UCLA
Labor Occupational Safety
& Health Program

INSTRUCTOR GUIDE: USING CHEMICAL SAFETY BOARD REPORTS AND VIDEOS

A RESOURCE FOR DEVELOPING CASE STUDIES TO USE IN HEALTH AND SAFETY TRAINING

Prepared By: Gail Bateson and Rocelyn de Leon-Minch with Linda Delp
www.losh.ucla.edu

Table of Contents

Introduction to the Guide

This Instructor Guide is an annotated tool for facilitators that includes a wealth of resources available from the U.S. Chemical Safety and Hazard Investigation Board (CSB). This Guide and other resources can be used in worker training programs to encourage discussion about ways to prevent the fatalities, injuries, illness, or hazardous situations investigated by the CSB.

The Guide is organized into two sections. Section one is **organized around special topics** that are a part of process safety management, drawing common themes from multiple investigations. Section two is **organized by location**; it summarizes key information from incident investigations at one chemical plant and eight refineries located throughout the U.S. Each major incident investigation typically covers multiple issues.

Under the guidance of an instructor, workers in a class can use materials in this guide to discuss underlying causes of chemical and refinery incidents as well as recommendations from CSB investigations. Possible discussion questions for workers are provided.

Additional Resources

In addition to this Guide, UCLA LOSH collaborated with the USW to develop a series of videos highlighting California's Process Safety Management Standard for refineries:

- "Process Safety Management: The Fight for Workers' Lives" is a compelling 12 minute video that illustrates refinery explosions and the coalition that came together to protect workers and surrounding communities.
- Three 6 min videos highlight key aspects of the Cal/OSHA PSM standard:
  1) What is PSM?
  2) Employee Participation
  3) Management of Change/Management of Organizational Change.
- The United Steelworkers also has materials available at: www.usw.org/

About the Chemical Safety Board

The Chemical Safety and Hazard Investigation Board (CSB) conducts investigations following major industrial chemical incidents and posts detailed information on their website, www.csb.gov.

CSB investigations look for the underlying causes of major incidents and recommend changes in management safety systems to prevent future incidents. While CSB primarily focuses on improving the work environment and organization, it may also recommend changes to regulatory agencies and industrial trade associations. This approach is much broader than traditional safety programs that narrowly focus on tracking and reducing individual worker injury rates. CSB now posts its videos at www.youtube.com/user/USCSB.

Documents describing completed and ongoing CSB investigations can be found at www.csb.gov/investigations. Links to some videos may also be found on the CSB website.

The CSB report's executive summary, key findings and recommendations, and timelines of incidents provide useful information for case studies to be used in training programs. Additional technical information can be useful for PSM representatives and others who want to apply lessons learned to their workplace.

What types of facilities does the CSB investigate?

In addition to oil refinery and chemical plant toxic releases, fires, and explosions, the CSB investigates other facilities including:

- Pharmaceutical plants
- Paper and pulp mills
- Food processing plants
- Metal processing plants
- Gas wells and gas plants
- Chlorine repackaging facilities
- Fertilizer distribution and storage facilities

What types of CSB materials are available?

- **CSB Investigation Reports** – include specific safety recommendations from major incidents. The reports from the Chevron 2012 fire are a good example of this.
- **CSB Case Studies** – discuss themes that emerge from multiple investigations.
- **CSB Safety Bulletins** – combine information from incidents with similar themes or root causes into an accessible bulletin.
- **Safety Videos** – most use animation to help visualize what happened in major incidents. Viewing the video before reading the longer reports can help determine if a report can be adapted into a useful case study.
- **Press Releases** – summarize the key findings and recommendations from investigations.

Do not overlook potentially useful charts and summary documents found in the appendices of individual investigations as these often cover a common theme from multiple incidents.

Who are potential audiences of CSB videos & materials?

These materials are a rich resource for developing case studies to use in training workers, particularly those employed in industries with the potential for catastrophic fires, explosions, and chemical releases.

Given the offsite consequences of many incidents, CSB case materials can be adapted to train potentially affected community members or local emergency response personnel.

PSM representatives can also use the information from CSB reports to improve conditions at their refineries.

Suggestions for Using CSB Videos and Materials to Train and Inform Workers

CSB videos and associated materials can be used in a variety of ways, depending on the amount of time available for teaching.

These include:

- **As ice breakers:** Begin a safety class or meeting with a short video clip to get the attention of participants and introduce specific topics.
- **As part of "on the job" training:** A case study built around a short video clip of an actual incident can make short, targeted, on-the-job training more focused and interesting by showing what has happened to workers facing similar hazards. It could be used at short "tail-gate" meetings, at Joint Health and Safety Committee meetings, or union meetings. Discussions might focus on the need to reflect and apply lessons from similar facilities, to improve hazard abatement, strengthen incident investigation procedures, and other elements of safety programs at your workplace.
- **As part of efforts to educate other stakeholders about potential hazards:** Use case studies built around videos at meetings or conferences to inform community members, offsite emergency responders, and relevant government agencies about the need for continual improvement in facility safety programs.
- **As part of comprehensive training programs:** Formal training classes can be enhanced by inserting actual incidents that reinforce the message and create interactive discussion among participants. In a classroom setting where resources (such as audio/visual equipment, props, safety equipment, display boards, flip charts) are available, case studies can be analyzed in detail to reinforce key points. Fact sheets summarizing the key points may be helpful.

WHAT IS THE U.S. CHEMICAL SAFETY BOARD?

The CSB is an independent federal agency charged with investigating industrial chemical accidents. Headquartered in Washington, DC, the CSB's mission is to "drive chemical safety change through independent investigation to protect people and the environment." Its mission is similar to other federal agencies that investigate transportation incidents.

The CSB conducts root cause investigations of chemical accidents at fixed industrial facilities. Root causes are usually deficiencies in safety management systems, but can be any factor that would have prevented the accident if that factor had not occurred. Other accident causes often involve equipment failures, human errors, unforeseen chemical reactions or other hazards.

The agency does not issue fines or citations, but does make recommendations to plants, regulatory agencies such as the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA), industry organizations, and labor groups.

Congress designed the CSB to be non-regulatory and independent of other agencies so that its investigations might, where appropriate, review the effectiveness of regulations and regulatory enforcement.

Source: www.csb.gov/about-the-csb/mission/

Tips When Developing and Using Case Studies in Training

Keep it Relevant

Most CSB investigations cover multiple issues, usually organized around the major elements of the OSHA Process Safety Management (PSM) Standard and industry guidance documents. Choose video clips that complement the specific topic that is relevant to the targeted group of workers, but make it clear to the audience that typically there are multiple underlying factors that together result in a major incident. For example, if you choose to use a video clip to focus the discussion on operating procedures, be sure to also refer to the summary section of your training to emphasize that it is just one particular element within a strong comprehensive management safety systems program at the facility.

You as instructor, or participant, can use themes raised in the case study to share personal experiences and apply your collective knowledge about hazard recognition, prevention, and control.

Know Your Audience

Evaluate the needs of your target audience and choose a case study that best fits the group. People with different job titles and years of experience will have different perspectives and responsibilities. Are you addressing new or experienced workers? What level of decision-making power do participants have? What level of safety training have they already received? Understand each scenario well enough to use relevant questions for operations, maintenance, or contract workers.

Plan Ahead

Choose cases in advance and prepare to lead a discussion about the cases. Identify the key points in the case that relate to the topic you want this training session to cover and then remember to reinforce these points in your summary. Before training, anticipate possible responses the class may generate and be ready to address them. Then take notes during discussions and use them in future trainings to refine your list of key summary points. As appropriate, gather fact sheets and other materials, photos, flip charts or A/V equipment to show videos or PowerPoint slides.

Tips When Developing and Using Case Studies in Training

Consider Literacy, Language, and Education Levels

Literacy is a critical factor in delivering effective training and goes hand-in-hand with knowing and respecting your audience. Choose a case study appropriate to your participants – neither above nor below their level of experience – and lead discussions to facilitate understanding and participation by everyone. Ask for volunteers to read the story aloud to ensure that everyone can fully participate in the discussion. Plan ahead for non-English-speaking audiences by having a facilitator who knows the language or arrange for translation. Remember that some terms in process safety industries do not translate directly to other languages; identify those terms and how to convey the key concepts before training.

Encourage Participation

Case studies are a great way for people to interact with one another and generate energy and interest. There are two approaches:

(1) As a class, facilitate a question/response dialogue in which you view the video and discuss the case as a group, or

(2) If time allows, break into small groups after viewing the video as a whole class, and have each small group review relevant written materials that provide additional information, such as a written summary of the major findings and recommendations and other materials that reinforce the major themes of the case study. Then reconvene to share ideas among the whole class.

Both methods elicit interaction, camaraderie, and problem-solving skills.

Share Stories

Encourage participants to contribute their own work stories relevant to the topic. This can promote new ideas for working together and supporting each other on the job.

Guide to CSB Videos and Materials:

I. CSB SOURCES CATEGORIZED BY SPECIAL TOPICS

- Inherently Safety Design & Hierarchy of Hazard Control Analysis (ISD & HCA)
- Safety Culture
- Hot Work
- Management of Change (MOC)
- Emergency Response & Stop Work Authority

INHERENTLY SAFER DESIGN (ISD) & HIERARCHY OF HAZARD CONTROL ANALYSIS (HCA)

CSB Source	Description, Application and Discussion Questions
Safety Video: "Inherently Safer: The Future of Risk Reduction" **(2012)** (11 minutes) (Note sometimes the term IST is used: Inherently Safer Technologies) **Article:** Amyotte, P. R., MacDonald, D. K. and Khan, F. I. (2011), An Analysis of CSB Investigation Reports Concerning the Hierarchy of Controls. *Process Safety Progress*, 30: 261-265.	**Description:** This safety video examines the concept of Inherently Safer Design (ISD) and its application across industry. California's revised PSM standard for refineries requires Hierarchy of Hazard Controls Analysis (HCA) using ISD principles. This video focuses on two incidents: a runaway chemical reaction at Bayer Crop Science in a pesticide plant in West Virginia and the Kleen Energy explosion in Connecticut. It provides recommendations for inherently safer ways to clean piping. Experts give a basic overview of the four approaches to ISD. The Amyotte et al. article identified over 90 ISD recommendations pulled from CSB reports (through 2012), including those at the Valero and BP refineries, DuPont, and ConAgra Foods. **Application:** Skip video section (4:47 – 7:17) which details the Bayer Crop Science West Virginia plant that closed down due to a settlement with EPA related to phasing out production of the final product The Kleen Energy explosion in Connecticut provides a positive example of using ISD to change standard industry practices at other locations **Possible Discussion Questions for Workers:** 1. How would you explain to a co-worker the basic concept of inherently safer design? How is it different from "add-on" protections? 2. The four inherently safer design strategies discussed in the video are: minimize, substitute, modify, and simplify. Can you give an example of these strategies, based on this video or hazard control methods used in your plant? 3. The California revised PSM standard requires applying ISD strategies from the most effective to the least effective. The required sequence is: "first order" strategies are

	measures that eliminate a hazard, such as chemical substitution; "second order" measures reduce risks without use of add-on devices, such as reducing operating temperature or pressure. Next are passive safeguards (dike), active safeguards (alarms, auto shutoffs), and procedural safeguards. Why do you think operating procedures are considered the least effective method of controlling hazards? How does this sequence of hazard control strategies compare with the management safety culture in your plant?
Safety Video: "Chevron Richmond Refinery Fire Animation" (2013) (selected segments - total 3:07 minutes)	**Description:** This safety video shows the sequence of events that led to the August 2012 fire at Chevron's Richmond, California refinery. It also highlights the history of safety system deficiencies that were ignored by Chevron and their repeated failure to implement internal engineering recommendations. Note that California's PSM standard for refineries now requires Hierarchy of Hazard Controls Analysis (HCA) using ISD principles. **Application:** • Use video from 1:00 – 2:00 (discovery of leak, lack of shut-off valve or way to isolate leak) and 5:43 – 7:50 (investigation, Chevron history of failing to replace corroded pipe, CSB recommendations) **Possible Discussion Questions:** • How could employee involvement in process safety decision-making (e.g. pipe corrosion assessments) have prevented the fire from occurring? • How can implementation of inherently safer design prevent major chemical incidents or other failures in refineries? • The 2017 California PSM revised standard now requires a Damage Mechanism Review (DRM) to identify material degradation of equipment. How could a DMR report after an incident help inform better use of ISD methods? • (See also discussion questions from previous page)

SAFETY CULTURE

CSB Source	Description, Application and Discussion Questions
CSB Case Study: *Tesoro Martinez Refinery: Process Safety Culture Case Study* (2014, Report No. 2014-02-I-CA) (60 pages)	**Description:** This case study examines the February and March 2014 sulfuric acid incidents that occurred at the Tesoro Martinez refinery in Martinez, California during maintenance activities. CSB found that the recurrence of these incidents was a result of process safety culture deficiencies, which routinely exposed workers to avoidable risks by minimizing the seriousness of process safety incidents and failing to take corrective actions. **Application:** • Discusses the importance of a strong process safety culture led by management to prevent incidents • Findings related to a poor safety culture include the failure to implement lessons from past incidents, conduct preventive inspections, and use process safety indicators to measure performance **Possible Discussion Questions:** 1. How would you explain to a new hire some of the ways you can measure the process safety culture in your plant? What were some of the findings that supported CSB's conclusion that there was a weak process safety culture? 2. Process Safety Indicators are now required in the California PSM standard. They include two types: looking back at past events (lagging indicators − such as frequent leaks) and programs in place to detect new hazards (leading indicators − frequency of pipe inspections). Make a short list of some of the lagging and leading indicators that you think would be most useful to identify and eliminate potential hazards in your unit or refinery. 3. Has your refinery conducted a Process Safety Culture Assessment (PSCA)? How were employees involved in developing and participating in this assessment? What changes were made after the PSCA to improve the safety culture?

CSB Investigation Report: *Catastrophic Rupture of Heat Exchanger (Seven Fatalities)* (2010, Report No. 2010-08-I-WA) (148 pages) (Pages 4-13 are key; pages 51-73 provide additional background)	**Description:** This report illustrates the catastrophic rupture of a heat exchanger in the naphtha hydrotreater unit due to a High Temperature Hydrogen Attack (HTHA) at the Tesoro Anacortes refinery in 2010. Highly flammable hydrogen and naphtha were released, causing a massive explosion and fire, killing seven workers who were working in the vicinity. They were in the final stage of a start-up activity following the cleaning of heat exchangers. Although the refinery had a history of frequent leaks and some fires during this activity, "management repeatedly failed to ensure that these hazards were controlled and that the number of workers exposed to these hazards was minimized." **Application:** • Use the Table of Contents of this comprehensive investigation to find sections discussing the "organizational deficiencies" identified by CSB • Note that the report also covers Inherent Safety Technologies (IST) and Mechanical Integrity issues • Use in conjunction with CSB Investigation Reports and/or videos of the 2012 Chevron Richmond refinery fire to compare the similarities between the two incidents and the Tesoro Martinez special report above **Possible Discussion Questions:** 1. CSB found that management ignored frequent leaks and often failed to investigate the causes and fix them. They also made decisions based on design parameters rather than data from actual process operating conditions. And the Process Hazard Analysis (PHA) failed to identify some key hazards that needed to be controlled. Pick one of these examples and discuss how it is handled in the plant where you work. What protections are in place? What more could be done? 2. What precautions should be taken to eliminate unnecessary personnel in an area when a process starts up? 3. See discussion questions above from the Tesoro Martinez case study.

HOT WORK

CSB Source	Description, Application and Discussion Questions
CSB Safety Bulletin: *Seven Key Lessons to Prevent Worker Deaths During Hot Work In and Around Tanks* (2010, Report No. 2009-01-SB) (13 pages)	**Description:** This safety bulletin provides summaries and findings from eleven CSB investigations including Motiva Enterprises refinery in Delaware (2001) and Pennzoil Product Company refinery in Pennsylvania (1995), in which hot work on storage tanks or containers ignited flammable gas inside. In some cases, workers had no knowledge that a flammable material was present; in *all* cases, workers had no knowledge that an explosive amount of flammable vapor had accumulated. Seven key lessons drawn from these incidents highlight recurring safety issues, aimed at preventing worker deaths during hot work (or spark-producing) operations. **Application:** • Relevant to refinery maintenance and contract workers • Use with the OSHA or Cal/OSHA standard for hot work, which addresses welding, cutting, and brazing as well as guidance documents from NFPA and the PSM **Possible Discussion Questions:** 1. Before reading the report, make a list of steps that should be taken before starting hot work to avoid these types of accidents. 2. Compare your list above with the list of seven action items in the report. 3. Pick a couple of the key action items and discuss how well you think they are being applied in your unit or department. Is there any gap between the written hot work procedures and testing protocol and how these steps are actually done? Identify any areas for improvement by making a list of items to raise with your PSM Rep or H&S committee. 4. (California refineries): Review the latest HCA (Hierarchy of Hazards Control Analysis) or PHA (Process Hazard Analysis) for a process covered by where you work. Did it identify areas where hot work could be avoided or explore the use of alternatives? Where any of these recommendations implemented?

MANAGEMENT OF CHANGE (MOC)

CSB Source	Description, Application and Discussion Questions
CSB Safety Bulletin: *Management of Change* (2001, Report No. 2001-04-SB) (8 pages)	**Description:** This bulletin profiles the following two incidents that occurred in 1998 to highlight the need for a systematic approach to management of change to effectively evaluate the safety effects of process changes in the chemical industry. 1. Equilon Enterprises Refinery, Anacortes, WA – A fire in the coker unit following a severe storm and power outage; six workers were killed following attempts to deal with a partially filled drum. Lessons learned: need for MOC policies that include abnormal situations, changes to procedures, and deviations from standard operation conditions (variance procedures). 2. CONDEA Vista Chemical Plant, Baltimore, MD – A reaction vessel explosion and fire; 4 workers injured. The absence of written instructions and miscommunication between shift supervisors contributed to the incident; the incident illustrates the importance of having an authorization or approval step for an MOC covering abnormal situations. **Application:** • MOC is relevant not only for preplanned changes when new processes are added, but also to manage deviations from normal operations and for variance procedures • Changing a chemical or catalyst can trigger an MOC **Possible Discussion questions:** 1. CSB notes that all workers should be trained on their facility's MOC policy and be made knowledgeable about normal limits for process variance so they can make informed judgments about when to apply the MOC system. How well do you think you and the other employees and contractors who work on your unit have been trained to manage non-routine or upset conditions? 2. CSB encourages management to "gather the right people and resources to review the situation" to ensure that the change is managed by a multidisciplinary team that includes those with hands-on operations as well as engineers and technical experts. Do the MOC teams at your facility meet this criteria?

EMERGENCY RESPONSE AND STOP WORK AUTHORITY

CSB Source	Description, Application and Discussion Questions
Safety Video: "Chevron Richmond Refinery Fire Animation" (2013) (selected segments)	**Description:** Chevron Richmond 2012 fire and explosion: while the big picture from this incident is understanding management decisions that *caused* the leak and taking steps to *prevent* it (see ISD section above), the video also covers lessons related to emergency response, such as the authority to stop a process unit and limit the number of people in the leak zone. **Application:** • Use video from 1:00 – 2:00 (describes the leak); 2:00 – 5:43 (describes the emergency response and resulting fire and explosion); 5:43 – 7:50 (covers the CSB investigation and its recommendations) **Possible Discussion Questions for Workers:** 1. Were hot zone and safe distance areas appropriately identified to consider the possibility of a pipe rupture? 2. Were fire department personnel sufficiently informed of the hazards and process conditions? 3. At what point should the Stop Work Authority have been implemented?

Guide to CSB Videos and Materials:

II. CSB SOURCES CATEGORIZED BY GEOGRAPHIC INCIDENTS

(STARTING WITH MOST RECENT):

1. ExxonMobil Refinery: Baton Rouge, LA, (2016)
2. ExxonMobil Refinery, Torrance, CA: 2015
3. Delaware City Refining Company, Delaware City, DE (2015)
4. Tesoro Avon Refinery, Martinez, CA (2014)
5. Chevron Refinery, Richmond, CA (2012)
6. Tesoro Refinery, Anacortes, WA (2010)
7. BP America Refinery, Texas City, TX (2005)
8. Tosco Avon Refinery, Martinez, CA (1999
9. Phillips 66 Houston Chemical Plant Complex, Pasadena, TX (1989)

1. EXXONMOBIL REFINERY, BATON ROUGE, LA (2016)

CSB Source(s)	Description, Key Issues or Recommendations
CSB Safety Bulletin: *Key Lessons from the ExxonMobil Baton Rouge Refinery Isobutane Release and Fire* **(2016, Report No. 2016-02-I-LA) (32 pages)** **Safety Videos:** "Animation of Fire at ExxonMobil's Baton Rouge Refinery" (2016) (3 minutes) "Fire in Baton Rouge" (2017) (8.27 minutes, includes findings and recommendations)	**Description:** An isobutane release and fire occurred in the sulfuric acid alkylation unit, resulting in four serious burn injuries to workers. The incident occurred during minor maintenance on a flammable isobutane line: while removing a gearbox of older design on a plug valve, critical bolts were also removed; the valve came apart, releasing isobutane which then ignited. Workers were following accepted plant practice applicable to 97% of valves. This valve was different; there were no written procedures or training provided. **Key Issues or Recommendations:** • Apply the Hierarchy of Hazard Controls (HCA) to mitigate identified hazards (upgrade the old valves per accepted guidelines) • Procedures and Training: Establish detailed and accurate procedures and provide training to ensure workers can perform all anticipated jobs safely (i.e., all models and designs of equipment) • Recent PHA lacked a Human Factors evaluation of operator interaction with valves to identify older plug valve design and reliability issues • Management Safety Culture – Allowed accepted practice versus using hierarchy of controls to address the problem

2. EXXONMOBIL REFINERY, TORRANCE, CA (2015)

CSB Source(s)	Description, Key Issues or Recommendations
CSB Investigation Report: *ExxonMobil Torrance Refinery Electrostatic Precipitator Explosion* (2017, Report No. 2015-02-I-CA) (73 pages) **Safety Video:** "Animation of 2015 Explosion at ExxonMobil Refinery in Torrance, CA" (2017) (7.12 minutes) **RAND Report:** Gonzales, D., Gulden, T.R., Strong, A. and Hoyle, W. (2016), Cost–Benefit Analysis of Proposed California Oil and Gas Refinery Regulations. *RAND Corporation*, RR-1421-DIR.	**Description:** Explosion on the refinery's Electrostatic Precipitator (ESP) during normal operation as facility was attempting to isolate equipment for maintenance while in an idled mode of operation. Preparation activities for maintenance caused a pressure deviation that allowed hydrocarbons to back-flow through the process and ignite in the ESP. A near miss event occurred in the modified hydrofluoric acid (MHF) alkylation unit when explosion debris nearly hit tanks in close proximity to the ESP, each containing hydrofluoric acid (HF) and other substances. The refinery was shut down over a year, causing a rise on gasoline prices; at least $2.4 billion cost to California motorists. **Key Issues or Recommendations:** • Overall gaps in management's PSM program • Lack of safe operating limits and operating procedures for all modes of operation • Lack of instrumentation to detect hydrocarbons flowing to the ESP (appears to be an industry-wide problem) • Mechanical Integrity: Operating safety-critical equipment beyond predicted safe operating life; erosion damage to critical valve • Re-use of previous procedure variance without sufficient MOC or hazard analysis to verify if its application was still valid • The RAND report was unique in its analysis of costs of incidents external to those borne by the company

3. DELAWARE CITY REFINING COMPANY, DELAWARE CITY, DE (2015)

CSB Source(s)	Description, Key Issues or Recommendations
CSB Safety Bulletin: *Key Lessons for Preventing Incidents When Preparing Process Equipment for Maintenance, Flash Fire at the Delaware City Refinery* (2015, Report No. 2015-01-I-DE) (23 pages) • See Appendix A: *CSB Incident Investigations Involving Maintenance and Non-Routine Operations* that cites 39 examples **News Clip from former CSB Chairperson:** "CSB Offer Releases Findings of Fire Investigation at Delaware City Refinery" (2017) (1.22 minutes)	**Description:** Operators were draining and isolating a section of piping to be replaced; problems encountered led to expanding the isolation scope, making it non-routine work. This is not unexpected given the complexity of refineries. However, this did not trigger additional hazard review. **Key Issues or Recommendations:** • Preparation for maintenance activities requires pre-planning and hazard identification before starting work (MOC) • Procedures are needed to cover steps for all types of equipment and tasks • Avoid reliance on single block valves and use closed systems to control potential releases – ISD, HCA

4. TESORO AVON REFINERY, MARTINEZ, CA (2014)

CSB Source(s)	Description, Key Issues or Recommendations
CSB Case Study: *Tesoro Martinez Refinery Process Safety Culture Case Study* (2016, Report No. 2014-02-I-CA) (60 pages) **News Clip from NBC Bay Area:** "Federal Investigation Faults Martinez's Tesoro Refinery for Safety Deficiencies, Worker Injuries" (2016) (2.34 minutes)	**Description:** On February 2014, a sulfuric acid spill resulted from insufficient tightening of a joint at a sulfuric acid sampling station; two workers were hospitalized for acid burns. Cal/OSHA ordered the unit shutdown for several days. A month later, on March 2014, in the same sulfuric acid alkylation unit, two contract workers were sprayed with acid during planned maintenance to remove some piping. **Key Issues or Recommendations:** CSB issued a special case study on how a weak process safety culture created conditions that were contributing factors to these two similar incidents. Examples to support this finding: • Incident investigations: Failure to learn from past incidents • Removal of a better ISD sample system • Deficiencies in permits and procedures, less protective than corporate standard • Staffing resource limitations and pressure on workers to put production and costs before safety

5. CHEVRON RICHMOND REFINERY, RICHMOND, CA (2012)

CSB Source(s)	Description, Key Issues or Recommendations
CSB Investigation Reports: *Final Investigation Report: Chevron Richmond Refinery Pipe Rupture and Fire* (2015, Report No. 2012-03-I-CA) (122 pages) *Interim Investigation Report: Chevron Richmond Refinery Fire* (2013) (70 pages) **CSB Regulatory Report:** *Regulatory Report: Chevron Richmond Refinery Pipe Rupture and Fire* (2014, Report No. 2012-03-I-CA) (126 pages) **Safety Video:** "Chevron Richmond Refinery Fire Animation" (2013) (8.14 minutes) **California's Interagency Refinery Task Force Report:** *Improving Public and Worker Safety at Oil Refineries, Report of the Interagency Working Group on Refinery Safety* (2014)	**Description:** The crude unit experienced a catastrophic pipe rupture, releasing flammable, high temperature light gas oil which then vaporized into a large vapor cloud that engulfed 19 employees. Two minutes later, the cloud ignited, just after the employees escaped. The subsequent burning of the hydrocarbon fluids resulted in a large plume of black smoke, which traveled into the surrounding community. A shelter-in-place alert was issued for nearby cities. About 15,000 sought medical care related to smoke inhalation. **Key Issues or Recommendations:** Interim CSB report: • Failed to apply inherently safer design principles • Failed to identify and evaluate damage mechanism hazards • Need for prescribed methodology to effectively identify and analyze process hazards Final CSB report: • Failure to invoke Stop Work Authority • Incident Command structure had insufficient technical expertise to effectively respond to hazardous process fluid leaks • Mechanical integrity industry standard deficiencies • Leak evaluation and response industry standard deficiencies • Failure to follow RAGAGEP guidelines, delaying maintenance • Need for MOC when crude oil, content, temperature and pressure change

6. TESORO REFINERY, ANACORTES, WA (2010)

CSB Source(s)	Description, Key Issues or Recommendations
CSB Investigation Report: *Catastrophic Rupture of Heat Exchanger (Seven Fatalities)* (2014, Report No. 2010-08-I-WA) (148 pages) **Safety Video:** "Behind the Curve" (2014) (14 minutes)	**Description:** A catastrophic rupture of a heat exchanger in the naphtha hydrotreater unit occurred due to a High Temperature Hydrogen Attack (HTHA). Highly flammable hydrogen and naphtha were released, causing a massive explosion and fire, killing one shift supervisor and six operators who were working in the vicinity. They were in the final stage of a start-up activity following the cleaning of heat exchangers. Given the history of frequent leaks and some fires during this activity, CSB considered the work to be hazardous and non-routine. **Key Issues or Recommendations:** • Failure to use inherently safer design and the hierarchy of controls to prevent equipment failure from HTHA • Implement a process safety culture program to continually assess and improve safety • Control of non-routine work activities • Mechanical Integrity industry standard deficiencies • Regulatory oversight of petroleum refineries

7. BP AMERICA REFINERY, TEXAS CITY, TX (2005)

CSB Source(s)	Description, Key Issues or Recommendations
CSB Investigation Report: *Refinery Explosion and Fire (15 Killed, 180 Injured)* (2007, Report No. 2005-04-I-TX) (341 pages) **Safety Video:** "Anatomy of a Disaster" (2008) (55.33 minutes) "BP Texas City 10 Year Anniversary Safety Message" (2015) (4.04 minutes) **United Steelworkers (USW) Report:** McQuiston, Thomas H., et al. (2009), Beyond Texas City: The State of Process Safety in the Unionized U.S. Oil Refining Industry. *New Solutions: A Journal of Environmental and Occupational Health Policy, 19*(3), 271-88. **The Baker Panel Report:** Baker, James., et al. (2007), The Report of the U.S. Refineries Independent Safety Review Panel	**Description:** Following lengthy maintenance with over 1100 contractors onsite, workers began to start up the isomerization unit when a raffinate splitter tower was overfilled. Pressure relief devices opened, resulting in a liquid geyser from a blowdown stack that was not equipped with a flare. The resulting fire and explosion killed 15 in or near office trailers close to the blowdown drum. **Key Issues or Recommendations:** • Safety Culture: "The Texas City disaster was caused by organization and safety deficiencies at all levels of the BP Corporation. Warning signs of a possible disaster were present for several years, but company officials did not intervene effectively to prevent it" • Corporate and Management Oversight and Mechanical Integrity issues: "cost-cutting, failure to invest and production pressures from BP Group executive managers impaired process safety performance at Texas City" • Human factors issues such as lack of training, operator fatigue, procedure deviations, understaffing and lack of supervisory oversight contributed to the accident • Process Safety Metrics (use leading and lagging process indicators versus personal injury statistics) • Lack of a reporting and learning culture • The independent Baker Panel Report found similar problems in other BP-owned U.S. refineries

8. TOSCO AVON REFINERY, MARTINEZ, CA (1999)

CSB Source(s)	Description, Key Issues or Recommendations
CSB Investigation Report: *Refinery Fire Incident (4 Dead, 1 Critically Injured)* (2001, Report No. 99-014-I-CA) (70 pages)	**Description:** A fire occurred in the crude unit as workers were attempting to replace a pipe in a 15-foot tall fractionator tower while the unit was still running. This followed the detection of a pinhole leak and several days of unsuccessful efforts to drain the pipe. During the removal of the piping, naphtha was released onto the hot fractionator and ignited engulfing five workers. **Key Issues or Recommendations:** • Failure to identify or control serious hazards during non-routine maintenance work activities • Lack of management oversight and accountability of hazardous work activities • Failure to conduct a management of change (MOC) analysis • Corrosion control program was inadequate • Discussion of stop work authority and supervision during non-routine hazardous maintenance work

9. PHILLIPS 66 HOUSTON CHEMICAL COMPLEX, PASADENA, TX (1989)

CSB Source(s)	Description, Key Issues or Recommendations
John Gray / OSHA Report: Wells, J. C., Kochan, T. A. and Smith, M. (1991), Managing Workplace Safety and Health: The Case of Contract Labor in the U.S. Petrochemical Industry. *John Gray Institute, Lamar University*. This report was done under contract to OSHA prior to the passage of the PSM standard and creation of the CSB, but its findings are often cited in subsequent CSB reports and so it is included in this guide.	**Description:** An explosion and ensuing fire occurred on October 23, 1989 at the Phillips Petroleum Houston Chemical Complex in Pasadena, Texas during regular maintenance operations, resulting in 23 fatalities and 314 injuries. The accident was caused by a massive release of process gas, a mixture of four chemicals, through an open valve forming a vapor cloud which exploded and led to the fire. This chain reaction also caused the explosion of nearby chemical storage tanks. This incident led to the passage of the 1992 federal OSHA Process Safety Management Standard [29 CFR § 1910.119]. **Key Issues or Recommendations:** • Supervision of outside contractors and impact on safety (John Gray Report) • Lack of effective management systems to prevent release of flammable vapors or minimize its impact • Failure to provide adequate fire protection; a dedicated water system • Failure to follow standard procedure – double blind or flange during online maintenance • Design flaw: air hose lacked unique coupling for “open” and “closed” sides • Design: valve lockout system was inadequate to prevent it from being either inadvertently or deliberately opened during a maintenance procedure