospheric gas-oil pipe line from the atmospheric distillation tower.

The primary location of the fire was near P-1149 (C-1100 Atmospheric Column No. 4 Sidecut pump). At the time of the fire, Operations personnel were in the process of evaluating a reported leak with the assistance of Chevron Fire Department personnel.

The #4 Crude Unit distills crude oil into various fractions of different boiling ranges, each of which is then processed further in the other refinery processing units. The #4 Crude Unit at Richmond Refinery has both an Atmospheric Distillation column and a Vacuum Distillation column. This incident involved equipment associated with the Atmospheric Distillation column.

[17] Sixth "Update to the 30 Day Follow-Up Notification Report Form" for the CWS Level 3 Event of August 6, 2012, dated March 29, 2013.

ATTACHMENT C
Update to the 30 DAY FOLLOW-UP NOTIFICATION REPORT FORM
CONTRA COSTA HEALTH SERVICES
Page 2 of 8

The company's investigation into this incident is on-going. Some of the information in this report is preliminary.

II. AGENCIES NOTIFIED, INCLUDING TIME OF NOTIFICATION

Primary: Community Warning System (CWS):

- Level 3 CWS (shelter in place) activated at approximately 6:35 PM (which served as the initial notification to most of the agencies below)
- The shelter in place was lifted by Contra Costa County Hazardous Materials Programs (CCHMP) at 11:30 PM

Secondary: Subsequent notifications via telephone to the agencies below:

State of Emergency Services	Bob McRae	800-852-7550 or 916-845-8911	6:53 PM
National Response Center (NRC)	Garther	800-424-8802	6:59 PM
Contra Costa Hazardous Materials Program (CCHMP)	Melissa Hagen	925-335-3200	7:28 PM
Bay Area Air Quality Management District (BAAQMD)	Mr. Scott	415-749-4979	7:33 PM
Richmond Fire/ Police Central Dispatch	Dispatch	510-620-6933	7:40 PM
California Division of Occupational Safety and Health (Cal/OSHA)	Clyde Trombettas	925-602-6517	10:09 PM

III. AGENCIES RESPONDING, INCLUDING CONTACT NAMES AND PHONE NUMBERS:

The list below does not include all representatives from the respective agencies

Cal/OSHA	Clyde Trombettas	925-602-2665
CCHMP	Trisha Asuncion	925-335-3200
BAAQMD	Jackie Huynh	415-749-4979
OSPR– Dept. Fish & Game	Bob Chedsey	707-864-4975
U.S. EPA	Scott Adair	415-947-4549
Richmond Police Department	Responding Officers	510-233-1214
U. S. Chemical Safety and Hazard Investigation Board (CSB)	Dan Tillema	303-236-8703

IV. EMERGENCY RESPONSE ACTION:

At or around 3:48 PM on August 6, 2012, an operator noticed a small leak from insulated piping on the C-1100 Atmospheric Distillation Column of the 4 Crude Unit. The operator immediately notified the Head Operator and Supervisor for the unit and initiated a dialogue regarding next steps and how to isolate the leak.

The standard practice of the Chevron Fire Department (CFD) is to respond to leaks, spills, and releases. In this instance, the CFD was notified at 4:02 PM that a leak had been discovered at the 4 Crude Unit. The CFD was asked to deploy a crew to the location as a precaution. The CFD arrived at the location between 4:07 PM and 4:09 PM and initiated air monitoring and assessment.

From 4:09 PM to 4:19 PM the rate of feed to the unit was reduced. Then, from 4:20 PM to 6:24 PM, Operations personnel, in conjunction with the CFD, investigated and assessed options. While the leak was being assessed, the CFD set up an engine and had two hose teams in place, one directed at the potential source of the leak and one directed at the personnel assessing the leak. At approximately 6:22PM, a small flash fire occurred on the insulated piping going to P-1149/A. The CFD and Plant Operators activated water spray and extinguished the small flash fire. At some point shortly before 6:25 PM, the size of the release abruptly increased. Between 6:25 PM and 6:28 PM, the order was given to shut down the unit. Around this time a white cloud was visible. At or around 6:32 PM, the fire that is the subject of this report and ongoing investigation ignited.

At 6:38 PM, a Community Warning System Level 3 alert was initiated by Chevron U.S.A. Inc. and the CWS alarm sounded. At or around this timeframe, both Petro-Chem Mutual Aid and Municipal Mutual Aid were called in for support. This included: Richmond Fire, El Cerrito Fire, Berkeley Fire, Contra Costa County Fire, Moraga/Orinda Fire, Hercules/Rodeo Fire, Phillips 66, Valero, Shell, Tesoro and Dow Fire. Also at or around this timeframe, a shelter-in-place order was issued for Richmond, San Pablo, and North Richmond. The shelter-in-place order advised residents to remain indoors until the fire was controlled. At 11:12 PM, the shelter-in-place order was lifted by CCHMP.

V. IDENTITY OF MATERIAL RELEASED AND ESTIMATED OR KNOWN QUANTITIES:

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Emergency Planning and Community Right-To-Know Act (EPCRA) require reporting when a facility releases more than a "reportable quantity" of a hazardous substance. The reportable release thresholds are based upon EPCRA & CERCLA reporting requirements. There was a reportable quantity of sulfur dioxide released from the fire and the flaring associated with the fire.

As a result of our continuing investigation, emission calculations from flaring associated with the event have been refined and summarized below.

Flare emissions (8/6 – 8/10)*	
Material Release	**Quantity Released**
Vent Gas Volume	8,021,389 SCF
Sulfur Dioxide (SO_2)	8,772 pounds
Methane	1,713 pounds
Non-Methane Hydrocarbon	3,794 pounds
Hydrogen Sulfide (H2S)	46 pounds
Nitric Oxides (NOx)	270 pounds

* Flare emission data includes emissions from the initial release and from depressuring the unit through August 10, 2012

As a result of our continuing investigation, emissions calculations from the fire that were in excess of a reportable quantity have been refined and summarized below:

Fire Emissions		
Material Released	**Quantity Released**	**Reportable Release Thresholds**
Sulfur Dioxide (SO_2)	2,017 pounds	500 pounds

Emission estimates herein are based on currently available data and are subject to change based on further investigation and analysis.

VI. METEROLOGICAL CONDITIONS AT TIME OF EVENT:

Wind Speed	11.5 MPH
Wind Direction	134° (SE)
Precipitation	None
Temperature (F)	75°

VII. DESCRIPTION OF INJURIES:

The following employee injuries were associated with this incident (all were part of the emergency response):

1) Employee received minor burn to small area of the left ear
2) Employee received minor burn to left wrist
3) Employee suffered abdominal discomfort
4) Employee suffered respiratory irritation
5) Employee suffered blister to lower leg from boot wear
6) Employee suffered bruise to a finger

All employees received first aid onsite by the Chevron Fire Department and/or the onsite clinic. All employees returned to work on the same shift. There were no injuries to contractor personnel associated with this incident.

VIII. COMMUNITY IMPACT:

A shelter-in-place order was issued for Richmond, San Pablo, and North Richmond, which advised residents to remain indoors until the fire was controlled. According to the Contra Costa Health Services website, a large number of people sought medical attention at local emergency rooms (three individuals were admitted to the hospital). Most cases have been minor complaints of nose, throat or eye irritation or respiratory issues.

a) Chevron U.S.A. Inc. established a claims process to compensate community members for medical and property expenses incurred as a result of the incident. As of January 21, 2013, approximately 23,900 claims have been initiated, and Chevron U.S.A. Inc. has spent approximately $10 million to compensate area hospitals, affected community members with valid claims, and local government agencies in Richmond and West Contra Costa County.

b) On August 6, 2012, seventeen (17) direct-reading samples were taken using an Industrial Scientific MX6 iBrid multi-gas monitor. The data from these samples confirms that concentrations for Hydrogen Sulfide (H2S), Sulfur Dioxide (SO2) and Carbon Monoxide (CO) were below detectable limits (<0.1ppm, <0.1ppm, and <1ppm respectively). Additionally, nineteen (19) grab samples were collected in Tedlar bags in various downwind locations in Richmond, California, El Sobrante, California, and El Cerrito, California. These samples were sent for analysis of sulfur compounds and hydrocarbons to Air Toxics Ltd., a laboratory specializing in the analysis of air using a wide variety of methods. All results from these samples were well below both the California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA) Reference Exposure Levels and California Occupational Safety and Health Administration (Cal/OSHA) Permissible Exposure Limits.

Follow-up community monitoring was conducted by Chevron U.S.A. Inc. at various locations throughout Richmond, California on August 7-8, 2012. Twenty (20) direct-reading air samples were taken during this timeframe using an Industrial Scientific MX6 iBrid multi-gas monitor. The data from these samples also confirms that concentrations of Hydrogen Sulfide (H2S), Sulfur Dioxide (SO2) and Carbon Monoxide (CO) were below detection limits (<0.1ppm, <0.1ppm, and <1ppm respectively). In addition, six (6) grab samples were collected in Tedlar bags during this timeframe at various locations in Richmond, California and were sent to Air Toxics Ltd Laboratory for analysis of sulfur compounds and hydrocarbons. Consistent with the above-referenced findings, all results from these samples were well below the OEHHA Reference Exposure Levels and Cal/OSHA Permissible Exposure Limits. Please note, however, that the laboratory detection limit for Acrolein is higher than the OEHHA Reference Exposure Limit.

c) Fence-line monitoring: Continuous monitoring data is gathered around the clock from instrumentation located at Chevron's Office Hill, Castro Street and Gertrude Street monitoring stations. A data point, close to or prior to the incident, is employed as a reference. The following maximum readings were recorded between the times the fire ignited and the time all-clear was called by CCHMP (between 6:30 PM and 11:31 PM on August 6, 2012). As reflected in the table below, none of the maximum readings exceeded Cal/OSHA's Permissible Exposure Limits (PELs).

Permissible Exposure Limits (PELs). Maximum Concentration Readings

	Cal/OSHA PEL	Castro Street	Office Hill	Gertrude Street
H2S (ppb) Background at 3:00 PM	10,000 ppb	3.04 ppb	3.99 ppb	2.09 ppb
H2S (ppb) Max.	10,000 ppb	3.27 ppb	5.41 ppb	2.51 ppb
SO2 (ppm) Background at 3:00 PM	2 ppm	0.006 ppm	0.003 ppm	0.002 ppm
SO2 (ppm) Max.	2 ppm	0.007 ppm	0.006 ppm	0.002 ppm

Note: The Cal/OSHA PEL are concentrations averaged over an 8-hour period.

IX. INCIDENT INVESTIGATION RESULTS:

Chevron U.S.A. Inc. promptly initiated an investigation of the incident using the TapRooT® methodology. The investigation team is composed of Subject Matter Experts (SMEs) as well as operations personnel, management personnel and representatives of the United Steel Workers. The investigation Team Leader and the investigation Facilitator are Chevron U.S.A. Inc. personnel external to the Richmond Refinery. The investigation is on-going.

X. SUMMARIZE INVESTIGATION RESULTS BELOW OR ATTACH COPY OF REPORT:

The investigation is not complete. Chevron U.S.A. Inc. worked with multiple governmental agencies, including the CSB and Cal/OSHA with respect to evidence identification and collection. Protocols for the removal and testing of relevant evidence have been agreed upon and subsequently, a five foot section of the affected piping system was sent for metallurgical analysis on September 10, 2012. Although the test laboratory has issued a preliminary report, the final report is not yet available. The final results of the testing are among the information necessary for the investigation team to complete its work. Chevron U.S.A. Inc. will provide updates to CCHMP as required until the investigation is concluded.

XI. SUMMARIZE PREVENTABLE MEASURES TO BE TAKEN TO PREVENT RECURRENCE INCLUDING MILESTONE AND COMPLETION DATES FOR IMPLEMENTATION

Since the company's investigation is ongoing, the company is currently unable to identify or summarize all measures to prevent a recurrence. The company has implemented or will implement the following measures.

Industry Alert

On September 26, 2012, Chevron U.S.A. Inc. shared some potentially significant preliminary information regarding the incident through issuance of an Industry Alert. The Alert noted that an area-of-interest in Chevron U.S.A. Inc.'s investigation of the incident is whether the pipe failure resulted from general thinning of the five-foot piping component.

Corrective Actions

The refinery has begun to develop and implement the following corrective actions based on preliminary observations from the investigation team. We have met with governmental agencies, including the CSB, Cal/OSHA, and the County to discuss these efforts. Additional actions may be identified upon completion of the investigation, but the following efforts are already underway:

<u>Low Silicon Carbon Steel and Piping Component Inspections</u>

- As stated in the above-referenced Industry Alert, carbon steel piping with low-silicon content is susceptible to accelerated corrosion when exposed to high-temperature sulfidation (HTS) conditions. Based on preliminary information from the test laboratory, the pipe component that ruptured had low-silicon content and general thinning. This thinning was not readily detected by existing corrosion monitoring locations. To address this issue, the company is inspecting all components potentially susceptible to accelerated HTS corrosion and will complete inspection of all such components in the No.

4 Crude Unit before restarting the unit. If we do locate any components that are not suitable for service they will be replaced.

Mechanical Integrity Program

- The refinery is implementing a process to review, prioritize, and act upon mechanical integrity-related recommendations from internal and external technical experts, including industry standards and alerts.
- The refinery is enhancing its mechanical integrity program to ensure that the proper identification and monitoring of piping circuits for all potential damage mechanisms, not just HTS corrosion. Our goal is to enhance and standardize our inspection method and documentation system.

Assessment, Decision-Making, and Oversight

- The refinery is implementing a process for additional oversight of mechanical integrity-related recommendations and inspection plans. We also are taking steps to make certain that relevant technical studies and inspection data are considered for equipment reliability plans and other processes used to ensure process safety.
- The refinery is reviewing and strengthening its procedures for analyzing process hazards to ensure that work teams consider known failure threats/mechanisms. We also are considering a project to evaluate the purpose and methods of various process safety-related reviews to determine if these activities can be combined or better sequenced to improve risk understanding and promote better process safety outcomes.
- The refinery is reviewing and improving its requirements for training and competency for leaders, inspectors, and engineers. We also are making certain that we have the appropriate technical resources to assist in any evaluation of the fitness of equipment for service.

Leak Response

- The refinery is revising internal policies and checklists to ensure appropriate information—including process safety information and inspection history and data—is considered when evaluating leaks and addressing whether to shut down or continue operation of equipment. We intend to share the resulting leak response protocol with other Bay Area refineries.
- We are looking at the industry's experience with major losses of containment to determine if we should change our standards for fire protection or loss prevention.

Safety Focus

- We are reemphasizing our expectations around process safety to clarify our responsibility for process safety performance and the importance of incorporating process safety into decision-making.

XII. ADDITIONAL INFORMATION. DETAILED EVENT TIMELINE, CORRESPONDENCE, RELEVANT HISTORY OF INCIDENTS WITH SIMILAR EQUIPMENT OR PROCEDURES:

The detailed event timeline is still under development as part of the Incident investigation. All required information will be provided upon completion and submittal of the investigation report.

Appendix 2: Timeline of Key Events

Date/Time	Description of Events
1976	The 4CU is put into service.
2002	Inspection of the 4SC piping noted one-third wall loss downstream of CML #3.
February 2006	The 4CU Metallurgy Review noted that operating conditions for the 4SC made the carbon steel piping in the 4CU susceptible to sulfidation corrosion and recommended inspection of the line using Guided Wave UT.
1st QTR 2007	Piping downstream of P-1149/A was replaced and 16 Guided Wave UT sensors were installed (none were installed on the failed component).
June 2009	ROI/IPR did not specifically mention sulfidation corrosion in the 4SC as an issue to be addressed in the 2011 Turnaround for the 4CU.
August 31, 2009 – November 17, 2009	The study teams on the 2009 PHA for the 4CU did not appear to recognize sulfidation corrosion as a specific possible hazard associated with the 4SC.
September 2009	ETC Sulfidation Inspection Guidelines were issued, which recommended 100% component-by-component inspection for certain carbon steel piping circuits operating above 500°F.
End of 2009	The 4CU Inspector continued traditional UT and RT techniques for measuring wall thickness because the data captured by the Guided Wave sensors was considered unreliable.
June 2010	An overview of the ETC Sulfidation Inspection Guidelines was presented to the RSC. It does not appear that there was a specific understanding on a path forward.
End of 2010	During 2010/2011 planning for the 4CU Turnaround, the Turnaround Core Team concluded that the 4SC piping should be inspected rather than replaced.
4th QTR 2011	During the fourth quarter 2011 Turnaround for the 4CU, the 4SC piping was inspected at CMLs 1-19, but not at every component.
February and June 2012	Inspections of the 4SC continued at CMLs 1-19, with no significant decrease in thicknesses recorded.
March 2012	Fabrication of replacement washout spool.
Day of Incident: August 6, 2012	
~1548 hours	The Plant Operator (PO) observed a leak on the 4SC piping and notified the Head Operator (HO).
1553 hours	The Shift Team Leader was notified and went to the 4CU.
1602 hours	The Chevron Fire Department (CFD) was called and went to the 4CU with two monitor trucks and Engine Foam 60.
~1608 hours	The CFD performed gas testing and determined the atmosphere around leak was not flammable, based on an LEL reading of 2%.

Date/Time	Description of Events
1609 hours	The Control Board Operator (CBO) began reducing the 4CU feed rate per routine shutdown procedures.
1619 hours	Operations determined that the section of leaking pipe could not be isolated.
	Assembled personnel concluded that the weather jacketing and piping insulation needed to be removed to allow visual assessment of leak.
	A plan was devised to erect scaffolding near the leaking pipe so that the insulation around the leak could be removed to better determine whether an online repair was feasible.
~1650 hours	While the scaffolding was being erected (~1 hour), a plan was developed for removing the weather jacketing and insulation from the leaking pipe, which entailed: two firefighters using hand tools to remove jacketing and insulation from the leaking pipe.
~1700 hours	Operations and CFD personnel arriving for the Night Shift conducted field turnovers with the Day Shift.
1810 – 1821 hours	Two firefighters cut the bands on the horizontal piping and the first two bands on the sloping portion of the pipe, and began removing the weather jacketing.
1822 hours	A small flash fire ignited when the second sheet of weather jacketing was removed.
	The fire was quickly extinguished. The two firefighters descended from the scaffolding and set up a Blitz monitor to provide additional firewater coverage on the leaking pipe.
	CFD hose teams switched from power cone to a straight stream nozzle pattern to knock away oil-soaked piping insulation.
	CFD hose teams briefly shut off the water to assess the insulation removal, revealing an increase in volume of material from the leak. At or around this time, the released material began to smoke.
1827 hours	The order for emergency shutdown of the 4CU was given at which time supporting field personnel began to evacuate the area.
1828 hours	The RSL was informed that the 4CU was being shut down.
~1829 hours	The CBO activated hand switches for emergency shutdown of the 4CU.
~1830 hours	The leak rapidly worsened and a large white cloud formed and enveloped the 4CU and downwind processing plants.
	The CFD hose teams shut off nozzles and withdrew from the area.
~1832 hours	A black smoke plume formed.
1838 hours	A shelter-in-place order was issued for the cities of Richmond, San Pablo, and North Richmond.
2215 hours	The CFD, with assistance from Petrochemical Mutual Aid Organization and Municipal Mutual Aid, brought the fire under control.
2312 hours	The shelter-in-place was lifted.
August 7, 2012	The Investigation Team met for the first time and began the investigation.

Appendix 3: MSDS for LGO

Material Safety Data Sheet

Chevron

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

GAS OIL, LIGHT

Product Use: Refinery stream

Company Identification

Chevron Products Company
Marketing, MSDS Coordinator
6001 Bollinger Canyon Road
San Ramon, CA 94583
United States of America

Transportation Emergency Response

CHEMTREC: (800) 424-9300 or (800) 424-9300 or (703) 527-3887

Health Emergency

Chevron Emergency Information Center: Located in the USA. International collect calls accepted. (800) 231-0623 or (510) 231-0623

Product Information

MSDS Requests: (800) 689-3998

SECTION 2 COMPOSITION/ INFORMATION ON INGREDIENTS

COMPONENTS	CAS NUMBER	AMOUNT
Distillates, straight run middle (gas oil, light)	64741-44-2	100 %weight

SECTION 3 HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

- COMBUSTIBLE LIQUID AND VAPOR
- CAUSES SKIN IRRITATION
- MAY BE HARMFUL OR FATAL IF INHALED
- MAY CAUSE RESPIRATORY TRACT IRRITATION IF INHALED
- MAY CAUSE LUNG DAMAGE IF SWALLOWED
- MAY CAUSE DIZZINESS, DROWSINESS AND REDUCED ALERTNESS
- CONTAINS MATERIAL THAT MAY CAUSE DAMAGE TO:
- LIVER
- BLOOD/BLOOD FORMING ORGANS
- TOXIC TO AQUATIC ORGANISMS. MAY CAUSE LONG-TERM ADVERSE EFFECTS IN THE AQUATIC ENVIRONMENT

IMMEDIATE HEALTH EFFECTS

Eye: Not expected to cause prolonged or significant eye irritation.
Skin: Contact with the skin causes irritation. Skin contact may cause drying or defatting of the skin. Symptoms may include pain, itching, discoloration, swelling, and blistering. Contact with the skin is not expected to cause an allergic skin response. Not expected to be harmful to internal organs if absorbed through the skin.
Ingestion: Because of its low viscosity, this material can directly enter the lungs, if swallowed, or if subsequently vomited. Once in the lungs it is very difficult to remove and can cause severe injury or death. May be irritating to mouth, throat, and stomach. Symptoms may include pain, nausea, vomiting, and diarrhea.
Inhalation: Toxic; may be harmful or fatal if inhaled. The vapor or fumes from this material may cause respiratory irritation. Symptoms of respiratory irritation may include coughing and difficulty breathing. Excessive or prolonged breathing of this material may cause central nervous system effects. Central nervous system effects may include headache, dizziness, nausea, vomiting, weakness, loss of coordination, blurred vision, drowsiness, confusion, or disorientation. At extreme exposures, central nervous system effects may include respiratory depression, tremors or convulsions, loss of consciousness, coma or death.

DELAYED OR OTHER HEALTH EFFECTS:

Target Organs: Contains material that may cause damage to the following organ(s) following repeated skin contact based on animal data: Liver Blood/Blood Forming Organs
See Section 11 for additional information. Risk depends on duration and level of exposure.

SECTION 4 FIRST AID MEASURES

Eye: No specific first aid measures are required. As a precaution, remove contact lenses, if worn, and flush eyes with water.
Skin: Wash skin with water immediately and remove contaminated clothing and shoes. Get medical attention if any symptoms develop. To remove the material from skin, use soap and water. Discard contaminated clothing and shoes or thoroughly clean before reuse.
Ingestion: If swallowed, get medical attention. Do not induce vomiting. Never give anything by mouth to an unconscious person.
Inhalation: During an emergency, wear an approved, positive pressure air-supplying respirator. Move the exposed person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get immediate medical attention.
Note to Physicians: Ingestion of this product or subsequent vomiting may result in aspiration of light hydrocarbon liquid, which may cause pneumonitis.

SECTION 5 FIRE FIGHTING MEASURES

See Section 7 for proper handling and storage.

FIRE CLASSIFICATION:
OSHA Classification (29 CFR 1910.1200): Combustible liquid.

NFPA RATINGS: Health: 2 Flammability: 2 Reactivity: 0

FLAMMABLE PROPERTIES:
Flashpoint: < 93 °C (< 200 °F)
Autoignition: 338 °C (640 °F) NFPA 325M
Flammability (Explosive) Limits (% by volume in air): Lower: 0.5 Upper: 5

EXTINGUISHING MEDIA: Use water fog, foam, dry chemical or carbon dioxide ($CO2$) to extinguish flames.

PROTECTION OF FIRE FIGHTERS:
Fire Fighting Instructions: For fires involving this material, do not enter any enclosed or confined fire space without proper protective equipment, including self-contained breathing apparatus.
Combustion Products: Highly dependent on combustion conditions. A complex mixture of airborne solids, liquids, and gases including carbon monoxide, carbon dioxide, and unidentified organic compounds will be evolved when this material undergoes combustion.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Protective Measures: Eliminate all sources of ignition in the vicinity of the spill or released vapor. If this material is released into the work area, evacuate the area immediately. Monitor area with combustible gas indicator.
Spill Management: Stop the source of the release if you can do it without risk. Contain release to prevent further contamination of soil, surface water or groundwater. Clean up spill as soon as possible, observing precautions in Exposure Controls/Personal Protection. Use appropriate techniques such as applying non-combustible absorbent materials or pumping. All equipment used when handling the product must be grounded. A vapor suppressing foam may be used to reduce vapors. Use clean non-sparking tools to collect absorbed material. Where feasible and appropriate, remove contaminated soil. Place contaminated materials in disposable containers and dispose of in a manner consistent with applicable regulations.
Reporting: Report spills to local authorities and/or the U.S. Coast Guard's National Response Center at (800) 424-8802 as appropriate or required.

SECTION 7 HANDLING AND STORAGE

Precautionary Measures: Liquid evaporates and forms vapor (fumes) which can catch fire and burn with explosive force. Invisible vapor spreads easily and can be set on fire by many sources such as pilot lights, welding equipment, and electrical motors and switches. Fire hazard is greater as liquid temperature rises above 29C (85F).
Do not get in eyes, on skin, or on clothing. Do not taste or swallow. Do not breathe vapor or fumes. Wash thoroughly after handling.
General Handling Information: Avoid contaminating soil or releasing this material into sewage and drainage systems and bodies of water.
Static Hazard: Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary but may not, by themselves, be sufficient. Review all operations which have the potential of generating and accumulating an electrostatic charge and/or a flammable atmosphere (including tank and container filling, splash filling, tank cleaning, sampling, gauging, switch loading, filtering, mixing, agitation, and vacuum truck operations) and use appropriate mitigating procedures. For more information, refer to OSHA Standard 29 CFR 1910.106, 'Flammable and Combustible Liquids', National Fire Protection Association (NFPA 77, 'Recommended Practice on Static Electricity', and/or the American Petroleum Institute (API) Recommended Practice 2003, 'Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents'.
General Storage Information: DO NOT USE OR STORE near heat, sparks, flames, or hot surfaces. USE AND STORE ONLY IN WELL VENTILATED AREA. Keep container closed when not in use.
Container Warnings: Container is not designed to contain pressure. Do not use pressure to empty container or it may rupture with explosive force. Empty containers retain product residue (solid, liquid, and/or vapor) and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, static electricity, or other sources of ignition. They may explode and cause injury or death. Empty containers should be completely drained, properly closed, and promptly returned to a drum reconditioner or disposed of properly.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

GENERAL CONSIDERATIONS:
Consider the potential hazards of this material (see Section 3), applicable exposure limits, job activities, and other substances in the work place when designing engineering controls and selecting personal protective equipment. If engineering controls or work practices are not adequate to prevent exposure to harmful levels of this material, the personal protective equipment listed below is recommended. The user should read and understand all instructions and limitations supplied with the equipment since protection is usually provided for a limited time or under certain circumstances.

ENGINEERING CONTROLS:
If user operations generate airborne material, use process enclosures, local exhaust ventilation, or other engineering controls to control exposure.

PERSONAL PROTECTIVE EQUIPMENT
Eye/Face Protection: No special eye protection is normally required. Where splashing is possible, wear safety glasses with side shields as a good safety practice.
Skin Protection: Wear protective clothing to prevent skin contact. Selection of protective clothing may include gloves, apron, boots, and complete facial protection depending on operations conducted. Suggested materials for protective gloves include: Chlorinated Polyethylene (or Chlorosulfonated Polyethylene), Nitrile Rubber, Polyurethane, Viton.
Respiratory Protection: If exposure to harmful levels of airborne material may occur when working with this material, wear an approved respirator that provides protection, such as: Air-Purifying Respirator for Organic Vapors.

Use a positive pressure air-supplying respirator in circumstances where air-purifying respirators may not provide adequate protection.
No applicable occupational exposure limits exist for this material or its components.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Attention: the data below are typical values and do not constitute a specification.

Color: No data available
Physical State: Liquid
Odor: Petroleum odor
pH: Not Applicable
Vapor Pressure: 0.4 kPa (Estimated) @ 40 °C (104 °F)
Vapor Density (Air = 1): >1 (Estimated)
Boiling Point: 205°C (401°F) - 345°C (653°F)
Solubility: Soluble in hydrocarbon solvents; insoluble in water.
Freezing Point: Not Applicable
Melting Point: Not Applicable
Specific Gravity: <1 NFPA 325M
Density: 0.844 g/ml
Viscosity: 4.16 cSt @ 40°C (104°F)

SECTION 10 STABILITY AND REACTIVITY

Chemical Stability: This material is considered stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
Incompatibility With Other Materials: May react with strong acids or strong oxidizing agents, such as

chlorates, nitrates, peroxides, etc.
Hazardous Decomposition Products: None known (None expected)
Hazardous Polymerization: Hazardous polymerization will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

IMMEDIATE HEALTH EFFECTS
Eye Irritation: The Draize eye irritation mean score in rabbits for a 24-hour exposure was: 1.0/110.
Skin Irritation: For a 24-hour exposure, the Primary Irritation Score (PIS) in rabbits is: 3.2/8.0.
Skin Sensitization: This material did not cause skin sensitization reactions in a Buehler guinea pig test. This material did not cause sensitization reactions in a Modified Buehler guinea pig test.
Acute Dermal Toxicity: LD50: >2g/kg (rabbit).

Acute Oral Toxicity: LD50: > 5 g/kg (rat)

Acute Inhalation Toxicity: 4 hour(s) LC50: 1.78mg/l (rat).
Genetic Toxicity: This product gave positive results in the following mutagenicity assays: <Mouse Lymphoma Gene Mutation Assay> This product gave negative results in the following mutagenicity assays: <In Vivo Mouse Micronucleus Test>
ADDITIONAL TOXICOLOGY INFORMATION:
This product may contain significant amounts of Polynuclear Aromatic Hydrocarbons (PAH's) which have been shown to cause skin cancer after prolonged and frequent contact with the skin of test animals. Brief or intermittent skin contact with this product is not expected to have serious effects if it is washed from the skin. While skin cancer is unlikely to occur in human beings following use of this product, skin contact and breathing, of mists, vapors or dusts should be reduced to a minimum.

SECTION 12 ECOLOGICAL INFORMATION

ECOTOXICITY
This material is expected to be toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment.

ENVIRONMENTAL FATE
This material is not expected to be readily biodegradable. The biodegradability of this material is based on data for the components.

SECTION 13 DISPOSAL CONSIDERATIONS

Use material for its intended purpose or recycle if possible. This material, if it must be discarded, may meet the criteria of a hazardous waste as defined by US EPA under RCRA (40 CFR 261) or other State and local regulations. Measurement of certain physical properties and analysis for regulated components may be necessary to make a correct determination. If this material is classified as a hazardous waste, federal law requires disposal at a licensed hazardous waste disposal facility.

SECTION 14 TRANSPORT INFORMATION

The description shown may not apply to all shipping situations. Consult 49CFR, or appropriate Dangerous Goods Regulations, for additional description requirements (e.g., technical name) and mode-specific or quantity-specific shipping requirements.

DOT Shipping Description: UN2810, TOXIC, LIQUIDS, ORGANIC, N.O.S. (STRAIGHT RUN MIDDLE DISTILLATE), 6.1, III

IMO/IMDG Shipping Description: UN2810, TOXIC, LIQUIDS, ORGANIC, N.O.S. (STRAIGHT RUN MIDDLE DISTILLATE), 6.1, III, MARINE POLLUTANT (STRAIGHT RUN MIDDLE DISTILLATE)

ICAO/IATA Shipping Description: UN2810, TOXIC, LIQUIDS, ORGANIC, N.O.S. (STRAIGHT RUN MIDDLE DISTILLATE), 6.1, III

SECTION 15 REGULATORY INFORMATION

EPCRA 311/312 CATEGORIES:

1. Immediate (Acute) Health Effects: YES
2. Delayed (Chronic) Health Effects: YES
3. Fire Hazard: YES
4. Sudden Release of Pressure Hazard: NO
5. Reactivity Hazard: NO

REGULATORY LISTS SEARCHED:

01-1=IARC Group 1	03=EPCRA 313
01-2A=IARC Group 2A	04=CA Proposition 65
01-2B=IARC Group 2B	05=MA RTK
02=NTP Carcinogen	06=NJ RTK
	07=PA RTK

The following components of this material are found on the regulatory lists indicated.
Distillates, straight run middle (gas oil, light) 06

CHEMICAL INVENTORIES:
All components comply with the following chemical inventory requirements: AICS (Australia), DSL (Canada), EINECS (European Union), IECSC (China), KECI (Korea), PICCS (Philippines), TSCA (United States).

SECTION 16 OTHER INFORMATION

NFPA RATINGS: Health: 2 Flammability: 2 Reactivity: 0

HMIS RATINGS: Health: 2* Flammability: 2 Reactivity: 0
(0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme, PPE:- Personal Protection Equipment Index recommendation, *- Chronic Effect Indicator). These values are obtained using the guidelines or published evaluations prepared by the National Fire Protection Association (NFPA) or the National Paint and Coating Association (for HMIS ratings).

REVISION STATEMENT: This revision updates the following sections of this Material Safety Data Sheet: 3, 5, 12, 14, 16
Revision Date: APRIL 11, 2011

ABBREVIATIONS THAT MAY HAVE BEEN USED IN THIS DOCUMENT:

TLV - Threshold Limit Value	TWA - Time Weighted Average
STEL - Short-term Exposure Limit	PEL - Permissible Exposure Limit

	CAS - Chemical Abstract Service Number
ACGIH - American Conference of Government Industrial Hygienists	IMO/IMDG - International Maritime Dangerous Goods Code
API - American Petroleum Institute	MSDS - Material Safety Data Sheet
CVX - Chevron	NFPA - National Fire Protection Association (USA)
DOT - Department of Transportation (USA)	NTP - National Toxicology Program (USA)
IARC - International Agency for Research on Cancer	OSHA - Occupational Safety and Health Administration

Prepared according to the OSHA Hazard Communication Standard (29 CFR 1910.1200) and the ANSI MSDS Standard (Z400.1) by the Chevron Energy Technology Company, 100 Chevron Way, Richmond, California 94802.

The above information is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made available subsequent to the date hereof may suggest modifications of the information, we do not assume any responsibility for the results of its use. This information is furnished upon condition that the person receiving it shall make his own determination of the suitability of the material for his particular purpose.

TESTIMONY OF JORDAN BARAB
DEPUTY ASSISTANT SECRETARY
FOR THE
OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
U.S. DEPARTMENT OF LABOR
BEFORE
THE COMMITTEE ON HEALTH, EDUCATION, LABOR AND PENSIONS
SUBCOMMITTEE ON EMPLOYMENT AND WORKPLACE SAFETY
UNITED STATES SENATE

JUNE 10, 2010

Chair Murray, Ranking Member Isakson, and Members of the Subcommittee, thank you for inviting me to join you this morning for this necessary conversation about worker safety in our nation's energy production industries. This issue has most recently been brought to the public's attention in the most tragic way possible, with deaths of eleven workers, and injuries to 17 others as the result of the April 20th explosion on the *Deepwater Horizon* offshore oil drilling platform. The *Deepwater Horizon* disaster occurred even as OSHA continues to deal with the ramifications of the 2005 fire and explosion at BP's Texas City refinery that killed 15 workers and injured more than 170 others, and to help our Washington State Plan partners investigate the April explosion at a Tesoro refinery that left seven more workers dead.

What have we learned from these tragic events? Certainly we have learned that in our nation's energy producing industry, the status quo is not working. In the past four months alone, at least 58 workers have died in explosions, fires and collapses at refineries, coal mines, an oil drilling rig, and a natural-gas-fired power plant construction site. Not all of these tragedies are within OSHA's jurisdiction; the *Deepwater Horizon* was an offshore drilling facility, technically a "vessel" not subject to OSHA requirements, while mine safety is within the purview of OSHA's sister agency, the Mine Safety and Health Administration (MSHA). Nevertheless, the toll of worker deaths and injuries on the job is sounding an alarm about a major problem throughout the energy industries - a problem that OSHA must help address.

Secretary Hilda Solis' vision for the Department of Labor is "good jobs for everyone." Good jobs are safe jobs and we must do more to ensure that all of our nation's workers, including those in the energy industries can go home safely when their work is done.

OSHA's Experience with refineries illustrates widespread problems

In the wake of the Texas City explosion, OSHA initiated a National Emphasis Program (NEP) with the goal of inspecting the process safety management programs of almost all of the nation's oil refineries. We adopted this saturation program partly because conventional methods of assessing workplace safety, such as injury and illness rates, are not adequate indicators of the risk of fires, explosions, or other catastrophic accidents, nor do they account for the fact that at many refineries, much of the most dangerous work is contracted out and injuries to the contract workers do not show up in the refinery operators' injury rates.

I am sorry to report that the results of this NEP are deeply troubling. Not only are we finding a significant lack of compliance during our inspections, but time and again, our inspectors are finding the same violations in multiple refineries, including those with common ownership, and sometimes even in different units in the same refinery. This is a clear indication that essential safety lessons are not being communicated within the industry, and often not even within a single corporation or facility. The old adage that those who do not learn from the past are doomed to repeat it is as true in the refinery industry as it is elsewhere. So we are particularly disturbed to find even refineries that have already suffered serious incidents or received major OSHA citations making the same mistakes again.

For example, because BP Texas City had failed to abate many of the problems that it agreed to address after 15 workers were killed in the 2005 explosion, and also failed to address a number of related hazards, late last year OSHA proposed additional penalties of $87 million at that refinery. Only a few months after that, OSHA found similar violations at the BP-Husky refinery in Toledo, Ohio, for which we proposed an additional $3 million in penalties for egregious willful violations. That refinery had also been inspected a few years earlier, and numerous violations identified. Although BP fixed the specific violations at the Toledo facility that OSHA had identified in the first inspection, we found the exact same problems in other units in the plant.

This failure to learn from earlier mishaps has exacted an alarming toll in human lives and suffering. In the last five years alone, OSHA has counted over 20 serious incidents, many resulting in deaths and injuries in refineries across the country. The Tesoro Anacortes explosion in Washington State that killed seven workers last April was one of these.

What do all of these incidents have in common? None resulted from unique technical causes. Each one repeated a lesson that should already have been learned by the industry. For example, last year, OSHA completed an investigation of a naphtha piping failure and release at the Delek Refinery in Tyler, Texas, in which the resulting explosion and fire seriously injured three workers and killed two other workers. One of these two workers was killed in the explosion, while the other struggled for 13 days in the hospital before dying from severe burns. But the saddest part of this story is that the naphtha pipe that exploded had already ruptured once before within the past few years.

This cycle of workers being hurt or killed because their employers failed to implement well-known safety measures points out major deficiencies in chemical process safety management in the nation's refineries and, quite possibly, to systemic safety and health problems in the entire petrochemical industry.

Chemical process safety management

Refineries, chemical plants, and other facilities that routinely handle large quantities of highly hazardous chemicals are not like conventional workplaces; the consequences of a single system failure anywhere in the system can be catastrophic. Safety professionals have long been aware that reliance on a safety approach that only addresses problems after they manifest themselves as obvious hazards is wholly inadequate to ensure safety in such workplaces.

For that reason, OSHA, in the wake of a disastrous chemical release in Bhopal, India and several other significant chemical accidents, issued its Process Safety Management of Highly Hazardous Chemicals standard nearly 20 years ago. That standard, embodying a comprehensive, systematic management approach to process safety, was one of OSHA's earliest attempts to create the kind of Plan / Prevent / Protect regimen that the Department is now working to implement in a much broader way. As an early effort, the standard has many strengths, but it is far from perfect. As I will describe below, we are seeing similar violations in too many of the refineries we inspect.

The standard, among other things, requires employers to compile process safety information and make hazard information and training available to employees and contractors; to develop and communicate written process hazard analyses (PHAs) that identify potential system failures; and to address and remediate risks identified by PHAs as well as risks identified in other ways, such as routine inspections or investigation of significant incidents. Employers must take extra steps to maintain the mechanical integrity of critical process components such as pressure vessels and relief systems. It is a key process safety management requirement that employers must timely address and resolve all identified safety issues, and must communicate the resulting safety information and recommendations to all affected personnel, which includes management, employees and contractors.

Consistently throughout the course of the Refinery NEP, we have found that more than 70 *percent* of the violations we are finding involve failures to comply with the same four essential requirements:

Process Safety Information: Frequent process safety information violations include failure to document compliance with Recognized and Generally Accepted Good Engineering Practices, (or RAGAGEP, which consists primarily of industry technical guidance on safe engineering, operating, or maintenance activities); failure to keep process safety information up to date; and failure to document the design of emergency pressure relief systems.

Process Hazards Analysis: We are finding many failures to conduct complete process hazards analyses. Often, there are significant shortcomings in attention to human factors and facility siting, and in many cases employers have failed to address Process Hazard Analysis (PHA) findings and recommendations in a timely manner, or, even to address them at all.

Operating Procedures: Operating procedures citations are for failure to establish and follow procedures for key operating phases, such as start-ups and emergency shutdowns, and for using inaccurate or out-of-date procedures.

Mechanical Integrity: This is a particular concern given the aging of refineries in the United States. Violations found by OSHA typically include failure to perform inspections and tests, and failure to correct deficiencies in a timely manner. In the Delek Refinery case mentioned above, for example, OSHA discovered multiple substandard pipes being operated, and the naphtha pipe whose explosion killed two workers and hospitalized three others had already ruptured once within the past few years.

I have been deeply frustrated by these results. Over a year ago, we sent a letter to every petroleum refinery manager in the country, informing them of these frequently cited hazards. Yet, a year later, our inspectors are still finding the same problems in too many facilities. Clearly, much more work must be done to ensure effective chemical process safety. OSHA has identified three important concepts to guide that work.

Concept Number One: Effective process safety management systems and workplace safety culture are critical for success in preventing catastrophic events.

In addition to effective process safety management systems, *organizational culture* is also a critical component to preventing workplace injuries, illnesses, and deaths. To paraphrase Professor Andrew Hopkins of the Australian National University and author of "Failure to Learn: The BP Texas City Refinery Disaster", workplace culture is not just an educational program that gets everyone to be more risk aware and think "safety first." It means establishing a set of practices that define the organization and influence the individuals who make up the organization. It's not how people think, it's what companies do.

And it may seem obvious, but it bears emphasizing: *Organizational safety culture must start at the top*. It is vitally important for corporate leadership to create an environment within the workplace where workers feel they can report safety and health concerns without repercussions. Since OSHA inspectors cannot visit more than a fraction of the nation's workplaces, we rely on the eyes and ears of workers to help identify workplace hazards. To this end, OSHA must protect whistleblowers from retaliation or discrimination. The need for effective whistleblower protection is especially important in process safety management, because PSM systems rely upon effective communication of hazard information to and from workers involved in these hazardous operations. We applaud the Subcommittee's work on the Protecting America's Workers Act to strengthen and expand protections for worker voice in the workplace.

Concept Number Two: The oil and gas industry must learn from its mistakes.

As discussed earlier, inspections under OSHA's Refinery NEP have found that over *70 percent* of violations are of the same four PSM standard provisions. Almost all of the catastrophic incidents that have killed so many workers were caused by failures that industry executives and facility managers knew how to prevent. They were repeats of earlier mishaps, from which lessons should have been learned.

Industry must do a better job of institutionalizing systems for learning from mistakes, so it does not continue to repeat the same mistakes at the expense of workers' lives. Reform in the management systems of companies that own, operate, or provide services to petrochemical operations is needed, and is needed now.

Concept Number Three: Conventional injury and illness rates are not adequate indicators of the risk of fires, explosions, or other catastrophic accidents, and companies need to develop better leading indicators to assess risks in their workplaces

To ensure strong PSM systems, we need to do a better job of identifying useful leading indicators of potential catastrophic hazards. The warning that "past performance is no guarantee of future success" applies with particular force to the low-frequency, high-impact events that process safety programs are intended to guard against.

One of the most important challenges in trying to measure performance is determining how and what we measure. Companies have good tools for measuring and managing personal, or "hard hat" safety, and the refining and chemical sectors have generally done well in this area. Standard, OSHA-mandated injury and illness recording on the OSHA 300 log measures conventional hazards such as, for example, those from falls, broken bones and amputations, and yields rates for mishaps resulting in days away from work, restricted work or job transfer (the "DART rate"). Unfortunately, as we have also discovered, having good numbers on the OSHA 300 injury logs does not correlate with having an effective chemical process safety program. The classic example of this is BP-Texas City, which had very good injury and illness numbers for its own employees prior to the 2005 explosion. That tragedy, of course, revealed serious problems with process safety and workplace culture at the facility. Focusing on low DART rates alone will not protect workers or employers from disaster.

Please do not misunderstand me; we need to keep reporting and tracking the illness and injury numbers - DART rates are useful - but we must not let those numbers lull us into a false sense of security. Looking *only* at these numbers does not warn us about pending doom from cutting corners on process safety. And to the extent we continue to factor DART rates into our targeting mechanism, we need to make sure that they are accurate. That is why we are paying special attention to incentive and discipline programs that discourage workers from reporting injuries and illnesses.

Conclusion

So where do we go from here? How do we ensure that safety conditions in the nation's refineries improve? OSHA will continue its efforts to intervene on behalf of workers in the nation's refinery and petrochemicals industries. These efforts will include both a strong and credible enforcement presence, and a concerted effort to enlist the cooperation of industry, labor, and other stakeholders. This cooperation is crucial to maximizing our impact because OSHA cannot inspect every refinery every year.

You can also expect to see OSHA collaborating more with the National Institute for Occupational Safety and Health (NIOSH), Environmental Protection Agency, and other agencies to address the worker health and safety problems in the refinery and petrochemical industry - and in other industries as well. Together, we can develop a more effective system for targeting problem hazards and problem worksites, and addressing the problems that we have identified. I also met recently with the National Petrochemical and Refiners Association (NPRA), the American Petroleum Institute (API), and the United Steelworkers to reemphasize OSHA's concerns. And, in connection with hazards to which workers outside our jurisdiction are exposed, OSHA is actively collaborating with other agencies to assist in promoting worker safety.

Finally, we need to pass the Protecting America's Workers Act (PAWA), which would significantly increase OSHA's ability to protect workers, and specifically workers in refineries and chemical plants. The Act would make meaningful and substantial changes to the Occupational Safety and Health Act that would increase OSHA's civil and criminal penalties for safety and health violations, making us much more able to issue significant and meaningful penalties to large oil companies before a disaster occurs.

And because safe process safety depends heavily on lessons learned from close calls and near misses, workers need to feel that they are protected when reporting these events and exercising other health and safety rights. The enhanced whistleblower protections that are included in PAWA would go far toward ensuring that workers are protected for speaking out. Another way PAWA could strengthen workers' rights would be to clarify that the whistleblower provisions of the Occupational Safety and Health Act, contained in section 11(c), prohibit retaliation for protected activity in connection with occupational safety and health hazards, similar to those aboard the Deepwater Horizon, that are regulated by other Federal agencies.

Giving OSHA the ability to require abatement of hazardous conditions before contests are decided would also significantly enhance the safety of refineries. Ultimately, stronger OSHA enforcement and a modern Occupational Safety and Health Act will save lives.

Chair Murray, thank you again for the opportunity to testify today. I applaud your efforts to shed light on the safety and health crisis in America's oil and gas industry. OSHA is committed to addressing this problem so that more workers do not needlessly die. As stated earlier, we also support Congress passing the Protecting America's Workers Act to give OSHA the tools needed to improve and expand its PSM enforcement and more effectively deter safety and health violations.

In closing, I would also like to express my condolences to all the friends and family members whose loved ones have been killed on the job, especially to those of the 11 workers killed in the *Deepwater Horizon* explosion. While OSHA's coverage of safety conditions on offshore oil platforms is limited, we are nevertheless very concerned about the hazards that these workers face. We are also actively collaborating with the Unified Command to help identify the hazards that that oil spill cleanup workers are facing, and to share our expertise on how to protect those workers. I am happy to answer your questions.

SUMMARY REPORT

Refinery Safety in California:
Labor, Community and Fire Agency Views

Mike Wilson, PhD, MPH
University of California, Berkeley
March 27, 2013

Prepared for:
Office of Governor Jerry Brown
Interagency Taskforce on Refinery Safety

CENTER FOR OCCUPATIONAL AND ENVIRONMENTAL HEALTH
LABOR OCCUPATIONAL HEALTH PROGRAM

Labor Occupational Health Program
Center for Occupational and Environmental Health
School of Public Health
University of California, Berkeley

2223 Fulton Street, 4th Floor
Berkeley, CA 94720-7410

(510) 642-5507
Program information: http://www.lohp.org/

About the Labor Occupational Health Program (LOHP)

The Labor Occupational Health Program (LOHP) operates under the aegis of the Center for Occupational and Environmental Health (COEH) at the University of California, Berkeley, School of Public Health. LOHP is one of the nation's preeminent public university outreach programs for advancing community, worker and environmental health. In addition to its educational programs, LOHP convenes strategic partnerships, conducts participatory research and technical assistance, consults on occupational health standards and policies, and facilitates interactions between the University and the community.

COEH was established by the California Legislature in 1978 (AB 3414) to improve understanding of occupational and environmental health problems in California and work toward their resolution through research, teaching, and service. The Northern California COEH consists of researchers and practitioners at the UC campuses of Berkeley, San Francisco, and Davis.

In addition to research, education, and public service, COEH provides technical support for the analysis and development of public and environmental health policies in California and the U.S. COEH provides technical assistance to policymakers and the public, commissions policy-relevant research, and disseminates research findings and recommendations through peer-reviewed publications and special briefings.

About the Summary Report

This report was prepared in response to a January 2013 request for technical assistance by the Governor's Interagency Taskforce on Refinery Safety, which was interested in hearing directly from labor unions, community groups, and fire agency officials on matters pertaining to the health, safety and environmental performance of the state's refinery industry.

The California Department of Industrial Relations provided funding for this report.

The views and recommendations expressed in the report were gathered by the author as described in the Methods section. The author has taken great care to accurately reflect the views of labor, community and fire agency participants; however, the report is not a consensus document, and final responsibility for its content resides with the author. The views presented here do not necessarily represent those of the author or the Regents of the University of California, or the University of California, Berkeley.

About the Author

Mike Wilson is Director of LOHP. He holds a PhD and Master of Public Health (MPH) in Environmental Health Sciences from the University of California, Berkeley, and a BA in Biology with Thesis Honors from the University of California, Santa Cruz. He holds diplomas from the Stanford Program in Pre-Hospital Care and the Harvard Trade Union Program. He serves as a hazardous materials specialist in the National Response System with FEMA Task Force 4, hosted by the Oakland Fire Department.

Acknowledgments

The author extends his appreciation to the meeting participants who freely offered their experience and knowledge in refinery safety.

CONTENTS

METHODS

The author convened, participated in, and/or facilitated the following meetings:

Date and location	Method	Participants
November 6, 2012 **UC Berkeley**	Conference call	United Steelworkers (USW) International USW District 12 USW Local 5
November 15, 2012 **UC Berkeley**	In-person meeting	USW International USW District 12 USW Local 5 BlueGreen Alliance National BlueGreen Alliance California Communities for a Better Environment Natural Resources Defense Council Asian Pacific Environmental Network Labor Occupational Health Program
December 6, 2012 **UC Berkeley**	Conference call	USW District 12 USW Local 5 BlueGreen Alliance National BlueGreen Alliance California Communities for a Better Environment Natural Resources Defense Council Asian Pacific Environmental Network Labor Occupational Health Program
January 2, 2013 **UC Berkeley**	In-person meeting	USW District 12 USW Local 5 BlueGreen Alliance National BlueGreen Alliance California Communities for a Better Environment Natural Resources Defense Council Asian Pacific Environmental Network Labor Occupational Health Program Governor's Office Department of Industrial Relations California EPA Cal/OSHA
January 14, 2013 **UC Berkeley**	In-person meeting	USW District 12 USW Local 5 BlueGreen Alliance National BlueGreen Alliance California Communities for a Better Environment Natural Resources Defense Council Asian Pacific Environmental Network Labor Occupational Health Program

January 23, 2013 **USW Local 5 Martinez, CA**	In-person meeting	USW District 12 USW Local 5 BlueGreen Alliance National BlueGreen Alliance California Communities for a Better Environment Natural Resources Defense Council Asian Pacific Environmental Network Labor Occupational Health Program Governor's Office Department of Industrial Relations California EPA Cal/OSHA U.S. Chemical Safety Board Director U.S. Chemical Safety Board Staff
February 15, 2013 **California State Building, Oakland, CA**	In-person meeting	Department of Industrial Relations Alameda County Fire Department Fremont Fire Department Moraga-Orinda Fire Department Richmond Fire Department El Cerrito Fire Department Los Angeles County Fire Department Office of the State Fire Marshall El Segundo Fire Department California Emergency Management Agency Contra Costa County Health Services Agency Contra Costa County Fire Department California EPA Air Resources Board
February 27, 2013 **St. Mark's Catholic Church gymnasium** **Richmond, CA**	In-person meeting	124 members of the Richmond community USW District 12 USW Local 5 Communities for a Better Environment Natural Resources Defense Council Asian Pacific Environmental Network Labor Occupational Health Program
March 13, 2013 **USW Local 675** **Carson, CA**	In-person meeting	Department of Industrial Relations USW Local 675 USW Local 5 USW District 12 USW Local 675 retired BlueGreen Alliance National BlueGreen Alliance California Communities for a Better Environment Natural Resources Defense Council Wilmington neighborhood leaders UCLA Labor Occupational Safety & Health CSU Dominguez Hill Labor Studies RAND Workplace Health and Safety

March 15, 2013 **Richmond Progressive Alliance,** **Richmond, CA**	In-person meeting	Department of Industrial Relations USW Local 5 IBEW Local 5 IBEW Local 302 BlueGreen Alliance National BlueGreen Alliance California Communities for a Better Environment Crockett-Rodeo Fenceline Committee Global Community Monitor Labor Occupational Health Program Richmond Progressive Alliance West County Toxics Coalition Worksafe Asian Pacific Environmental Network Alliance of Californians for Community Empowerment Contra Costa Labor Council RAND Workplace Health and Safety
March 18, 2013 **RAND Corporation** **Santa Monica, CA**	In-person meeting	Representatives of California refineries and refinery trade associations

The author prepared detailed notes from each of these meetings as the basis for the findings in the report. These notes are available on request. To facilitate interaction, the meetings were not recorded and a written transcript was not produced.

INTRODUCTION

By 2050, California's population is expected to grow by about 50%, from 36 to 55 million residents. This expansion will be accompanied by a growing set of social, economic, and environmental problems whose *magnitude* will be determined in large part by the policy decisions California makes now and in coming years. In charting a course to a sustainable future, government will need to guide industrial development in such a way that it fully integrates matters of environmental quality and human health. In practice, if California is to create a future characterized by improving social, environmental, and economic conditions, industrial development will need to *solve*, not exacerbate, the public and environmental health problems facing the state today.

To move California in this direction, government can benefit from the support of solution-oriented research and outreach efforts that organize the concerns and recommendations of stakeholders in areas of importance to California's future. This report takes the first steps in serving that purpose in the area of refinery safety.

The report summarizes issues raised and recommendations made by labor and community representatives and public fire agency officials regarding refinery safety and environmental performance. Most of the issues raised are not unique to the refining industry and could be applied to other high hazard facilities. The report is framed within three primary focus areas: preparedness, monitoring and emergency response; prevention; and sustainability. In each of these areas, an initial summary of findings is presented. These findings are not intended to represent an exhaustive treatment of the issues.

BACKGROUND

Refining oil—transforming crude petroleum into gasoline and other fuels—is an inherently dangerous process. Every week, the U.S. Department of Energy (DOE) receives reports on process safety incidents in the U.S. refinery industry. The week that ended March 14, 2013 had 26 reported incidents, including unplanned flaring at the Torrance, California Exxon Mobil Refinery; an unplanned shut-down of the hydrocracking unit at Valero's Benicia facility; and the unexplained restart of a major electrical unit at the Chevron Refinery in Richmond, California.

With some exceptions, explosions, fires and fatalities in other countries that refine oil have led to substantive reductions in major refinery incidents, whereas the U.S. appears to be following the opposite trajectory. According to a 2006 report by Swiss Re, the world's second-largest reinsurer, the U.S. has sustained financial losses from refinery incidents at a rate about three times as high as the industry's counterparts in the European Union. Swiss Re concluded that the difference is due in part to U.S. companies "pushing the operating envelope" and, among other things, flaws in refinery design, safety procedures and employee "alertness."

In a 2012 briefing to the U.S. Chemical Safety Board, Swiss Re officials reported that the incident gap between U.S. refineries and those in other parts of the world had widened since their 2006 report.

The U.S. Chemical Safety Board, the Federal and California OSHA programs, the United Steelworkers, the U.S. EPA, the American Institute of Chemical Engineers, and the Contra Costa County Health Services Agency have all created recommendations for improving refinery safety. Many of these strategies have been adopted in California, and yet improvements continue to be urgently needed.

The opportunity for Governor Brown and the California Interagency Taskforce on Refinery Safety is to turn these recommendations into requirements, informed by the improved safety record of many other countries that have moved successfully from should to shall, while retaining a robust and innovative refinery industry.

I. PREPAREDNESS, MONITORING, AND EMERGENCY RESPONSE

Background

Many oil refineries train certain employees to function as members of on-site fire brigades, in addition to their primary, day-to-day responsibilities. Fire brigades may respond to fires, spills, rescues and other incidents that occur inside the plant boundaries. They will also respond to neighboring industrial facilities, if pre-arranged and requested. Some large refineries, including the Chevron refinery in Richmond, also employ full-time firefighters, who serve as first responders and are supported by on-site fire brigades.

Fire brigades and on-site fire departments provide three benefits to the public: (1) a rapid response to a refinery incident; (2) increased staffing to supplement public fire agencies during a refinery incident; and (3) a source of technical expertise for public fire agencies during an incident.

A) On-site fire brigades, refinery fire departments, and public fire agencies operate on different radio frequencies and are not able to communicate with each other.

- *Example*: At the August 6, 2012 refinery fire in Richmond, fire brigades were unable to communicate by radio to on-site refinery firefighters, who were unable to communicate to public fire agencies.
- *Implications*: Communication failures impair the effectiveness of the response, make personnel accountability at an incident difficult, and endanger the health and safety of responders and the public.
- *Action needed*: California should require that fire brigades and refinery fire departments operate with radios and frequencies that allow regular communication with public fire agencies.

B) Sometimes public fire agencies are not allowed immediate access to a refinery when they arrive at the plant gate.

- *Example*: If a member of the public calls 911 to report an incident at a refinery, the arrival of fire equipment at the plant gate can come as a surprise to plant personnel.
- *Implications*: There is the potential for disagreement between the public agency and refinery personnel over jurisdiction and authority for ensuring public safety.
- *Action needed*: California should put in place a mechanism to ensure site-specific refinery training and incident pre-planning for public fire agencies, with agreements established regarding access.

C) A unified command approach is appropriate for most major incidents; however, in the case of large refinery incidents, there is an inherent conflict between refinery fire departments, which are accountable to the corporation, and public fire agencies, which are accountable to the public.

- *Example*: This inherent conflict can potentially influence the nature of communications with the public and decisions about the need for additional fire resources. Refinery departments may tend to "downplay" the severity of an incident in both requesting additional resources and in communicating to the public. On August 6, important fire resources were not requested; a joint information center was never established; and communication to the public and to health care providers was non-existent or ineffective.
- *Implications*: Members of the public and health care providers are left without adequate information regarding the severity of an incident, the potential effects of toxic materials released, and recommended courses of action. This prevents the public from taking protective actions, and it creates uncertainty among health care providers regarding health effects and the need for decontamination of patients prior to treatment.
- *Actions needed*: California should clarify that at a refinery incident, the responsibility for requesting additional resources and communicating with the public rests solely with

the senior public fire officer on scene. “Trigger points” should be investigated as a mechanism for automatically deploying additional resources to a major refinery incident; technical experts in air monitoring should be incorporated into the incident command system to assist in unifying communications with the public.

D) In responding to a major refinery incident, public fire agencies carry financial burdens, draw on neighboring agencies for mutual aid coverage, and leave their own jurisdictions with fewer available resources.

- *Example*: A significant number of public fire agencies responded to the August 6 Chevron refinery fire, which produced wear-and-tear on equipment and reduced fire resources available to the public.

- *Implications*: The public bears the cost of a refinery incident in both fire department expenses and in heightened risks associated with fewer available fire resources.

- *Actions needed*: California should evaluate strategies for refineries to “pre-pay” public fire agencies for emergency response and equipment costs, including payments for overtime to back-fill positions for the duration of an incident, if necessary. When a refinery does not staff its own on-site fire department, the refinery should support costs of public fire agency training and equipment.

E) Insurers, employers, taxpayers, and residents carry the responsibility of paying for medical services rendered to individuals who seek medical attention as a consequence of a refinery fire. There is no system in place for tracking and documenting the health of these individuals in the wake of an incident.

- *Example:* Following the August 6 fire, the cost of medical services for the approximately 15,000 individuals seeking medical attention for respiratory distress, eye irritation, anxiety and other symptoms exceeded $10 million, as reported by Chevron, which elected to pay these bills. The subsequent health status of these individuals was not documented or tracked.

- *Implications:* Payment of medical bills typically falls to insurers, employers, taxpayers or residents. The true social and financial costs of these incidents are unknown because the health status of affected individuals is not tracked over time.

- *Actions needed:* California should ensure that procedures are in place to facilitate payment by refineries of costs incurred for both immediate and long-term medical services related to a refinery incident. To do this, a system is needed to track and document the longer-term health status of affected individuals, including those who seek out medical attention.

F) During a refinery incident, regional air districts do not have sufficient capacity to monitor atmospheric conditions, plume travel, and real-time emissions, nor are they able to communicate effectively with the public, including residents living in fenceline communities.

- *Example*: On August 6, 2012, the Bay Area Air Quality Management District (BAAQMD) collected a very small number of samples and communicated to the public that the air was free of toxic air contaminants. A large number of people, however, continued to visit health care facilities with complaints of respiratory distress, burning of the eyes, and other symptoms.

- *Implications*: If the districts are not able to adequately assess the nature of refinery emissions during upset events, it is not possible to determine what protective actions are most appropriate. The public loses trust in the ability of government to protect public health and safety during a refinery incident.

- *Actions needed*: California should ensure that air districts, in cooperation with the state Air Resources Board, have the capacity to effectively monitor air contaminants during unusual refinery events and report this information to the public in multiple ways. The districts should also establish systems to communicate this information to health care providers, emergency responders, and others.

The refineries should carry the costs for the purchase and maintenance of state-of-the-art, real-time air monitoring and communications equipment.

G) During routine refinery operations, regional air districts do not have sufficient capacity to monitor toxic air contaminants, particulates, and other air pollutants emitted by the refineries on a daily basis, nor are they able to effectively communicate information of this nature to the public.

- *Example:* The BAAQMD operates a small number of ambient air monitoring stations situated at various locations around the East Bay. These devices are not able to adequately capture refinery emissions.

- *Implications:* It is not possible to adequately assess the health and environmental impact of refinery emissions; this impedes actions to reduce emissions. The public loses trust in the ability of government to protect public and environmental health from refinery emissions.

- *Actions needed:* California should ensure that air districts, in cooperation with the state Air Resources Board, have the capacity to conduct air monitoring on a routine basis and are able to post that information online. The districts should establish systems to effectively communicate this information to the public. Health warning levels for both acute and chronic effects should be those established by the California EPA Office of Environmental Health Hazard Assessment (OEHHA) and should be calibrated for exposures to children and other susceptible groups. The refineries should carry the costs for the purchase and maintenance of state-of-the-art, real-time air monitoring and communications equipment.

H) Refinery safety is compromised by the use of transient, contract employees, who are generally less-well trained, less committed to safety, and less able and willing to speak up about safety hazards, compared to full-time, union refinery workers.

- *Example*: During turn-around periods, hundreds of transient, contract employees are hired by a refinery to perform maintenance work. In some areas, contractors are serving as plant operators.

- *Implications*: Contract employees often perform critical tasks with less attention to safety for themselves, their co-workers, and the public.

- *Actions needed*: California should require refineries to report the number of contract employees they hire each year, their duration of employment, their level of training, and the positions these employees fill. Local hiring requirements and incentives should be implemented, along with industry-supported and state-organized apprenticeship programs for residents of cities that host a refinery.

I) The emergency public warning system largely failed to function during the August 6 Chevron refinery fire.

- *Example*: The automated phone system crashed and the auditory alarms were not activated broadly or were simply not heard; there was no public agency website dedicated to providing information to residents and updates on the incident.

- *Implications*: Residents in Richmond and neighboring areas could see a large black cloud of smoke coming from the refinery, but they did not know what actions they should take, where they could get information, or how serious their situation could become.

- *Actions needed*: California should ensure that refineries fund the development of effective, audible warning sirens and a dedicated website that can be updated by a public agency in the event of an incident. These systems should be coupled with outreach to the public and to radio and television stations. Funding to establish community emergency response teams (CERTs) and training for block captains would improve community resiliency during a major incident.

J) Public transit lines were shut down during the August 6 Chevron refinery fire.

- *Example*: Without having developed an alternative plan, the Bay Area Rapid Transit

(BART) train system stopped carrying passengers into Richmond, stranding passengers in outlying stations.

- *Implications*: This made it nearly impossible for some residents to return to Richmond to take care of families and other needs.

- *Action needed*: California should ensure that local transit districts have developed protocols to respond effectively in the event of an industrial emergency. Shutting down transit lines might be appropriate in some cases; these decisions, however, should be made using pre-planned protocols and with information from emergency services personnel; they should not be made *ad hoc* or left to the individual judgment of bus and train operators.

II. PREVENTION

Background

The U.S. Chemical Safety Board, the Federal and California OSHA programs, the United Steelworkers, the U.S. EPA, the American Institute of Chemical Engineers, and the Contra Costa County Health Services Agency have all created recommendations for improving refinery safety, most of which focus on a broad range of prevention strategies. Many of these strategies have been adopted in California, and yet improvements continue to be urgently needed, in part because most of these efforts rely primarily on self-regulation by the industry and lack robust regulatory requirements with stiff civil and criminal penalties. The evidence here suggests that health, safety and environmental performance remains tangential—not central—to the primary mission of the refinery industry.

A) The refineries have not proactively communicated information on corrosion damage to government, workers, or the public.

- *Example*: After a corroded pipe burst in the August 6 Chevron incident, evidence of serious corrosion damage and deferred maintenance was uncovered throughout the Richmond refinery.

- *Implications:* Unless corrosion information is gathered and communicated proactively by the refineries, it is not possible for the public, workers, or government to understand the nature of this hazard and take steps to ensure that it is corrected.

- *Actions needed:* California should require the refinery industry to conduct a comprehensive audit of corrosion damage, and the results should be reported publicly. A useful initial measure for providing information on corrosion damage is through reporting on the use of clamps and Management of Change (MOC) actions taken for each clamp. Ongoing auditing and public reporting of clamp usage, and its scheduled replacement time, should be required of the refineries to ensure that corrosion risks are identified, prioritized, and repaired.

B) While workers have the authority to shut-down unsafe operations, the power to do so is continually undermined by plant managers; relying on shut-down actions taken by workers also shifts responsibility away from management's obligation to ensure mechanical integrity through preventive maintenance.

- *Example*: Although workers raised concerns over corrosion at the Richmond Chevron refinery, corrosion problems were not prioritized and corrected by plant managers, and a hole subsequently opened in the crude unit piping on August 6. Chevron continued to operate the unit under pressure while workers attempted to fix the source of the leak.

- *Implications*: The resulting catastrophic fire nearly killed 12 workers and ultimately sent some 15,000 residents to area health care facilities.

- *Actions needed*: California should require the implementation of a robust preventive maintenance program at all refineries, as noted below. California should also consider a means for workers to report immediate unsafe conditions to an agency, in addition to reporting to plant managers.

C) Maintenance and safety problems identified by refinery workers are often not corrected for months or years.

- *Example*: Since 2002, Chevron repeatedly postponed replacing the corroded section of pipe that finally burst on August 6, 2012.

- *Implications*: Refineries run an increasing risk of failure, which can range from a small leak to a catastrophic explosion and fire.

- *Actions needed*: California should require refineries to disclose to government, employee representatives, and to a publicly accessible database normalized information on (i) maintenance and safety requests made, (ii) corrective actions taken or not taken, (iii) outcomes, (iv) root cause of the maintenance or safety problem, and (v) the management individual accountable. An accessible record of this type will highlight best practices among leading refineries and will allow the public, workers and government to track refinery performance. Regulatory actions should be triggered based on the number of maintenance and safety requests left open and uncompleted over a defined period of time.

D) There is a need for much greater worker involvement in management decisions regarding health, safety and environmental performance.

- *Example*: While workers at unionized refineries can provide input into safety issues, they do not share decision-making authority with plant managers, whose economic interests are not consistently aligned with safety.

- *Implications*: Safety is continually marginalized in favor of production during both routine operations and turn-overs.

- A*ction needed*: California should require that refineries operate with a tripartite labor-management-government structure for decisions pertaining to health, safety and environmental performance. This structure would provide the authority for full-time workers and government to engage in tracking of leading and lagging indicators, near-miss reporting and investigation, and sharing of lessons for continuous improvement, based on the United Steelworkers (USW) *Triangle of Prevention* framework.

E) It is unknown whether and to what extent refineries are tracking and acting on leading, lagging, and near-miss performance indicators.

- *Example*: Even under its Industrial Safety Ordinance, Contra Costa County is unable to identify, track and compare performance indicators among refineries; had it been able to do so, the County might have been made aware of extensive corrosion problems at the Richmond Chevron plant.

- *Implications*: A refinery that documents, tracks and takes action on performance indicators is more likely to identify problems early and operate more safely and efficiently, compared to refineries that pay less attention to performance metrics. It is currently not possible to identify the best and worst performing refineries in the state, which makes it difficult to take appropriately scaled regulatory and other actions.

- *Action needed*: California should require refineries to disclose to government and to a publicly accessible database normalized information on (i) leading, lagging, and near-miss performance metrics, including both planned and unplanned flaring events; (ii) corrective actions taken or not taken; (iii) outcomes; (iv) root cause of deviations in the performance metric; and (v) the management individual accountable. Regulatory actions should be triggered based on continuing failures in certain performance indicators, based on a to-be-determined set of metrics.

F) The Contra Costa County Industrial Safety Ordinance (ISO) is a nationally recognized regulatory program that has produced a marked decline in refinery incidents and could serve as a statewide model; there are also areas where it should be modernized and strengthened.

- *Example*: Incorporating inherent safety through choices in the types of materials, technology, feedstocks, and equipment used at a plant eliminates (or reduces) hazards at the source and is therefore the preferred method for reducing health, safety and environmental risks. Inherent safety is recommended in the ISO but is not required.

- *Implications*: The potential benefits of inherent safety in the refinery industry have not been fully realized.

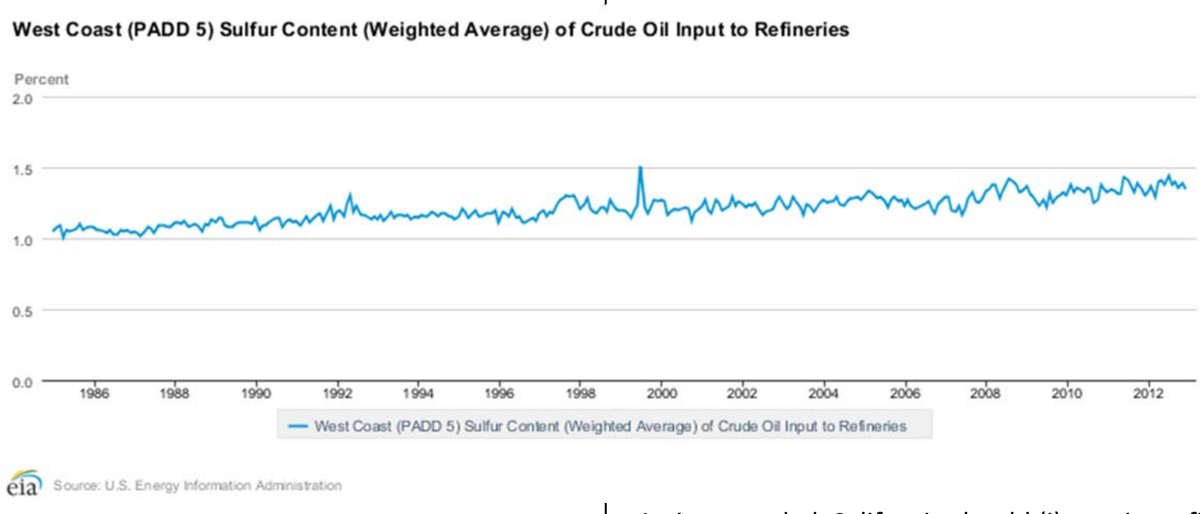
- *Action needed*: Evaluate the ISO for areas that are in need of modernization and strengthening, and then evaluate its efficacy as a statewide model.

III) SUSTAINABILITY

A) The sulfur content of crude oil imports into California refineries has increased steadily since 1985 and is expected to continue to do so.

Example: The U.S. Energy Information Agency reports that the weighted average sulfur content of crude oil inputs for West Coast refineries increased from 1.05% in January 1985 to 1.35% in December 2012 (Table 1).

Table 1. U.S. EIA trend data on West Coast sulfur content, 1985—2013.



Implications: When the total sulfur content in the crude oil used by refineries is greater than 0.5 to 1.0%, the oil is classified as "sour" and is less expensive and more difficult to process. Sulfur impurities need to be removed prior to processing, which increases energy demands. Higher-sulfur crude oil also produces toxic air contaminants (hydrogen sulfide and sulfur dioxide) and greenhouse gasses (GHGs), and it increases the rate of corrosion throughout a refinery's piping and mechanical systems.

Action needed: Require air districts to promulgate rules that prohibit increases in routine and episodic air emissions that result from the use of higher sulfur-content oil inputs. Consider rules that would bar or limit the importation of refined oil products.

B) Refineries are the largest energy-using industry in California and the most energy intensive industry in the U.S. The state's refineries have added energy intensive equipment, such as hydrogen plants and hydrotreaters, to process higher-sulfur crude oil inputs.

Example: California industrial facilities emit about 23% of the state's GHGs; refineries produce 40% of these industrial emissions, or about 10% of the state's total GHG emissions. One new refinery hydrogen plant can emit over one million tons of CO_2 annually.

Implications: GHG emissions are increasing as a result of direct plant emissions and from increased energy use.

Actions needed: California should (i) require refineries to conduct a comprehensive energy audit, report on the results, and establish a reduction schedule. The audit should include energy uses by, for example, hydrogen plants, hydrotreaters, hydrocrackers, fluid catalytic crackers, cokers, sulfur recovery units, boilers and heaters; (ii) require refineries to proactively replace old boilers, heaters, and other inefficient equipment, some of which were built over 50 years ago; (iii) require refineries to replace a portion of grid energy used each year with alternative energy sources; and (iv) evaluate U.S. EPA recommendations on available and emerging technologies for reducing greenhouse gas emissions in the refining industry.

C) Refineries are the largest industrial emitters of toxic air contaminants in California.

Example: The U.S. EPA Toxics Release Inventory (TRI) shows that refineries dominate by far the top 15 largest sources of toxic air emissions in both Northern and Southern California.

Implications: Air contaminants are dispersed regionally, causing population-wide health effects and reducing quality of life; residents of communities that host a refinery—who are disproportionately minority and lower income—are exposed to toxic air contaminants at high levels and suffer higher rates of asthma, cancer and other diseases, relative to rates in California as a whole.

Actions needed: California should require refineries to rapidly and continually reduce emissions through the use of Best Available Control Technologies (BACT) or Best Available Retrofit Control Technologies (BARCT), as defined under the Federal Clean Air Act.

* * * * * *

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

DEC 17 2013

OFFICE OF THE
REGIONAL ADMINISTRATOR

Kory Judd, General Manager
Chevron Richmond Refinery
841 Chevron Way
Richmond, CA 94801

Dear Mr. Judd:

On August 6, 2012, a "sidecut" pipe ruptured in a Crude Unit at the oil refinery in Richmond, California owned and operated by Chevron U.S.A., Inc. (Chevron). This rupture led to a release of hydrocarbons, a vapor cloud explosion, and a fire. The incident threatened the lives of several nearby workers and led thousands of residents to seek medical care for respiratory concerns and other health complaints. Following this incident, the U.S. Environmental Protection Agency (EPA) began an investigation of Chevron's compliance with laws and regulations governing prevention of chemical accidents and reporting of chemical releases. EPA closely coordinated with state, local, and other federal agencies, given the importance of cross-agency cooperation as underscored by the August 1, 2013 Executive Order on Improving Chemical Facility Safety and Security. As described in the enclosed Finding of Violations, EPA has determined that Chevron has not complied with these laws and regulations. EPA's primary concern is that Chevron repeatedly failed to follow its own policies, plans, and recommendations intended to minimize chemical safety risks consistent with federal law.

The incident on August 6, 2012 raises concerns about Chevron's implementation of the Risk Management Program (RMP) required by EPA's Chemical Accident Prevention Provisions. These rules, issued by EPA in 1994 under Section 112(r) of the Clean Air Act, are designed to minimize the probability and consequences of accidental chemical releases to better protect workers, communities, and the environment. Specifically, these rules require facilities covered by the statute to properly maintain and monitor equipment, train employees, respond to accidental chemical releases and inform the public and local emergency response agencies about such releases. A key requirement necessary for the success of an RMP is the implementation of a management system to oversee all the program elements.

EPA comprehensively reviewed Chevron's implementation of its RMP in three of the processes covered at its refinery in Richmond. The investigation identified 49 failures in Chevron's implementation of most of the required elements, indicating a failure to develop and apply an effective management system to oversee the implementation of the RMP.

A few examples related to the equipment that failed on August 6, 2012 (i.e., the 4-sidecut in the No. 4 Crude Unit) illustrate the pervasiveness and gravity of the issues. As described in more detail in the Finding of Violations, Chevron failed to:

- keep accurate information pertaining to the sidecut (Finding 2);
- safely maintain, inspect, test and operate the sidecut (Finding 5);
- adequately assess the consequences of a failure of the sidecut (Finding 7);

- test the sidecut consistent with accepted engineering practices (Findings 22 – 27);
- correct deficiencies in the sidecut noted in Chevron's own compliance audit (Finding 43); and
- implement Chevron's own emergency response plan when the sidecut failed (Finding 49).

These violations increased the probability of failure of the 4-sidecut and the risk that such a failure would have significant consequences. Moreover, EPA's investigation identified similar problems throughout Chevron's implementation of its RMP, indicating an overarching failure to implement an effective management system to oversee the program.

In addition, the Finding of Violations identifies 13 instances of late and deficient release reporting to federal, state and local emergency response authorities, as required by Section 103 of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Section 304 of the Emergency Planning and Community Right-to-Know Act (EPCRA).

The Finding of Violations requires that Chevron correct deficient release reports, submit any documentation of actions which have corrected the identified violations, and provide information regarding Chevron's plans to improve safety at the facility. Upon review of such information, EPA intends to identify remaining gaps in risk management and to seek a federally enforceable agreement to ensure full compliance.

Issuance of the Finding of Violations is EPA's first official action upon completion of its investigation. The Finding of Violations helps to identify requirements necessary to improve safety and to come into compliance with federal law at the Richmond Refinery. In the future, as authorized under Section 113 of the Clean Air Act, EPA may seek injunctive relief and penalties of up to $37,500 per day per violation.

Please provide a written response within 30 days, stating whether Chevron intends to comply with these requirements and proposing a time frame in which to do so. The Finding of Violations provides staff contact information for following up on technical and legal aspects of these issues.

Your compliance with federal requirements, as well as state and local laws, is essential for the health, safety and well being of the residents in the City of Richmond and surrounding communities. I look forward to your response and working to ensure future compliance by Chevron.

Sincerely,

Jared Blumenfeld

Enclosure

cc: The Honorable Gayle McLaughlin, Mayor, City of Richmond
Randy Sawyer, Chief Environmental Health and Hazardous Materials Officer
Contra Costa County Health Department
Matt Rodriquez, Secretary, California Environmental Protection Agency
Christine Baker, Director of Cal-DIR, CalOSHA
Dan Tillema, Chemical Incident Investigator, U.S. Chemical Safety Board

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

Finding of Violations
Chevron Richmond Refinery,
841 Chevron Way, Richmond, CA

CAA Section112(r)(7) Risk Management Program
CERCLA Section 103 Release Reporting
EPCRA Section 304 Release Reporting

As a result of the incident at the Chevron Richmond Refinery (Facility) which occurred on August 6, 2012, the U.S. Environmental Protection Agency (US EPA) began an investigation of Chevron U.S.A., Inc.'s (Chevron) compliance at the Facility with the following statutes and their implementing regulations:

- Clean Air Act (CAA) Section 112(r), as amended, 42 U.S.C. § 7412(r), 40 Code of Federal Regulations (CFR) Part 68;

- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 103, as amended, 42 U.S.C § 9603, 40 CFR § 302; and

- Emergency Planning and Community Right-to-Know Act (EPCRA), 42 U.S.C. § 11001 *et seq.*, 40 CFR Part 355.

This Finding of Violations (FOV) provides notice to Chevron of the violations discovered through the investigation, as detailed in the enclosed "Summary of Findings," and provides a path forward for ensuring future compliance with these laws.

EPA comprehensively reviewed Chevron's implementation of its RMP in three of the covered processes at the Facility. The investigation identified numerous failures in Chevron's implementation of most of the required elements, indicating a failure to develop and implement an effective management system to oversee implementation of its RMP.

As specified in the Summary of Findings, EPA has identified numerous instances at the Facility where Chevron violated 40 CFR Part 68. Broadly stated, these violations include Chevron's failure to:

A) develop and implement a Management System to oversee implementation of a Risk Management Program, as required by CAA § 112(r)(7) and 40 CFR §§ 68.12 – 15 (Finding 1);

B) ensure the accuracy of Process Safety Information (PSI) pertaining to the equipment in process, including Piping and Instrument Diagrams (P&IDs) and Pressure Safety Valves (PSV), as required by 40 CFR § 68.65(d)(1) (Findings 2- 4);

C) determine safe procedures for use of existing equipment which was designed and constructed in accordance with past codes, standards or practices that are no longer in general use, as required under 40 CFR § 68.65(d)(3) (Findings 5- 6);

D) conduct an adequate Process Hazard Analysis of covered processes, including an assessment of the consequences of failure of engineering controls and the range of possible safety and health effects of failure of controls, as required 40 CFR § 68.67(c) (Findings 7- 8);

E) develop and implement written Operating Procedures that provide clear instructions for safely conducting activities involved in each covered process, as required by 40 CFR § 68.69(a) (Findings 9- 19);

F) provide required refresher training to each employee involved in operating a process, to ascertain that it is received and understood by employees, and to document such training, as required by 40 CFR § 68.71 (Findings 20 – 21);

G) establish and implement written procedures to maintain the ongoing integrity of process equipment, as required by 40 CFR § 68.73(b) (Findings 22 – 27);

H) establish and implement written procedures to manage changes to process equipment and procedures, as required by 40 CFR § 68.75 (Findings 28 – 42);

I) promptly determine and document an appropriate response to each of the findings of the compliance audit, and document that deficiencies had been corrected, as required under 40 CFR § 68.79 (Finding 43);

J) ensure that findings and recommendations of incident investigations had been adequately addressed and implemented, as required by 40 CFR § 68.81(e) (Findings 44 – 48); and

K) implement the emergency response plan applicable to the August 6, 2012 response to the leaking pipe and subsequent fire as required under 40 CFR § 68.95(a) (Finding 49).

EPA's overarching concern is the pervasive failure of Chevron to adequately develop and manage its RMP for the Facility, as referenced in Finding 1.

In addition, the Summary of Findings identifies late and deficient release reporting to the National Response Center (NRC), as required by Section 103 of CERCLA, and to appropriate state and local emergency response authorities, as required by the Section 304 of EPCRA. These reporting deficiencies relate to releases which occurred on March 5, 2010, August 2, 2012, August 6, 2012, and May 17, 2013.

Based on these findings of violations, EPA concludes that Chevron must (a) correct deficient release reporting to the National Response Center and the appropriate state and local authorities; (b) submit any documentation of actions which have corrected the identified violations; and (c) provide information regarding Chevron's plans to improve safety at the Facility, whether such plans are voluntary or subject to agreements made to other agencies. Upon review of such information, EPA intends to identify remaining gaps in risk management or enforceability of plans for safety improvements, and to seek a federally enforceable agreement to ensure full compliance with CAA Sections 112(r)(1) and (7) and implementing regulations, 40 CFR Part 68, for the safe operation of all covered processes at the Facility.

Please provide a written response to this letter within 30 days, stating whether Chevron intends to comply with these requirements and proposing a time frame in which to do so. The response should be sent to:

Mary Wesling, EPCRA/RMP Enforcement Coordinator
U.S. Environmental Protection Agency (SFD-9)
75 Hawthorne Street
San Francisco, CA 94105

Failure to comply with Section 112(r) of CAA, Section 304 of EPCRA or Section 103 of CERCLA may potentially result in enforcement action by EPA. Section 113 of CAA (42 U.S.C. § 7413), Section 325 of EPCRA (42 U.S.C. § 11045) and Section 109 of CERCLA (42 U.S.C. § 9609) permit EPA to seek civil and/or criminal penalties for failure to comply with the Accidental Release Prevention Requirements of Section 112(r) and release reporting requirements under EPCRA and CERCLA. Issuance of this FOV does not prejudice EPA's rights or authority to bring an enforcement action for violations of CAA, EPCRA, or CERCLA.

Questions about the legal aspects of this investigation should be directed to Mr. Joshua Wirtschafter, Assistant Regional Counsel, U.S. EPA Region 9, at (415) 972-3912. The Region 9 technical contact for this matter is Mary Wesling, who can be reached at (415) 972-3080.

Enclosure

SUMMARY OF FINDINGS
Chevron Richmond Refinery Investigation
August 6, 2012 – July 31, 2013

Summary of Findings under CAA § 112(r)(7), 40 CFR Part 68		
CAA Finding No.	***Description***	***Citation***
1	Management System	40 CFR §§ 68.12 – 15
2 – 6	Process Safety Information	40 CFR § 68.65
7 – 8	Process Hazard Analysis	40 CFR § 68.67
9 – 19	Operating Procedures	40 CFR § 68.69
20 – 21	Training	40 CFR § 68.71
22 – 27	Mechanical Integrity	40 CFR § 68.73
28 – 42	Management of Change	40 CFR §68.75
43	Compliance Audits	40 CFR § 68.79
44– 48	Incident Investigations	40 CFR § 68.81(e)
49	Emergency Response Program	40 CFR § 68.95(a)
Summary of Findings under EPCRA § 304, 40 CFR § 355.33		
EPCRA Finding No.	***Description***	***Citation***
1 – 4	Release reporting to the State Emergency Response Commission (SERC)	40 CFR § 355.33
5 – 8	Release reporting to the Local Emergency Planning Agency Response Commission (LEPC)	40 CFR § 355.33
Summary of Findings under CERCLA § 103, 40 CFR § 302.6		
9 – 13	Release reporting to the National Response Center	40 CFR § 302.6

CAA 112(r)(7) RMP FINDINGS:

FINDING 1: MANAGEMENT SYSTEM (40 CFR §§ 68.12 – 68.15)

Requirement found at Subpart A – General – Management, 40 CFR § 68.12(d)(1) and 68.15(a). The owner or operator of a stationary source with processes subject to Program 2 or Program 3 shall develop a management system to oversee the implementation of the risk management program elements.

- Causal factors in five of Chevron's incident investigation reports reviewed by EPA identified inadequate communications of expectations and failure of communications between management and staff. Interviews with employees and numerous deficiencies identified during this investigation indicate inadequate implementation of the Chevron Risk Management System and prevention requirements of that system. Failure of communication was also cited in a California Division of Occupational Safety and Health (CalOSHA) report of their investigation following a corrosion failure at F1550 in the Refinery Lubrication Oil Process (RLOP).

- **Finding 1:** The violations identified in EPA's current investigation following the August 6, 2012 incident indicate deficiencies in the development and implementation of the Management System as required under 40 CFR §§ 68.12(d)(1) and 68.15(a).

FINDINGS 2 – 6: PROCESS SAFETY INFORMATION (40 CFR § 68.65)

Requirement found at Subpart D – Prevention Program – Process Safety Information, 40 CFR § 68.65(d)(1)(ii). The owner or operator shall complete a compilation of written process safety information including information pertaining to the equipment in the process, which shall include: (ii) Piping and instrument diagrams (P&ID's);

- EPA's review of relevant documentation showed that monitoring devices which were installed on the 8-inch 4 side-cut line located on the C-1100 Column of No. 4 Crude Unit were not shown on the P&ID.
  - **Finding 2:** Chevron failed to ensure that information pertaining to the equipment in the process, specifically the P&ID for the 4-sidecut line, was accurate, in violation of 40 CFR § 68.65(d)(1)(ii).

Requirement found at Subpart D – Prevention Program – Process Safety Information, 40 CFR § 68.65(d)(1)(iv). The owner or operator shall complete a compilation of written process safety information including information pertaining to the equipment in the process, which shall include (iv) Relief system design and design basis.

- Based on a review of Drawing #D-349791-0, valves had been installed in the No. 4 Crude Unit. However, in cross-checking the associated records for accuracy, it was noted that Chevron did not update the relevant table in the No. 4 Crude Unit Electronic Operating Manual (EOM) equipment lists to include the two newly installed PSVs.
- Based on a review of documentation for a project concerning heat exchangers E-1165A and E-1165B in the No. 4 Crude Unit, it was noted that the Facility had installed equipment. The installed equipment was identified on Drawing #D-349791-0A-REV-0. However, in cross-checking the associated records for accuracy, it was noted that Chevron did not update the relevant Table 3.5-1 in the No. 4 Crude Unit EOM to include the newly installed equipment.
  - **Findings 3 and 4:** Chevron failed to ensure that information pertaining to the equipment in the process was accurately updated, specifically Table 3.5-1 in the No. 4 Crude Unit EOM PSV for information pertaining to PSVs (Finding 3) and equipment installed on heat exchangers E-1165A and E1165B (Finding 4), as required under 40 CFR § 68.65(d)(1)(iv).

Requirement found at Subpart D – Prevention Program – Process Safety Information, 40 CFR § 68.65(d)(3). For existing equipment designed and constructed in accordance with codes, standards, or practices that are no longer in general use, the owner or operator shall determine and document that the equipment is designed, maintained, inspected, tested, and operating in a safe manner.

- Based on studies done and reported by Chevron's own Energy Technology Company (ETC), Chevron knew that A53 carbon steel was susceptible to sulfidation corrosion and should be inspected at an increased frequency. Chevron's PSI information demonstrates Chevron knew the 4-sidecut was constructed from A53 carbon steel. Nonetheless, Chevron failed to evaluate and complete upgrades in accordance with recognized and accepted good engineering practices established by industry, including API 943 "High-Temperature Crude Oil Corrosivity Studies" (1st ed. 1974) and API Recommended Practice 939-C "Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries" (May 2009). Chevron also failed to follow the recommendations of its own experts and inspectors.

- Based on review of the documentation and interviews, the process safety information for existing equipment, such as the RLOP furnaces F-1550 and F1250, had not been verified to ensure that it had been designed, maintained, inspected, tested and operated in a safe manner. The process safety information for these particular furnaces did not include all weld and construction information necessary to evaluate the design, maintenance or operational safety of these units. Failure to ensure that the PSI for the F-1550 existed and had been reviewed resulted in a failure of a carbon steel elbow and the November 2011 fire.

    - **Findings 5 and 6:** Chevron continued to operate older equipment designed and constructed in accordance with past codes, standards, or practices without determining that such equipment is designed, maintained, inspected, tested, and operated in a safe manner, and without documenting that determination, in violation of 40 CFR § 68.65(d)(3). Chevron failed to meet these requirements with regard to: the 8-inch carbon steel piping of the 4-sidecut (Finding 5); and the F-1550 and F-1250 RLOP furnaces (Finding 6).

FINDINGS 7 AND 8: PROCESS HAZARD ANALYSIS (40 CFR § 68.67)

Requirement found at Subpart D – Prevention Program – Process Hazardous Analysis, 40 CFR § 68.67(c)(4) and (7). The process hazard analysis (PHA) shall address: (4) Consequences of failure of engineering and administrative controls; and (7) A qualitative evaluation of a range of the possible safety and health effects of failure of controls.

- Chevron's PHA did not identify that a failure of the 4-sidecut piping would result in a loss of containment.

- The August 6, 2012 loss of containment of the 4-sidecut due to pipe rupture and subsequent fire actually resulted in more than $500,000 in on-site property damage, approximately 15,000 people in the community seeking medical attention and a Community Warning System (CWS) Level 3 alert, which would indicate a more serious consequence than identified by Chevron in its PHA.

    - **Finding 7 and 8:** Chevron's PHA failed to adequately address: the consequences of failure of the 4-sidecut 8" pipe (Finding 7), and a qualitative evaluation of a range of possible safety and health effects of failure of controls (Finding 8), as required under 40 CFR § 68.67(c)(4) and (7).

FINDINGS 9 – 19: OPERATING PROCEDURES (40 CFR § 68.69)

Requirement found at Subpart D – Prevention Program – Operating Procedures, 40 CFR § 68.69(a)(2)(i) and (ii). The owner or operator shall develop and implement written operating procedures that provide clear instructions for safely conducting activities involved in each covered process consistent with the process safety information and shall address…. (2) Operating limits: (i) Consequences of deviation (CoD); and (ii) Steps required to correct or avoid deviation.

- EPA found that Chevron had not adequately identified the consequence of deviations (CoDs) for operating outside specified limits in the No. 4 Crude Unit, Diesel Hydrotreater (DHT), and South Isomax EOMs for the following equipment:

    - Vacuum Bottom Circulating Reflux (VBCR)
    - C-1650 H2S Stripper
    - V-1660 Splitter Reflux Drum
    - Isomax South Vessel Level (V-910, V-912, V-913, V-920, V-921, V-922, V-930, V-931)

  - **Findings 9 - 12:** Chevron failed to develop and implement written operating procedures that provide clear instructions for safely conducting activities involved in each covered process consistent with the process safety information which addressed operating limits which included all consequences of deviation, as required under 40 CFR § 68.69(2)(i).

- EPA's review of the operating procedures concerning the shutdown procedures did not find information that would adequately assist an operator to clearly understand the consequences that may occur if they fail to follow the procedure as written and/or operate outside predetermined safe operating limits. EPA found that Chevron had not adequately identified the steps required to correct or avoid deviation, per 40 CFR § 68.69(a)(2)(ii) for the following variables relating to equipment in the No. 4 Crude Unit, DHT, and South Isomax Electronic Operating Manuals:

    - Crude Feed Pressure E-1102
    - F-1100A, F-1100B, and F-1160 furnace outlet temperature
    - F-1100A, F-1100B, and F-1160 furnace skin
    - Vacuum Top Circulating Reflux (VTCR) Rate
    - VBCR Rate
    - DHT Reactor Minimum-Pressure-Temperature.
    - Isomax South Vessel Level (V-910, V-912, V-913, V-920, V-921, V-922, V-930, V-931).

  - **Findings 13 - 19**: Chevron failed to develop and implement written operating procedures that provide clear instructions for safely conducting activities involved in each covered process consistent with the process safety information which addressed operating limits which included steps to correct or avoid deviation, as required under 40 CFR § 68.69(2)(ii).

FINDINGS 20 – 21: TRAINING (40 CFR § 68.71)

Requirement found at Subpart D – Prevention Program – Operating Procedures, 40 CFR § 68.71(b). Refresher Training. Refresher training shall be provided at least every three years, and more often if necessary, to each employee involved in operating a process to assure that the employee understands and adheres to the current operating procedures of the process; and (c) T*raining documentation.* The owner or operator shall ascertain that each employee involved in operating a process has received and understood the training required by this paragraph. The owner or operator shall prepare a record which contains the identity of the employee, the date of training, and the means used to verify that the employee understood the training.

- EPA reviewed an internal Chevron evaluation of their training program conducted in June 2007. EPA concludes that deficiencies in the training program were indicated.

- Details of the August 6, 2012 incident reveal inadequate training of personnel, as evidenced by the lack of full recognition of the risk of piping rupture and the possibility of auto-ignition.

- RMP requires that the refresher training be provided, at least every three years, and more often if necessary, to each employee involved in operating a process to assure that the employee understands and adheres to the current operating procedures of the process.

    - **Finding 20:** Chevron failed to ensure that refresher training for employees was frequent enough so that employees understood and adhered to the current operating procedures of the process, as required under 40 CFR § 68.71(b).

- The Contra Costa Health Services (CCHS) Hazardous Materials Program conducted an audit of Chevron's program under California Accidental Release Prevention Program (CalARPP) and completed a Preliminary Determination by CCHS Hazardous Materials Program dated July 7, 2011 (A-14-03 CalARP&ISO). As stated in the audit preliminary determination report, the Hazardous Materials Program auditors found that during training, many of the slides provided links to other documents (emergency procedures, consequences of deviation). Operators are expected to read over the other documents – although the text may or may not include that expectation. Specific to operating procedures, operators are expected to know where they are and to follow them, but there is not verification that operators actually followed the links and actually reached the other documents.

- As a result of the CCHS audit, CCHS required that Chevron ensure that the auditing process was expanded to confirm that operators are following the procedures as intended (e.g. procedure printed, used in the field, filled out as steps are completed, and tasks are performed in the order identified in the procedure).

- The updated Chevron incident investigation report on the August 6, 2012 Richmond fire, dated April 12, 2013, to the Certified Unified Program Agency (CUPA) provides examples of instances in which employees were not trained adequately in the execution of operating procedures.

- Many of Chevron's incident investigations identify a lack of communication between various personnel groups and between personnel and management as causal factors in the incidents. Chevron's investigation of the August 6, 2012 incident similarly identified lack of communication as a causal factor. More discussion of these finding can be found in the “Incident Investigation” section of this Summary of Findings. (See, Findings 44 – 48 below.)

- CCHS, Hazardous Materials Program’s Preliminary Determination, issued on July 7, 2011, details that the CCHS auditors asked the following question to Chevron personnel (A-25-09 RISO) – *“Are operating teams trained together in the transfer of information”* (Question 4-16)? And the answer was: “*No formal training is given to the operations personnel regarding the transfer of information*.”

- EPA reviewed five internal Chevron Incident Investigation reports, including the final report on the August 6, 2012 incident. EPA concludes that these reports show deficiencies in training.

- Lack of training on the transfer of information appears to be a factor in causing the August 6, 2012 incident. As stated in Chevron’s April 12, 2013, update to its report to CCHS: the incident “…occurred at change of shift and most of the dayshift personnel stayed to assist the nightshift personnel and were engaged in supporting and performing the insulation removal tasks. There was not a single meeting where all parties collectively considered the potential risks and outcomes.”

- In discussions with plant personnel during EPA’s inspection and in a review of Chevron’s latest update to the CCHS auditor on April 12, 2013, it was clear that the information indicating that the material in the pipe was near its auto-ignition temperature was not relayed to all those individuals making strategic decisions. The latest update states: “While operations personnel understood that the material was near its auto ignition temperature, some Chevron Fire Department personnel thought the temperature was near or below its flash point”.

    - **Finding 21:** Chevron failed to ascertain that each employee involved in operating a process has received and understood the training required. The owner or operator shall prepare a record which contains the identity of the employee, the date of training, and the means used to verify that the employee understood the training, as required under 40 CFR § 68.71 (c).

FINDINGS 22 – 27: MECHANICAL INTEGRITY (40 CFR § 68.73)

Requirement found at Subpart D – Prevention Program – Mechanical Integrity, 40 CFR § 68.73(b). Written procedures. The owner or operator shall establish and implement written procedures to maintain the ongoing integrity of process equipment.

- Chevron failed to implement a written mechanical integrity (MI) procedure titled “Corrosion Mitigation Plan” which Chevron issued on or before February 2006 (2006 MI Procedure”).

- Chevron never performed an inspection of the line as recommended in the 2006 MI Procedure. Chevron continued to use inadequate inspection techniques when an identified damage mechanism and system design led to multiple recommendations for more in-depth inspection of the 4-sidecut.

- Chevron failed to implement a written MI procedure titled “Updated Inspection Strategies for Preventing Sulfidation Corrosion Failures in Chevron Refineries,” which Chevron issued on or before September 30, 2009 (“2009 MI Procedure”).

- Although Chevron, during a 2002 one-time inspection of the 4-sidecut downstream from thickness monitoring location (TML) # 3, identified it as having low silica content and susceptibility to corrosion at higher rates, Chevron did not subsequently inspect this component, contrary to its 2009 MI Procedure. Chevron personnel indicated that some components were in hard to reach locations. The TMLs selected did not represent the limiting corrosion.

  - **Findings 22 - 23:** Chevron failed implement the 2006 MI Procedure (Finding 22) and the 2009 MI Procedure (Finding 23), to maintain the ongoing integrity of process equipment, as required by 40 CFR § 68.73(b).

Requirement found at Subpart D – Prevention Program – Mechanical Integrity, 40 CFR § 68.73(d)(2). Inspection and testing procedures shall follow recognized and generally accepted good engineering practices.

- Recognized and generally accepted good engineering practices applicable to the inspection of the 4-sidecut during the relevant periods include the following parallel provisions on selection of TMLs or corrosion monitoring locations (CMLs) (Section 5.5.3 of API 570 (2nd Edition, 1998) and Section 5.6.3 of API 570 (Third Edition, 2009)):

  - In selecting or adjusting the number and locations of TMLs/CMLs the inspector should take into account the patterns of corrosion that would be expected and have been experienced in the process unit. . . .

  - More TMLs/CMLs should be selected for piping systems with any of the following characteristics:

    - higher potential for creating a safety or environmental emergency in the event of a leak;
    - piping systems with higher expected or experienced corrosion rates; and
    - higher potential for localized corrosion;

- Chevron's design and construction of the 4-sidecut did not include any means to isolate the piping section in the event of a leak or failure, such as isolation valves. This resulted in a higher potential for creating a safety or environmental emergency in the event of a leak.

- In 2002, Chevron identified corrosion downstream of TML #3. Due to the identified corrosion and the service conditions, this piping was recommended for replacement in 2002. The piping was never replaced. Despite Chevron's identification of corrosion and pitting downstream of TML #3, Chevron did not adjust or increase the TML locations. Subsequent to the 2002 inspection, Chevron never again monitored the area downstream of TML #3 which showed increased corrosion, nor did Chevron monitor TML #3 again until 2011.

- Chevron was aware that this portion of the 4-sidecut was constructed of low Si content and was thus more susceptible to localized corrosion.

- Chevron failed to add or adjust TMLs at the 4-sidecut despite the presence of all three of the characteristics listed in API Standard 570 (2nd Edition, 1998 and 3rd Edition, 2009).

  - **Finding 24:** Chevron failed to follow recognized and generally accepted good engineering practices applicable to the inspection of the 4-sidecut, as required under 40 CFR § 73(d)(2).

- Recognized and generally accepted good engineering practices applicable to the piping inspections during the relevant periods include provisions on Reporting and Records for Piping System Inspections provided in Section 7.6 of API 570 (2nd Edition, 1998) and Section 7.6 of API 570 (Third Edition, 2009). These Standards require that the owners and users of piping systems "shall maintain" "permanent and progressive records" of the covered systems, including data on inspections including thickness measurements.

- Chevron was unable to produce the drawings showing thickness measurement locations and data that was described in a 2002 inspection report (indicating the lowest thickness reading on the 4-sidecut downstream from #3 TML.

  - **Finding 25:** Chevron failed to follow recognized and generally accepted good engineering practices applicable to the piping inspections, as required under 40 CFR § 68.73(d)(2).

Requirement found at Subpart D – Prevention Program – Mechanical Integrity, 40 CFR § 68.73(d)(4). The owner or operator shall document each inspection and test that has been performed on process equipment. The documentation shall identify the date of the inspection or test, the name of the person who performed the inspection or test, the serial number or other identifier of the equipment on which the inspection or test was performed, a description of the inspection or test performed, and the results of the inspection or test.

- Chevron was unable to produce the thickness measurement data that was described in a 2002 inspection report indicating the lowest thickness reading on the 4-sidecut in the area of the #3 TML/CML.

  - **Finding 26:** Chevron failed to document the results of inspections or tests performed on process equipment, as required under 40 CFR § 68.73(d)(4).

Requirement found at Subpart D – Prevention Program – Mechanical Integrity, 40 CFR § 68.73(e). The owner or operator shall correct deficiencies in equipment that are outside acceptable limits (defined by the process safety information in 40 CFR § 68.65) before further use or in a safe and timely manner when necessary means are taken to assure safe operation.

- The process safety information for the 4-sidecut requires that equipment complies with recognized and generally accepted good engineering practices. 40 CFR § 68.65(d)(2).

- Post-accident thickness measurements of the 4-sidecut taken near the point of rupture showed thickness ranging between 0.012 to 0.070 inches.

  - **Finding 27:** Chevron failed to correct deficiencies in the 4-sidecut that were outside acceptable limits before further use or taking necessary measures to assure safe operation, as required under 40 CFR § 68.73(e).

FINDINGS 28 – 42: MANAGEMENT OF CHANGE (40 CFR § 68.75)

Requirement found at Subpart D – Prevention Program – Management of Change 40 CFR § 68.75(a). The owner or operator shall establish and implement written procedures to manage changes (except for ''replacements in kind'') to process chemicals, technology, equipment, and procedures; and, changes to stationary sources that affect a covered process.

- Chevron established a written Management of Change (MOC) refinery instruction (RI-370) that defines the process for implementing temporary changes, including leak seal repairs. RI-370 limits the duration allowed for a temporary change before long-term resolution. In multiple instances, Chevron has issued temporary MOCs and extended the expiration dates beyond the time frame specified in its refinery instruction.

    - MOC #2599 – Temporary MOC for clamping a flange leak.
    - MOC #10855 – Temporary MOC for leak sealing a pump case gasket unit.
    - MOC #15197 – Temporary MOC for leak sealing a flange and two valve packings.
    - MOC #16210 – Temporary MOC for leak sealing a valve packing.
    - MOC #17395 - Temporary MOC for leak sealing an orifice flange.
    - MOC #20968 - Temporary MOC for replacing existing clamps on piping.
    - MOC #21434 - Temporary MOC for leak sealing an Inlet block valve.
    - MOC #21513 - Temporary MOC for leak sealing a valve.

    - o **Findings 28 - 38:** Chevron failed to implement its MOC Procedure RI-370 (defining the process for temporary changes), as required under 40 CFR § 68.75(a).

Requirement found at Subpart D – Prevention Program – Management of Change, 40 CFR § 68.75(b)(1) and (2). The procedures shall assure that the following considerations are addressed prior to any change: (1) The technical basis for the proposed change; and (2) Impact of change on safety and health.

- Chevron completed MOC #25789 (4 Crude Recover – Processing Piping Material Changes), but Chevron failed to address in writing the 1) technical basis for the proposed changes and 2) impact of change on safety and health.

- Chevron completed Temporary MOC #24255 to begin monitoring on the 8" 4-sidecut piping circuit from C-1100 to P-1149A in the No. 4 Crude Unit and to replace the piping with the next shutdown. The MOC was issued on 11/22/2011 with an expiration date of 12/31/2016. A Chevron employee was assigned as responsible person for the PHA/HSE Review but no completion date or sign off was documented and no HSE form was provided with the MOC.

    - o **Findings 39 – 40:** Chevron failed to follow the Management of Change procedures ensuring that prior to the change the technical basis for the proposed change and the impact of change on safety and health had been addressed, as required under 40 CFR § 68.75(b).

***Requirement found at Subpart D – Prevention Program – Management of Change, 40 CFR §§68.75(d) and (e). Management of Change*.** (d) If a change covered by this paragraph results in a change in the process safety information required by § 68.65 of this part, such information shall be updated accordingly. (e) If a change covered by this paragraph results in a change in the operating procedures or practices required by § 68.69, such procedures or practices shall be updated accordingly.

- When Chevron completed MOC #21023 to implement a process change to install equipment in the No. 4 Crude Unit, the Facility installed valves as identified on Drawing #D-349791-0 but did not update the relevant table in the No. 4 Crude Unit EOM to include the two newly installed valves.

- When Chevron completed MOC #23282 to implement a process change relevant to heat exchangers in the No. 4 Crude Unit, the Facility installed four valves as identified on Drawing #D-349791-0A-REV-0 but did not update the relevant table in the No. 4 Crude Unit EOM to include the four newly installed valves.

    - **Findings 41 - 42:** Chevron implemented a process change that resulted in a change to the process safety information and operating procedures, but failed to update the information accordingly, as required by 40 CFR § 68.75(d) and (e).

FINDING 43: COMPLIANCE AUDITS (40 CFR § 68.79)

Requirement found at Subpart D – Prevention Program – Compliance Audits, 40 CFR § 68.79(d). The owner or operator shall promptly determine and document an appropriate response to each of the findings of the compliance audit, and document that deficiencies have been corrected.

- The most recent compliance audit, at the time of the EPA investigation, dated 2010, resulted in the identification of deficiencies which were not promptly addressed by an appropriate response.

    - **Finding 43:** Chevron failed to promptly determine and document an appropriate response to each of the findings of the compliance audit, and document that deficiencies had been corrected, as required under 40 CFR § 68.79(d).

FINDINGS 44 – 48: INCIDENT INVESTIGATION (40 CFR § 68.81)

Requirement found at Subpart D – Prevention Program – Incident Investigations, 40 CFR § 68.81(e). The owner or operator shall establish a system to promptly address and resolve the incident report findings and recommendations. Resolutions and corrective actions shall be documented.

- Chevron completed the five incident investigations listed below, but failed to promptly address and resolve the findings and recommendations, as evidenced by the repeat findings in subsequent incident investigations.

    - Loss/Near Loss ID 503
    - Loss/Near Loss ID: 23483
    - Loss/Near Loss ID: 23624

- Loss/Near Loss ID 23903
- Loss/Near Loss 38106

  - **Findings 44 – 48:** Chevron failed to ensure that findings and recommendations of incident investigations had been adequately addressed and implemented.

FINDING 49: EMERGENCY RESPONSE (40 CFR § 68.95)

Requirement found at Subpart E – Emergency Response, 40 CFR § 68.95(a). The owner or operator shall develop and implement an emergency response program for the purpose of protecting public health and the environment.

- The Chevron Fire Department did not implement the emergency response plan applicable to the August 6, 2012 response to the leaking pipe and subsequent fire. For example, Chevron Fire Department personnel completed a Scene Safety and Action Plan form, but they did not complete a Hazard Material Data Sheet for this leak as directed by the Scene Safety and Action Plan form. (7th Interim Report to Contra Costa County on the August 6th, 2012 Incident).

  - **Finding 49:** Chevron failed to implement its emergency response program for the purpose of protecting public health and the environment, as required under 40 CFR § 68.95(a).

EPCRA SECTION 304 / CERCLA SECTION 103 NOTIFICATIONS
40 CFR §§ 355.33 AND 302.6

FINDINGS 1 – 8: EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT

EPCRA 304 Requirement found at 40 CFR § 355.33, Emergency Release Notification. The owner or operator of a covered facility must provide the required emergency release notification information described under § 355.40(a) immediately following a release of a reportable quantity (RQ) of an EPCRA Extremely Hazardous Substance (EHS) or a CERCLA Hazardous Substance (HS) to the State Emergency Response Commission (SERC) and the Local Emergency Response Committee (LEPC).

- On March 5, 2010, at 0900 Pacific Standard Time (PST), Chevron released 725 lbs. of sodium hypochlorite within a 24-hour period, a CERCLA HS with a reportable quantity of 100 lbs. Chevron reported the release to the SERC and LEPC on March 5, 2010 at 1242 PST, a delay of three hours and 42 minutes.

- On August 2, 2012, at 0715 PST, Chevron released 838 lbs. of hydrogen sulfide within a 24-hour period, an EPCRA EHS and a CERCLA HS with an RQ of 100 lbs. Chevron reported the release to the SERC and LEPC on August 2, 2012 at approximately 1414 PST, a delay of six hours and 59 minutes.

- On August 6, 2012, at approximately 1836 PST, Chevron released over 100 lbs of hydrogen sulfide within a 24-hour period, an EPCRA EHS and a CERCLA HS with an RQ of 100 lbs. Chevron failed to report the release to the SERC and LEPC.

- On May 17, 2013, at approximately 1000 PST, Chevron released 120.6 lbs of ammonia within a 24-hour period, an EPCRA EHS and CERCLA HS with and RQ of 100 lbs. Chevron reported the release to the SERC and LEPC on May 20, 2013 at approximately 1630 PST, a delay of 3 days, six hours and 30 minutes.

  - **Findings 1 – 4:** On March 5, 2010, August 2, 2012, August 6, 2012 and May 17, 2013, Chevron failed to immediately notify the SERC of release of reportable quantities of EPCRA EHSs and/or CERCLA HSs, as required under 40 CFR § 355.33.

  - **Findings 5 – 8:** On March 5, 2010, August 2, 2012, August 6, 2012 and May 17, 2013, Chevron failed to immediately notify the LEPC of release of reportable quantities of EPCRA EHSs and/or CERCLA HSs, as required under 40 CFR § 355.33.

FINDINGS 9 – 13: CERCLA

***CERCLA Requirement found at 40 CFR § 302.6, Emergency Release Notification**.* Any person in charge of a facility shall, as soon as he or she has knowledge of any release (other than a federally permitted release or application of a pesticide) of an HS from such facility in a quantity equal to or exceeding the RQ in any 24-hour period, immediately notify the National Response Center (NRC).

- On March 5, 2010, at 0900 Pacific Standard Time (PST), Chevron released 725 lbs. of sodium hypochlorite within a 24-hour period, a CERCLA HS with an RQ of 100 lbs. Chevron failed to report the release to the NRC.

- On August 2, 2012, at 0715 PST, Chevron released 838 lbs. of hydrogen sulfide within a 24-hour period a CERCLA HS with an RQ of 100 lbs. Chevron reported the release to the NRC on August 2, 2012 at approximately 1425 PST, a delay of seven hours and 10 minutes.

- On August 6, 2012, at approximately 1836 PST (based on video of the incident), Chevron released over 1000 lbs of nitrogen dioxide, a CERCLA HS with an RQ of 1000 lbs. Chevron reported the release to the NRC on August 6, 2012 at approximately 1908, a delay of 32 minutes. On August 6, 2012, at approximately 1836 PST, Chevron released over 100 lbs of hydrogen sulfide, a CERCLA HS with an RQ of 100 lbs. Chevron reported the release to the NRC on August 6, 2012 at approximately 1908, a delay of 32 minutes.

- On May 17, 2013, at approximately 1000 PST, Chevron released 120.6 lbs of ammonia within a 24-hour period, a CERCLA HS with an RQ of 100 lbs. Chevron reported the release to the NRC on May 20, 2013 at approximately 1630 PST, a delay of 3 days, six hours and 37 minutes.

  - **Findings 9 - 13:** On March 5, 2010, August 2, 2012, August 6, 2012 and May 17, 2013, Chevron failed to immediately notify the NRC of releases of reportable quantities of CERCLA HSs, as required under 40 CFR § 302.6(a).