CHEVRON RICHMOND REFINERY
FEBRUARY 9, 2021, OIL SPILL INCIDENT INVESTIGATION
THIRD-PARTY REVIEW

Prepared for:

CONTRA COSTA
HEALTH SERVICES

Contra Costa County
4585 Pacheco Blvd, Suite 100
Martinez, California 94553

June 1, 2023

AcuTech Group, Inc.
1919 Gallows Rd., Suite 900
Vienna, Virginia 22182 USA
www.acutech-consulting.com

Table of Contents

1. EXECUTIVE SUMMARY

Background

On February 9th, 2021, Chevron Richmond Refinery confirmed an oil leak from the 003 line at the Richmond Long Wharf. The leak released approximately 18 barrels of hydrocarbons into the San Francisco bay. Chevron Richmond Refinery issued a level 2 Community Warning System (CWS) Notification via their CWS Terminal by Contra Costa Health (CCH). In response to the incident, CCH - Hazardous Materials Programs (CCHHMP) designated the incident a Major Chemical Accident or Release (MCAR) per Contra Costa County's (CCC) industrial safety ordinance (ISO) and City of Richmond industrial safety ordinance (RISO) regulatory requirements.

CCH commissioned AcuTech Group, Inc. (AcuTech) to provide a third-party review of the Chevron Richmond Refinery February 9, 2021 oil spill investigation. AcuTech was contracted by CCH to initiate the project on August 13, 2021, but was unable to begin the assessment per the contract until Chevron released the report of their investigation. The contract was again updated, to extend the term only, on June 22, 2022, while awaiting the Chevron report. On August 26, 2022, Chevron provided the report titled **"*Event Title: February 9, 2021 Richmond Long Wharf Incident, IMPACT ERM Investigation #128842 & LI #192231, September 23, 2021*"**[1], to AcuTech.

AcuTech Scope of Work and Approach

AcuTech's scope of work was not to conduct an independent investigation but was limited to providing a third-party review of the incident investigation report conducted by Chevron. This involved AcuTech performing the following tasks:

- Reviewing the root cause analysis report to ascertain the completeness of the report and adherence to the requirements and expectations of the ISO or RISO
- Developing a set of questions and additional data required to further understand the events leading up to the incident, discovery, mitigation, and recommended actions related to the incident
- Reviewing data provided by Chevron on the response to the event, root cause analysis (RCA) process and mechanical integrity specific aspects for line 003 including the design, construction, maintenance, inspection, procedures, surveillance, and repair
- Reviewing Chevron's follow-up response and status of their recommended actions related to the incident and RCA including the actions taken to date by Chevron to address their findings
- Evaluating agency notifications along with other completed and available agency notification and investigation reports
- Developing an opinion on the RCA and actions by Chevron related to the investigation and follow-up

To aid in completion of the above tasks, AcuTech requested additional documents be provided by Chevron to understand the incident and how they were addressing the findings of their investigation. Questions were posed to Chevron regarding the incident investigation report and Chevron provided written responses along with verbal responses through interviews conducted with Chevron personnel.

Conclusions

Contributing factors and root causes that led to the Richmond Long Wharf line 003 pipeline leak were identified in the Chevron incident investigation report. Based on the review of these factors, root causes, recommended actions and the Chevron incident investigation report, AcuTech concluded the following:

- The TapRoot® methodology used by Chevron is a recognized commercially available root cause analysis tool that is widely used in industry for this purpose and is referenced in guidance from CCHHMP for compliance with the ISO/RISO. They used this tool and other means (interviews, engineering reviews, further site inspections, records reviews) to determine the root causes and contributing factors.
- Chevron identified two contributing factors and five root causes to the event (Table 1) that AcuTech also believes were the underlying causes and factors leading to the event. The five recommended actions (Table 3) do address preventing reoccurrence of the events of the Richmond Long Wharf oil spill incident and are in line with industry best practices.
- Beyond the TapRoot® process, Chevron showed through interviews and actions that they took the incident very seriously and management was directly engaged in understanding the root causes and seeing to the resolution of corrective actions. The Refinery manager held meetings to ensure actions were taken to understand the root causes of the event and take corrective action to prevent reoccurrence. AcuTech believes this is a key purpose of root cause analysis and so the intent of the process was met as addressed by the thoroughness of the investigation and implementation of technical lessons learned.
- The root causes identified failures in both Chevron Richmond Refinery's management of change (MOC) system and fixed equipment asset strategy (FEAS) program for the wharf. Shortcomings in these two systems played a large role in contributing to this event which Chevron acknowledged through their root cause analysis report conclusions and recommended actions.
    - Chevron identified the failures of the mechanical integrity systems adequately with critical introspection and has committed to improved methods for inspection and maintenance of wharf line 003.
    - Damage mechanisms for line 003 have been updated and Chevron has made improvements to their processes for inspection and replacement or repair of the line including implementation of the MOC program for pipe material changes.
- The five recommended actions were completed by the targeted completion date identified by Chevron in the 30 day follow up report[2]. These recommended actions address the root causes identified in the incident investigation. Positive changes were made regarding training of MOC and incident investigation by specifically discussing this incident. MOC training also discussed changes in piping type from cement lined to carbon steel pipe would classify as a change needing to follow the MOC process. In addition, updates to process safety related programs such as mechanical integrity inspections using Saturated Low Frequency Eddy Current (SLOFEC), implementing more robust data analyses for repeat pipeline repairs ("bad actors"), and corrections to P&IDs. Chevron is also working to pilot a leak detection technology on one of its Richmond Long Wharf pipelines.

- The appropriate agencies were notified by Chevron approximately 1 hour after Chevron received the initial public notification. While CCH requires notification as soon as possible or within 15 minutes, it is AcuTech's opinion that Chevron made all reasonable efforts to meet the requirements of CCH notification while still maintaining good emergency response practices of containing a leak to reduce environmental consequences.

2. INTRODUCTION

2.1. Background & Objectives

Chevron Richmond Refinery had a hydrocarbon leak from a pipeline (003 line, also known as 16 Ballast line) at the Chevron Richmond Long Wharf on February 9, 2021. Per Chevron calculations, up to 18.41 barrels of hydrocarbon leaked into the San Francisco Bay which was a mix of ultra-low sulfur diesel fuel and flush water[2]. Containment booms were deployed to protect environmentally sensitive sites and shorelines. A Level 2 community warning public health advisory was issued to nearby residents following the CCH - Hazardous Materials Program policy for hazardous materials incident notification.

In response to the incident, CCH - Hazardous Materials Programs designated the incident a Major Chemical Accident or Release (MCAR) per ISO and RISO regulatory requirements. Section 6.43.090(c)(2) of the RISO (similar to Section 450-8.016(c)(2) of the ISO) allows Contra Costa Health Hazardous Materials Program to conduct an independent root cause analysis of the MCAR. In this case, CCHHMP recommended to the Contra Costa County Industrial Safety Ordinance/Community Warning System Ad Hoc Committee, which is appointed by the County Board of Supervisors, that CCH hire an independent expert to review the root cause investigation report conducted by Chevron.

CCH requested AcuTech Group, Inc. (AcuTech) to provide a proposal to conduct a third-party review of the Chevron Richmond Refinery February 9, 2021 oil spill investigation. AcuTech was contracted by CCH to initiate the project on August 13, 2021, but was unable to begin the assessment per the contract until Chevron released the report of their investigation allowing AcuTech to begin the review. The contract was again updated, to extend the term only, on June 22, 2022, while awaiting the Chevron report. Chevron then provided the report titled "***Event Title: February 9, 2021 Richmond Long Wharf Incident, IMPACT ERM Investigation #128842 & LI #192231, September 23, 2021***"[1], to AcuTech on August 26, 2022.

2.2. Report Format

This report includes information requested by CCH including the scope (section 3), evaluations of the following in the Chevron report:

- Incident investigation review; section 4
- Findings / incident causes (root causes); section 5
- Recommendations and action plans; section 6
  - Proposed and completed action plans and their current status
- Agency Notifications; section 7
- A conclusion is provided in section 8.

2.3. Review Team

The study was conducted by AcuTech Group, Inc. Personnel involved in the review were:

- David Moore, PE, CSP – President and CEO
- David Heller, CSP, CPSA – Senior Principal Engineer, Incident Investigation Specialist
- Alison Ballon – Principal Engineer, Incident Investigation Specialist
- Mark Politte – Senior Principal Engineer, Mechanical Integrity Specialist
- Ken Min – Senior Engineer, Mechanical Integrity Specialist

3. SCOPE AND APPROACH

The scope for this project was to conduct a third-party review of the RCA investigation of the Chevron Long Wharf Oil Spill incident, including the notification process at the Chevron Richmond Refinery as performed by Chevron. AcuTech's scope of work was not to conduct an independent investigation of the Long Wharf Line 003 release. The purpose of Chevron's RCA investigation and report was to adequately address any gaps in the safety program and management practices at the Chevron Richmond Refinery.

As defined by CCH, AcuTech's scope specifically consisted of:

a. Review the completed RCA report provided by the Chevron Richmond Refinery and interview key members of their investigation. AcuTech's independent review and investigation, and final report to Contra Costa County include, but not be limited to:
   i. Review of the Mechanical Integrity program and how it applies to the pipeline, including:
      A. Inspection data of the ballast line;
      B. Corrosion monitoring;
      C. Determination of the metallurgy and failure route;
      D. Procedure for use of the ballast line pre- and post-loading operation;
      E. Surveillance during use; and
      F. Other process safety management systems that may be applicable to this incident.
   ii. Review Chevron Richmond Refinery's action plan to ensure that the recommendations and action plans are addressing the findings from the incident investigation;

A. NOTE: due to the length of time that passed since the incident occurred, the original scope was expanded to evaluate how action plans were addressed and ensuring recommended actions were completed as intended

iii. Review the creation of the incident/event timeline; and

iv. Review the Chevron Richmond Refinery's notification process.

b. Review other completed and available investigation reports from the Coast Guard, the Oil Spill and Prevention Response team from California Department of Fish and Wildlife, and CalOSHA.

c. Take part in a public participation process, which will include the following:

i. Develop a public Oversight Committee to oversee the investigation review process;

A. Hold a report-out meeting with the Oversight Committee after review of Chevron's incident investigation report is complete and provide a written completeness evaluation of Chevron's incident investigation. Contractor will make appropriate changes to the evaluation report based on feedback received from the Oversight Committee; and

B. Hold a public meeting once the written completeness report has been accepted from the Oversight Committee. This report will have a 45-day public comment period during which the public meeting will held, Contractor will listen to the public's concerns and consider making changes in the report and work with Chevron to complete the evaluation report. Contractor shall respond to all written comments and comments raised in the public meeting.

ii. Attend and present reports at the following meetings:

A. A public meeting to present the draft evaluation report; and

B. Two (2) public meetings to present the final evaluation report to Contra Costa County Board of Supervisors and the Richmond City Council.

d. Provide a final evaluation report to the Contra Costa Health Hazardous Materials Programs Director, or designee, which will include the results of its independent review and investigation into the Chevron Long Wharf Oil Spill incident, Chevron's investigation into the incident (including a RCA), the public comments received during the public comment

Scope covered under items c and d above have not been completed as of this issue of this draft report. After the draft third-party review report is issued, scope item c will commence and timing to complete may vary. A final evaluation report (scope item d) will only be issued after completion of tasks in scope item c.

The approach used by AcuTech to complete the scope of work included the following tasks:

- Reviewing the root cause analysis report to ascertain the completeness of the report and compare the method used and work product to the requirements and expectations of the ISO/RISO requirements for investigating incidents and for handling a MCAR
- Developing a set of questions and additional data required to further understand the events leading up to the incident, discovery, mitigation, and recommended actions related to the incident
- Reviewing data provided by Chevron on the response to the event and RCA process

- Assessing the mechanical integrity program including the design, construction, maintenance, inspection, procedures, surveillance, and repair of line 003 on the Long Wharf
- Interviewing Chevron personnel regarding the investigation process and to determine the policies and procedures employed for mechanical integrity of line 003 including
    - Investigation Team Lead
    - Richmond Refinery Fixed Equipment Inspection Team Lead
    - Richmond Refinery PSM Manager
- Reviewing Chevron's follow-up response and status of their actions related to the incident and RCA
- Reviewing draft recommended action completion reports provided by Chevron to evaluate and comment on how recommended actions were completed
- Evaluating agency notifications along with other completed and available agency notification and investigation reports
- Developing an opinion on the RCA and actions by Chevron related to the investigation and follow-up.

4. EVALUATION OF INCIDENT INVESTIGATION

Chevron's Richmond Long Wharf incident investigation was conducted using the TapRooT® RCA methodology which is a recognized commercially available root cause analysis tool that is widely used in industry for this purpose. TapRooT® incident investigation system is also referenced in guidance from CCC ISO for compliance with the ISO/RISO as one of the acceptable methodologies of conducting a root cause analysis.

Per Chevron instruction document RI-371, Near Loss, Event Reporting and Incident Investigation, the severity of this incident did not warrant a TapRooT® investigation. This was done to ensure the investigation addressed potential issues relating to management systems and technical systems. Chevron had an independent leader from corporate HSE in San Ramon to lead the incident investigation and along with a qualified TapRoot investigator providing support. They used this tool and other means (interviews, engineering reviews, further site inspections, records reviews) to determine the root causes and contributing factors.

The investigation began shortly after the incident occurred with the investigation concluding on October 24, 2021 before Chevron provided the last 30-day follow-up report[2] to CCH. A copy of the final 30-day follow-up report can be found on the CCH website.

Included in the Chevron incident investigation report is a SnapCharT® event timeline prepared by members of the Chevron incident investigation team. This timeline starts with the install of line 003 in 1948, covers various damages and leaks that occurred in the history of line 003 along with inspection and repairs made prior to the incident. Details are also included in the timeline for day of events beginning with estimated start time of the leak based on pressure drops in the line, confirmation of the leak, when the leak was stopped and ended with installation of the repair clamp on the leak location. The SnapCharT® identified the two contributing factors or contributing causes (shown in Table 1) along with the direct cause which is the leak of line 003. Each of the contributing factors were reviewed using the TapRooT® Root Cause Tree® process to identify

the appropriate root causes of the incident described in Table 1. Evaluation of the actual contributing factors and root causes is described in section 5.

AcuTech's review of the incident investigation root cause methodology found the approach to be complete in capturing direct causes, contributing factors, root causes and providing a complete timeline of events. It was also confirmed that the RCA investigation performed by Chevron was in compliance with RISO/ISO requirements including those in Section 6.43.090(c)(1) of the RISO (similar to Section 450-8.016(c)(1) of the ISO).

Beyond the TapRoot® process, Chevron showed through interviews and actions that they took the incident very seriously and management was directly engaged in understanding the root causes and seeing to the resolution of corrective actions. The Refinery manager held meetings to ensure actions were taken to understand the root causes of the event and take corrective action to prevent reoccurrence. AcuTech believes this is a key purpose of root cause analysis and so the intent of the process was met as addressed by the thoroughness of the investigation and implementation of technical lessons learned.

5. EVALUATION OF RCA FINDINGS / ROOT CAUSES

The Chevron Richmond Wharf incident investigation team identified two contributing factors and five root causes for the 003 line which are provided in Table 1.

Table 1: Contributing Factors and Root Causes (Chevron RCA Report)

Contributing Factors and Root Causes
Contributing Factor 1: The cement-lined carbon steel pipe in intermittent use failed due to internal corrosion
• Root Cause 1. The asset strategy for the 003 Line did not include inspection techniques that were adequate for detecting localized corrosion in cement-lined pipe. • Root Cause 2. Loss/Near Loss Reports for prior incidents had not been consistently generated. • Root Cause 3. There is no formal process to trigger lookbacks on the history of the line that could track "bad actors." • Root Cause 4. MOC review may have provided an opportunity to identify any concerns unique to cement-lined piping.
Contributing Factor 2: If the leak was detected and contained sooner, the severity of the event would have been reduced (i.e., Level 1 or 2 instead of Level 3a incident)
• Root Cause 5: Leak detection and passive containment at RLW requires further review

AcuTech performed a detailed review of the RCA investigation report evaluating each of the identified contributing factors and root causes. Results of this review are broken down into three sections: management systems, inspection history and human factors. AcuTech did not perform an audit of the evaluated management systems, only reviewed them with respect to the 003 Line pipeline leak.

AcuTech concluded that this event was a failure to follow good engineering and industry practices for mechanical integrity for piping systems handling hydrocarbons. It was exacerbated by the complexity of the piping system (the length of piping, the concrete lining making inspection more challenging, the location over water, and other factors). It is believed Chevron identified these issues adequately with critical introspection and has committed to improved methods for inspection and maintenance of wharf line 003.

5.1. Management Systems

5.1.1. Management of Change

An effective management of change (MOC) system ensures hazards posed by potential changes are identified and mitigated to the extent possible. Chevron noted in their investigation report that sections of the 003 line were replaced with unlined carbon steel pipe and in several instances, these changes did not go through the standard Richmond Refinery MOC process. AcuTech reviewed several of the MOCs conducted on the 003 line along with changes in the piping that were completed outside of the MOC process.

Section 6.43.090(a)(6) of the RISO requires regulated stationary sources to establish and implement written procedures to manage changes except for replacement in kind.

Changing cement lined carbon steel pipe with unlined carbon steel would be considered a change in design specification and therefore does not meet the definition of a replacement in kind. A MOC should have been completed whenever portions of the 003 line were changed from cement lined carbon steel piping to unlined carbon steel pipe. Section 6.43.090(a)(6)(B) of the RISO also requires that the MOC procedure addresses the following considerations prior to any change being implemented: the technical basis for the proposed change; the impact of change on safety and health; modifications to operating procedures; necessary time period for the change; and authorization requirements for the proposed change. Root cause 4 identified that following the MOC process may have provided the opportunity for relevant parties, such as materials engineering group, to identify concerns of making this change including impacts to the integrity of the piping. Following the MOC process may have also provided an opportunity to update associated inspection isometrics as the Chevron MOC process does require updating relevant process safety information. Recommended action 2 in Table 3 was developed to address the root cause of failure to conduct MOCs. Chevron confirmed that personnel are trained in their MOC program and to address possible confusion, their MOC training material was updated to include changing of pipe material as an example change that would warrant a MOC.

5.1.2. Fixed Equipment Asset Strategies Program

Chevron utilizes their internal standard, MFG 525, Manufacturing Instruction for Fixed Equipment Asset Strategies, to implement their fixed equipment asset strategies (FEAS) program which includes piping. The FEAS system is part of Chevron's Richmond Refinery mechanical integrity program. The program aspects related to the wharf line 003 in question were reviewed in detail including the inspection history, inspection technique, and ultimate failure of the line.

A review of this information found the Chevron FEAS program for the Wharf line 003 to be designed to address the requirements of regulatory standards including those of Contra Costa County Ordinance Chapter 450-8 (ISO) and the City of Richmond Industrial Safety Ordinance (Municipal Code Chapter 6.43, RISO).

The refinery followed industry standards such as API 570 (as described in MFG-525), *Piping Inspection Code: In-Service Inspection, Repair, and Alteration of Piping Systems*; an inspection code developed and published by the American Petroleum Institute (API). API 570 covers in-service inspection, rating, repair, and alteration of piping systems and their respective pressure relieving devices. API 570 establishes the requirements and guidelines needed to maintain the safety and mechanical integrity of piping systems after they have been commissioned.

API RP 574, *Inspection Practices for Piping System Components*, is also followed by the Richmond refinery (as described in MFG-525). It is a recommended practice developed and published by API that discusses inspection practices for piping, tubing, valves (other than control valves), and fittings used in petroleum refineries and chemical plants. This RP describes common piping components, valve types, pipe joining methods, inspection planning processes, inspection intervals and techniques, and types of records. API RP 574 supplements API 570 to provide information and best practices that assist practitioners in the "how to" inspect piping and common piping components.

The Chevron FEAS program is intended to "validate and improve API 570 inspection plans", as noted in the Chevron investigation report. Per Chevron requirements, an asset strategy is used for operating, monitoring and maintaining fixed equipment to preserve the integrity and process function of such equipment. MFG-525 requires an asset strategy to identify applicable damage mechanisms, determine the need for and define integrity operating windows, and prescribe inspection, testing and preventative maintenance. These requirements are in alignment with those outlined in API 570 and API RP 574.

Another requirement of MFG-525 is to review past inspection findings, repairs, and modifications to ensure they are covered as possible damage mechanisms in the FEAS evaluation. The 003 line was reviewed in 2019 during the initial rollout of the FEAS program and as noted in the investigation report, that review did not identify "potential coating/lining failure" or "under deposit corrosion" as damage mechanisms. However, there were previous failures of the 003 line due to broken or cracked cement lining including one in 2018 which resulted in partial implementation of a SLOFEC technique which can detect this type of damage. The review of line history during the implementation

of the FEAS program for the 003 line should have identified "coating/lining failure" and "under deposit corrosion" as damage mechanisms and should have resulted in broader implementation of inspection techniques designed to find this type of damage.

The issue of not following MFG-525 and not implementing proper inspection techniques was identified in root cause 1 and root cause 2. Root cause 2 also identified the inconsistency in developing loss/near loss reports for incidents on the 003 line. The Chevron investigation report noted that only two of the four incidents had loss/near loss reports. While some of the incidents may not have required formal investigations, generating such near loss reports allows for trending of the incidents and prompted for proper damage mechanisms to be included in the FEAS of the 003 line.

Root cause 3 took a deeper evaluation into potential shortcomings of MFG-525. As the standard is written, the FEAS should be reviewed after a "trigger event" which would be any event that requires evaluating or updating an asset strategy or creating a new one. This is also a requirement of API 574. However, the Chevron standard does not require any sort of trending review of historical data that could have an impact on the fixed equipment. The investigation report references use of a "bad actor" process that is in place for rotating equipment. In root cause 3, Chevron recognized that reviewing historical data for the 003 line may have also prompted the proper damage mechanism to be included in the asset strategy resulting in a correct inspection technique for this line.

Since the incident, Chevron conducted a full SLOFEC analysis of the entire length of line 003, which is industry best practice for identifying deficiencies in piping systems in this service and design. Damage mechanisms are known, and Chevron has made improvements to their processes for inspection and replacement or repair of the line.

5.2. Inspection History

5.2.1. Ballast Line Inspection Data and Corrosion Monitoring

The Chevron investigation report contains a thorough review of the inspection history of the 003 line which was reviewed by AcuTech. In the report, Chevron states that the fixed equipment inspection (FEAS) program would include corrosion monitoring, and AcuTech agrees the program is in line with the applicable industry, regulatory, and refinery standards and practices including API 570 and others. Samples of relevant inspection data were requested and reviewed by AcuTech including external visual inspection reports, operator visual surveillance reports and mechanical integrity computerized data management reports showing thickness data and inspection dates as shown in Table 2. None of the data indicated an imminent failure at the leak location. It should be noted that based on AcuTech's review of the data provided, inspections were performed at appropriate frequencies and incident recommendations were addressed in a timely manner. AcuTech is in agreement with Chevron's report statement that their inspection program and developed internal standards (MFG-525) meet the requirements of relevant industry standards.

Table 2: Inspection Report Data

Inspection Data	Inspection Date	Standard Used	Completed By
Piping Asset Strategy Report	Report Date: November 3, 2022	n/a	Chevron
Piping Asset Strategy Report	Report Date: February 10, 2021	n/a	Chevron
TML Corrosion Report	8/12/2020	API 570	Chevron
External visual inspection report of circuit 'Line 003'	5/8/2020	API 570	Redacted
SLOFEC Report	2/22/2021	API 570	Third Party

5.3. Human Factors

5.3.1. Ballast Line Loading Procedure and Surveillance

AcuTech requested and was provided with a copy of the Marine Transfer Operations Manual. This manual contains instructions for transfer of material through the 003 line and is treated as any other cargo transfer. The procedure has instructions for wharf personnel during pre- and post-transfer of material. During transfer operations, the manual requires a transfer to be continuously monitored by the berth operator. Operations monitor pressure and/or flow in real time on the central control board and can respond to alarms triggered at certain set points.

When transfer lines are not in operation, Chevron provided clarification that wharf operators routinely make rounds performing visual inspections of the lines as part of their shift duties. The 003 line was not in active transfer when the leak occurred therefore the line was not being continuously monitored via board operators.

Chevron identified casual factor 2 that the leak was not mitigated by leak detection and/or passive containment. Root cause 5 was subsequently identified relating to the lack of leak detection and/or passive containment in the wharf. If Chevron had other means of leak detection besides just visual inspections by operations, it is possible that the leak may have been caught earlier and the event severity reduced. This concern was identified and adopted with recommended action 5 in Table 3.

5.3.2. Determination of the Metallurgy and Failure Route

A comprehensive postmortem inspection and failure analysis was completed by Chevron as documented in several places in the Chevron investigation report. The exact failure mode of the leak could not be determined until the 003 line segment was removed and a failure analysis completed. Initial visual inspections provided indication of local internal corrosion of a cement lined section of the 003 line causing the leak.

Chevron performed a test on the 003 line using handheld x-ray fluorescence to confirm the piping consisted of carbon steel, as suspected. A variety of other postmortem field and laboratory tests and inspections were performed on the section of 003 line to evaluate the failure route. Testing concluded the initial findings to be correct that under deposit corrosion was the likely failure mode. This under deposit corrosion determination was based on localized thinning on the interior pipe surface and presence of corrosion scaling. Specifically, the corrosion scaling composition reviewed by Chevron indicated the presence of oxygen and chlorides which can increase corrosion severity in piping. After reviewing the failure analysis report in detail, AcuTech agrees with Chevron's findings regarding the determination and decision of the likely failure mode.

5.3.3. Inspection Plan

An inspection plan for Line 003 was developed by Chevron as a result of the 2019 FEAS which was in compliance with API 570, API 574 and internal standards. That inspection plan was then fully implemented by trained inspectors. However, as noted in section 5.1.2, Chevron recognized that the FEAS for the 003 line was lacking proper damage mechanisms resulting in a possible incomplete inspection plan. Since the incident, Chevron has updated the inspection plan for the 003 line and added SLOFEC as alternative means to complete inspections of the line. AcuTech reviewed the updated inspection plan and is in agreement with the revised plan.

6. EVALUATION OF RCA RECOMMENDATIONS / ACTION PLANS

Chevron identified five recommended actions to address each of the root causes identified from the RCA investigation as noted in their final incident investigation report to CCH. These recommended actions include those shown in Table 3:

Table 3: Recommended Actions (Chevron RCA Report)

Recommended Action	Targeted Milestone / Completion Date(s)
1. Review the design and inspection plan that applied to the 003 Line and provide any recommended alternatives.	**1/28/2022**
2. Communicate/train wharf operations on Loss/Near Loss and Management of Change practices and procedures.	**4/29/2022**
3. For fixed equipment at the wharf, consider implementing a process and/or utilizing tools similar to the "bad actor" process utilized for rotating equipment.	**4/29/2022**
4. Review piping and instrumentation diagrams (P&IDs) and inspection isometrics for lines with cement lined piping in hydrocarbon service and other lines whose piping design is unique to the wharf.	Cement-lined piping **(4/29/2022)** Other lines unique to the Wharf **(1/27/2023)**
5. Review leak detection technologies (e.g., tell tales, cameras, flow/pressure indication, etc.) and/or passive containment technologies.	**10/28/2022**

Based on discussions with Chevron and a review of documentation provided to the Contra Costa County District Attorney's Office, AcuTech has confirmed that all of the identified recommended actions have been completed and/or implemented by Chevron.

While reviewing the actions and whether they resolved the root causes, it was noted that recommended actions 2, 3, and 4 mainly pertain to Richmond Long Wharf operations and not all the Chevron Richmond Refinery. AcuTech reviewed Chevron document RI-371, Chevron Instruction for Near Loss, Event Reporting, and Incident Investigation. This document states *"... for all Level 2 and Level 3 incidents to ensure lessons learned are communicated to all affected personnel."* For this Long Wharf incident, the affected personnel would have been limited to Wharf personnel (including technical staff, supervisors, managers, and operators) and not all refinery staff. Based on interviews with Chevron personnel, AcuTech learned that the Chevron investigation team identified that the wharf was not treated to the same level of integrity management and exhibited signs that the process safety culture was not as robust as the remainder of the facility. Chevron identified these organizational issues and made recommended actions for improving focusing on wharf operations.

During interviews with personnel, Chevron also confirmed that information was disseminated throughout the refinery via a "local reliability site bulletin". This site bulletin included a variety of lessons learned that also addressed recommended actions 2, 3 and 4. Between the process safety culture at the wharf and Chevron internal standards requiring actions to only be implemented for those areas affected by the incident (i.e., only wharf operations), AcuTech is in agreement with limiting some of the recommended actions to wharf operations.

It is AcuTech's opinion that recommended actions 1 – 5 developed by Chevron address the root causes identified from the root cause incident investigation.

6.1. Implementation of Recommendations / Action Plans

Recommended action 1 required Chevron to review the inspection plan and provide recommended alternatives. Chevron did complete a SLOFEC inspection across the entire portion of line 003 and not just portions after the incident occurred. While SLOFEC is not required by industry or government regulations, Chevron recognized the advantages of SLOFEC inspection were worth the cost and has added SLOFEC as a supplemental inspection technique at the Richmond Long Wharf to inspect cement-lined piping. The asset strategy for the 003 line moving forward has been revised to include 21 new condition monitoring locations (CMLs), conducting a triennial SLOFEC inspection of the bottom 180 of the pipeline and a triennial ultrasonic thickness inspection for the remaining areas of the pipeline (those that cannot have a SLOFEC inspection). According to Chevron, over 50% of the original 003 pipeline has been air-gapped including the section in the causeway. Removing a large portion of the pipeline, increasing the CMLs, and requiring SLOFEC inspection provides a more robust FEAS for the 003 pipeline.

Communication and training on loss/near loss (L/NL) and management of change practices and procedures was completed via a mandatory in-person training for Richmond Long Wharf personnel. The L/NL training covered the requirement to formally investigate any release of hydrocarbons to water and provided an emphasis on the lessons learned from this event. PSM training material on incident investigations was also updated to train personnel that they are required to enter actual and potential incidents into the incident tracking database and investigate appropriately which was one of the factors in root cause 2 (not all incidents were reported and investigated).

MOC training conducted for Richmond Long Wharf operations did address the types of changes requiring a MOC and discussed incorrectly not performing a MOC as related to this incident. Both the wharf personnel MOC training and the optional MOC refresher training did include, an example change requiring a MOC, changing piping material from cement-lined carbon steel pipe to unlined carbon steel pipe. This explicit reference to types of changes speaks to the root cause that MOCs were not performed when previously changing the pipe material on the 003 pipeline.

A data visualization tool to identify pipeline circuit "bad actors" was developed to address recommended action 3. Chevrons "bad actors" process assists in identify repeat repairs on equipment over a defined period of time but prior to this incident, was only in use for rotating equipment. This tool will allow Chevron to monitor integrity threats, inspection recommendations, and history briefs which are then used to determine areas for increased focus and characterized as "bad actors" of wharf piping. Those "bad actors" are then reviewed every 6 months by a cross-functional team including the area inspector, reliability engineer, operations management and others as needed. If needed or deemed appropriate, revisions to the underlying asset strategies are made based on the requirements in MFG-525. This "bad actor" program is in addition to the inspection and review requirements outlined in MFG-525.

Three piping circuits at the Richmond refinery were identified by Chevron with cement lined pipe, one being the 003 pipeline related to this incident and the other two in sump drain lines. The associated P&IDs and inspection isometrics have since been updated to reflect the cement lined pipe and associated asset strategies have also been updated. Updating the asset strategies ensures appropriate damage mechanisms and additional surveillance activities are properly documented. Recommended action 4 also required a review of P&IDs and inspection isometrics for lines unique to the Richmond Long Wharf which Chevron considered to include: linear expansion joints, loading arms, vapor collection piping and equipment, large threaded pipe, detonation arrestors, flame arrestors, sumps and sewage tanks. Based on field verification, the associated P&IDs and inspection isometrics were updated, which is standard practice. Chevron also confirmed that no changes were needed to the asset strategies for the corresponding Richmond Long Wharf lines.

Evaluating various different leak detection and containment technologies, as required in action 5, can present different options with varying degrees of results. AcuTech confirmed that not only were alternate technologies evaluated, Chevron is now proceeding with further measures to pilot one of the proposed leak detection technologies, a hydrocarbon rope sensor, to better understand feasibility and sustainability. The pilot will occur on a fuel oil line at the Richmond Long Wharf which is a heavily used line and sits below other lines which may allow the technology to detect a loss of containment from the piping circuits above.

Passive containment technologies were reviewed including those for secondary containment and booms, both of which Chevron determined to be not feasible. Secondary containment was considered largely unfeasible as it would prohibit the inspection of the bottom of the piping circuits. Given that this is where the leak occurred in this incident, AcuTech is in agreement that installing secondary containment would not be good practice for pipelines over water in the Richmond Long Wharf. Booms along the causeway of the Richmond Long Wharf were deemed not feasible due to restricting access to the piping circuits for both spill response boats and fixed equipment inspectors in work boats. The boats would not be able to jump the booms or have very limited entry points. Costs associated with causeway booms was also a concern of Chevron as they would be exposed to higher damage (location against marine current), require more frequent replacement, and have an overall increased level of maintenance. While booms serve as a first line of defense in oil spill recovery, if they restrict the ability for response or proper maintenance that could serve to increase the severity of the incident.

7. EVALUATION OF AGENCY NOTIFICATIONS

A review of the notifications made by Chevron found the authorities notified included, but not limited to, those from Contra Costa Health, California Occupational and Health Administration (CalOSHA), U.S. Coast Guard, California Department of Fish and Wildlife and others. These notifications are in alignment with those that would be required for a release of hazardous material to the San Francisco bay. AcuTech did identify that agencies were notified approximately 1 hour after Chevron received the initial public notification and sought further information regarding the timing to ensure compliance with regulations. Agency notification timelines were provided in the CCH 72 hour report[3].

The notification to CalOSHA was in compliance with California Code of Regulations, Title 19 Section 2631 (e) which falls under the California Governor's Office of Emergency Services. Chevron and CalOSHA settlement reports were reviewed and no items of concern were noted by AcuTech.

The CCH - Hazardous Materials Program includes the Hazardous Materials Incident Notification Policy. According to Section III.E of that policy, CCH requires notification "…as soon as possible or within 15 minutes from discovery of a release….". Based on interviews with Chevron, it was determined that after the initial public concern was identified, Chevron attempted to confirm the leak was an oil spill and not other ship/barge related issues and then made the appropriate notifications following that determination. It is AcuTech's opinion that Chevron made all reasonable efforts to meet the requirements of the Contra Costa Health notification requirements

while still maintaining good emergency response practices of containing a leak to reduce environmental consequences.

After the event, various agencies including Contra Costa Health, Department of Fish and Wildlife, and US Coast Guard worked alongside Chevron to ensure potential impacts from the leak were evaluated and thoroughly remediated. Ten liaison reports from the Office of Spill Prevention and Response (OSPR) were reviewed and thoroughly document the collaboration between Chevron and various regulatory agencies to evaluate the spill and its response.

8. CONCLUSIONS

AcuTech was commissioned by Contra Costa County to perform a third-party independent review of the February 9th, 2021 Chevron Long Wharf incident root cause analysis report as further described above. AcuTech conducted the review based on the available data including from documents presented, interviews, and observations.

The evaluation of incident investigation, root causes, actions and agency notifications described in sections 4,5, 6, and 7, respectively, of this report represent our main conclusions with respect to how Chevron conducted the root cause analysis and incident investigation. AcuTech did not identify concerns associated with the Chevron investigation report and believes it to be thorough in nature.

9. DOCUMENTS REVIEWED

The following is a high level list of documents provided by Chevron and reviewed by AcuTech

- RI-621: Temporary Leak repairs
- RI-371: Near Loss, Event Reporting, and Incident Investigation
- RI-410: Marine Oil Spill Emergency Response
- RI-368: Mechanical Integrity
- MFG-525: Fixed Equipment Asset Strategies
- Marine Transfer Operations Manual, Job Aid for Washing Bert Laters
- Spill Preparedness and Emergency Response Plan
- Feb 9, 2021 Wharf 16" Ballast Line Leak - volume estimate
- 2013 Damage Mechanism Review (DMR) report relevant to Line 003
- Agency notifications made after incident
- Reports from USCG, DFW and CalOSHA
- Line 003 Piping Asset Strategy Report
- IDMS data export in excel of the circuit 'Line003'
- External visual inspection report of the circuit 'Line003'
- 2018 Loss/Near Loss report
- 2021 SLOFEC Report
- MOCs discussed in Chevron investigation report
- 2023.03.30 Ltr to S Grassini & J Brooks (Response to Contra Costa County District Attorney's Office)

- Fixed equipment asset strategy for the 003 line
- Chapter 5: Normal Operations in the Equipment Operations Manual
- Pressure trend of piping circuit 1611-X005-003 ("003 Line") from May 2019 through March 2021

10. REFERENCES

1. Chevron. (2021). *Event Title: February 9, 2021 Richmond Long Wharf Incident, IMPACT ERM Investigation #128842 & LI #192231, September 23, 2021*. Richmond.

2. Chevron. (2021, October 27). *Contra Costa Health*. Retrieved from 30 Day Follow-up Notification Report: https://cchealth.org/hazmat/data-incident-report/63683412.pdf

3. Chevron. (2021, February 15). *Contra Costa Health*. Retrieved from 72 hour Inicide Report: https://cchealth.org/hazmat/data-incident-report/62455645.pdf

11. APPENDIX

11.1. Scope of Work

AcuTech's scope of work as prescribed in the request for proposal (RFP672021) is shown below:

A. The successful candidate will be reviewing the completed/draft RCA report provided by the Chevron Richmond Refinery as well as opportunity to interview key members of the investigation. CCHS expects the independent review report to include at a minimum the following:
   1. Review Mechanical Integrity program and how it applies to the pipeline
      a. Inspection data of the ballast line
      b. Corrosion monitoring
      c. Determination of the metallurgy and failure route
      d. Procedure for use of the ballast line pre- and post-loading operation
      e. Surveillance during use
      f. Other process safety management systems that may be applicable to this incident
   2. The candidate will review Chevron Richmond Refinery's action plan to address the findings of the incident investigation to ensure that the recommendations and action plans are addressing the findings from the incident investigation.
   3. Verification and review of incident / event timeline
   4. Verification of agencies notifications process

B. Review other completed and available investigation reports from the Coast Guard and the Oil Spill and Prevention Response team from California Department of Fish and Wildlife, and from Cal/OSHA.

C. The successful candidate will be involved in a Public Participation process.
   1. A public oversight committee has been developed that will oversee the investigation review process.

a. The Oversight Committee will assist in selecting the successful contractor company to review the investigation.
b. A report-out meeting will be held with the Oversight committee after review of Chevron's incident investigation report is complete. The candidate will provide a written completeness evaluation of Chevron's incident investigation. The Oversight Committee will have the opportunity during this meeting to ask questions and give comments on the draft completeness evaluation. At this meeting the Oversight Committee may ask questions and give suggestions on the evaluation report. The contractor will make appropriate changes to the evaluation report based on the feedback from the Oversight Committee.
c. When the written completeness report has been accepted from the feedback from the Oversight Committee, this report will have a 45-day public comment period. During the 45-day public comment period, a public meeting will be held. The public meeting will be an opportunity for the reviewer to listen to the public's concerns and consider making changes in the report including working with Chevron to complete the evaluation report. The contractor working with CCHS shall respond to all written comments and comments that are raised in the public meeting.

2. The contractor should expect to attend and present reports at the following meetings:
   a. A public meeting (expected to be virtual) to present the draft evaluation report.
   b. The final evaluation report will include the findings of the independent review of Chevron's incident investigation and public comments received during the public comment period and the comments from the public meeting and the responses to these comments.
   c. Two public meetings will be held to present the final evaluation report to Contra Costa County Board of Supervisors and the Richmond City Council.

11.2. Glossary – Abbreviations and Definitions

Abbreviation	**Name**
API	American Petroleum Institute
CalOSHA	California Occupational and Health Administration
CCC	Contra Costa County
CCH	Contra Costa Health
CCHHMP	Contra Costa Health Hazardous Materials Program
CCR	California Code of Regulations
CFR	Code of Federal Regulations
CML	Condition Monitoring Location
HSE	Health, Safety, and Environmental
ISO	Industrial Safety Ordinance
L/NL	Loss/Near Loss
MCAR	Major Chemical Accident or Release
MOC	Management of Change
OSHA	Occupational Safety and Health Administration
OSPR	Office of Spill Prevention and Response
P&ID	Piping and Instrumentation Diagram

Abbreviation	Name
PSM	Process Safety Management
RCA	Root Cause Analysis
RISO	Richmond Industrial Safety Ordinance
RLW	Richmond Long Wharf
SLOFEC	Saturated Low Frequency Eddy Current

Term	Definition
American Petroleum Institute (API)	The largest U.S. trade association for the oil and gas industry
Article	A manufactured item, as defined under 29 CFR 1910.1200(b) and Section 5189 of Title 8 of the California Code of Regulations, that is formed to a specific shape or design during manufacture, that has end use functions dependent in whole or in part upon the shape or design during end use, and that does not release or otherwise result in exposure to a regulated substance under normal conditions of processing and use
Major Change	Introduction of a new process, process equipment, or regulated substance, an alteration of process chemistry that results in any change to safe operating limits, or other alteration that introduces a new hazard
Mechanical Integrity	The process of ensuring that process equipment is fabricated from the proper materials of construction and is properly installed, maintained, and replaced to prevent failures and accidental releases
Mitigation system (active and passive)	Specific activities, technologies, or equipment designed or deployed to capture or control substances upon loss of containment to minimize exposure of the public or the environment • Passive mitigation: Equipment, devices, or technologies that function without human, mechanical, or other energy input • Active mitigation: Equipment, devices, or technologies that need human, mechanical, or other energy input to function
Process	Any activity involving a regulated substance including any use, storage, manufacturing, handling, or the onsite movement of such chemicals, or combination of these activities. For purposes of this definition, any group of vessels which are interconnected and separate vessels which are located such that a highly hazardous chemical could be involved in a potential release shall be considered a single process
Public	Any person except employees or contractors at the stationary source
Regulated substance	Any substance listed pursuant to section II 2(r)(3) of the Clean Air Act as amended in §68.130 of 40 CFR 68 or in Section 2770.5 of the CalARP regulation
Replacement-in-Kind	A replacement that satisfies the design specifications

Term	Definition
Root cause	Prime reasons, such as failures of some management systems, that allow faulty design, inadequate training, or improper changes, which lead to an unsafe act or condition, and result in an incident. Root causes are also known as underlying causes. If root causes were removed, the particular incident would not have occurred
Stationary source	Any buildings, structures, equipment, installations, or substance-emitting stationary activities that belong to the same industrial group, which are located on one or more contiguous properties, which are under the control of the same person (or persons under common control), and from which an accidental release may occur. The term stationary source does not apply to transportation, including storage incident to transportation, of any regulated substance or any other extremely hazardous substance under the provisions of this chapter. A stationary source includes transportation containers used for storage not incident to transportation and transportation containers connected to equipment at a stationary source for loading or unloading. Transportation includes, but is not limited to, transportation subject to oversight or regulation under 49 CFR part 192, 193, or 195, or a state natural gas or hazardous liquid program for which the state has in effect a certification to DOT under 49 U.S.C. Section 60105. Properties shall not be considered contiguous solely because of a railroad or gas pipeline right-of-way