Testimony of Kim Nibarger, United Steelworkers
Before the
U.S. Senate Committee on Environment and Public Works

Oversight of Federal Risk Management and Emergency Planning Programs to Prevent and Address Chemical Threats, Including the Events Leading Up to the Explosion in West, TX and Geismar, LA

June 27, 2013
Washington, DC

Chairman Boxer, Ranking Member Vitter and members of the committee, thank you for the opportunity to testify at this hearing. My name is Kim Nibarger. I am a health, safety and environmental specialist for the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union, or USW for short. We are the largest and most diverse industrial union in the US. The relevant fact for this hearing is that we represent the majority of organized workers in the petrochemical industry, as well as hundreds of thousands of workers who use chemicals on the job. My own background is in the refining industry; I worked in a West Coast oil refinery for 17 years.

First, I would like to point out that the two events under discussion; the explosions at the West Texas fertilizer plant and the Williams Chemical facility are in no way isolated incidents. On April 17 of this year, 12 workers were burned at the ExxonMobil Beaumont refinery, two of whom subsequently died from their injuries. On April 27, eight workers were sent to the hospital after an explosion and fire at the Chevron Port Arthur refinery. And on this past Monday an explosion at a fertilizer plant in Indiana killed one person.

Since 2008 the oil industry has reported an average of over 45 fires a year; so far 2013 appears to be right on track with 22 fires through the 21st of June. These are industry self-reported and do not include many smaller seal fires or electrical fires that USW members bring to our attention. This also does not include oil rigs, pipelines or storage terminal fires nor does it include fires in chemical plants.

These sometimes deadly and potentially catastrophic events take place all too often in this industry. The first response from industry after a tragedy is that the safety of their employees is their top priority. The widowed wives and children left without a father or mother may feel differently. More must be done to prevent these types of incidents from occurring in the first place.

The USW recently released a study entitled, “A Risk Too Great, Hydrofluoric Acid in U.S. Refineries.” Twenty three USW sites were surveyed, which represent nearly half of the fifty US refineries that use hydrofluoric acid (HF) as a catalyst in the alkylation process.

EPA requires companies using or storing highly toxic chemicals to develop a risk management plan (RMP) in part to gauge how far a worst case release might travel and how many people might be in harm's way. For HF releases from US refineries, the range is three to 25 miles, depending mostly on the amount stored. Twenty-six million people live within the vulnerable zone of these US refineries, many in urban areas like Philadelphia, Memphis, Salt Lake City, and the Houston – Galveston corridor. These locations would be impossible to evacuate quickly in the event of a major release. No other chemical operation puts as many people at risk.

The sites were asked to rate on a descending scale from very effective or very prepared to very ineffective or very unprepared their sites were in taking the necessary steps for maintaining safety in the facility. Questions asked dealt with mechanical integrity, effectiveness of existing safety systems, preparedness of emergency responders, both on and off site. Rarely was the highest level reached. In an alarming number of cases, workers rated the site as unprepared or ineffective.

From this survey, we made seven recommendations to improve safety in these facilities. Two of them, investigate and learn about safer alternatives to HF and pilot test alternative solutions speak to the heart of the problem; there are safer alternatives for manufacturing available.

A pilot project and even conversion is not expensive compared to the possibility of a Macondo-type event at one of these refineries using HF acid. Solid acid catalyst and liquid ionic catalyst are two possible options. They have been piloted successfully and only lack industry's commitment to make the change. But industry has been resistant, citing the cost for conversion. Eight oil companies operate 18 of the study refineries. In total, these eight companies had gross operating profits in 2011 of approximately $150 billion.

The USW also released a survey in October of 2007 of the oil refineries we represent in the US. Following the BP Texas City disaster 70% of the local unions we surveyed reported that their facilities were less than very prepared for emergencies. Time and again we hear from our members that staffing is not adequate on a day to day basis, overtime is excessive and they do not have enough people on the units for emergencies. The companies tell us that they do not staff for emergencies. I cannot think of a more critical situation to be staffing for.

As seen at the West fertilizer plant and the fire last year at the USW-represented Chevron refinery in Richmond California, the events at these facilities can have a far reaching impact on the communities. These potential impacts are the very reason the EPA requires companies to develop a RMP. While the EPA does many plant inspections during a year I would dare say that most of these are air or water inspections as opposed to RMP inspections. To a great extent the limited numbers of inspections are tied to budget and staffing conditions, not unlike what we hear with federal OSHA.

The regulatory process relies on much self-reporting which in essence allows the industry to self-regulate. As seen in the November 2012 EPA RMP inspection report on the ExxonMobil facility in Baton Rouge, 40 CFR (Code of Federal Regulations) 68.79 which addresses Compliance Audits says; "The owner and operator shall certify they have evaluated compliance with the provisions of this subpart at least every three years to verify that procedures and practices developed under this subpart are adequate and are being followed."

The refinery has done two OSHA Process Safety Management (PSM) audits but had never completed a compliance audit for RMP, which are required every three years. In order to assess compliance, EPA reviewed the PSM audits since the regulations are similar. The EPA evaluation found that not only were required elements missing altogether, but even where an element was addressed, the company did not follow the appropriate technical procedures and practices that are required to be reviewed, developed and followed.

One of the problems with the OSHA PSM standard (29CFR 1910.119) which governs the health and safety of facilities using a specified volume of highly hazardous chemicals is that it is performance based. The standard tells you what to do but how it is done is left up to the company. This is necessary to a degree in that it allows the employer to bring in new technology or what is termed recognized and generally accepted good engineering practices (RAGAGEP) to make improvements under the standard. What we typically see are employers riding on past practice as this was RAGAGEP at the time it was put in place, so they don't need to upgrade it now. There are certainly some elements of PSM that could be made prescriptive and standardized throughout the industry.

But this calls back to the difficulty with inspections; OSHA is underfunded and under staffed. The PSM standard requires considerable technical expertise to enforce and there are not enough adequately trained compliance officers to address the PSM covered sites, as is the case with RMP under the EPA.

And then there is the Process Safety Management standard itself; it is written to require certain plans but there is no requirement that these plans be good, only that certain items are addressed. For example, as long as a site has done a Management of Change (MOC) on a replacement other than in kind, they are seen as meeting the standard for compliance or regulatory purposes; there is no requirement to do a beneficial or comprehensive MOC. A simple check-the-box checklist is sufficient. There is no required rigor that has to be built into a MOC.

The USW has been involved with a consortium of groups in California involved in sending comments to Governor Jerry Brown in the aftermath of the Chevron Richmond refinery accident. Even though no one was killed in this event, 15,000 community folks sought medical attention. Nineteen workers who were in the area at the time escaped death or serious injury due to sheer luck.

Our coalition has sent a broad number of proactive steps that can be taken to improve refinery safety and we applaud the state of California for embarking on this journey.

While we have made mention of OSHA and EPA being underfunded and short staffed which hinders their ability to sufficiently do inspections, I want to emphasize that part of following a performance based standard is performing. You can have a great written plan but if you are not following it, it is of little benefit.

Let's go back to Chevron Richmond. The company had a written Mechanical Integrity program that covered inspection of piping. Some engineers raised concerns on a number of occasions that the section of pipe that ultimately failed should have come under more scrutiny. Somewhere along the line a decision was made to not do further inspections or replace the pipe.

We hear that workers have the "Stop Work Authority", that if they identify an unsafe condition, they can have the work stopped until it is safe to continue. That was not the case for our members at Chevron. Workers wanted to take the unit offline but were overruled. While we as workers may have the authority, we certainly do not have the power. This is the fallacy in talking about a safety culture; it is based on a harmonized model. Without the power, the authority means nothing.

While we complain about the lack of regulatory involvement, what about the companies responsibility to act? The same when the leak was discovered; the decision should have been made to depressure and shut the unit down based on material and volume. To maintain the idea that it is safer to operate a unit with a hole in the pipe – which is not going to get better – than to shut a unit down is absurd. If that is the case, you need to take a serious look at your operating procedures and parameters.

Calling this type of operation risk based management is not managing the risk at all. It is just taking a risk.

The core issue is that too often, huge quantities of toxic and/or flammable materials are stored on site posing a needless risk to workers and communities – particularly when reducing quantities or using safer alternatives is possible.

Thank you again for the opportunity to raise some fears workers have about the state of process safety in the petrochemical industry.

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Region 6 Enforcement Division Surveillance Section RMP Inspection Report, 11-05-2012

A RISK TOO GREAT

HYDROFLUORIC ACID IN U.S. REFINERIES

Surveillance video from July 19, 2009, fire and explosion at the CITGO Corpus Christi Refinery

TONY MAZZOCCHI CENTER

New Perspectives CONSULTING GROUP INC

UNITED STEELWORKERS
USW
UNITY AND STRENGTH FOR WORKERS

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In 2010, the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union (USW) initiated the Refinery Alkylation Research Action Project to address the alarming number of fatalities and serious injuries in the U.S. oil refining industry. The project was coordinated through the USW-affiliated Tony Mazzocchi Center for Health, Safety and Environmental Education (TMC). We gratefully acknowledge the contributions of all the local unions who participated, and the members of the Project Team:

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Dedicated to Sylvia Kieding

We dedicate this report as a small measure of appreciation for Sylvia Kieding who long served as a union health and safety leader for workers everywhere and especially refinery workers. A long-time supporter and colleague of Tony Mazzocchi, Sylvia was a devoted staff member in health, safety and the environment for the Oil, Chemical and Atomic Workers International Union (OCAW), the Paper, Allied Industrial, Chemical and Energy Workers Union (PACE) and the United Steelworkers (USW) and its Tony Mazzocchi Center for Health, Safety and Environmental Education (TMC) and in cooperation with Queens College, the Worker Health Protection Program (WHPP).

PREFACE: A CULTURE OF RISK

Risk is a natural and unavoidable part of the oil business. As many as four exploratory wells are dry for every well that actually finds oil. Such wells are increasingly expensive, as the hunt for new reserves moves into deeper water and higher latitudes with more extreme weather. A single well can cost hundreds of millions of dollars, and if the well is dry the investment is a total loss. Yet if the risks are great, so too are the rewards. A new field can generate billions in profits. Oil executives are gamblers. They assess, manipulate and ultimately accept huge financial risks every day. The culture of top management is a culture of risk. The oil business rewards risk takers.

But it is one thing to risk money; quite another to risk lives. No industrial process risks more lives from a single accident than does the subject of this report – alkylation using hydrogen fluoride in oil refining. Fifty American refineries use HF alkylation to improve the octane of gasoline. Many are situated in or close to major cities, including Houston, Philadelphia, Salt Lake City and Memphis. In some cases, more than a million residents live in the danger zone of a single refinery. All in all, more than 26 million Americans are at risk.

It is bad enough that such risks exist, especially when much safer processes are available. But are the risks at least being reduced to the absolute minimum through the best possible safety programs? That is the question this report seeks to answer. The study team included safety experts from inside and outside the United Steelworkers as well as refinery workers themselves. Through a standardized questionnaire and data from OSHA, the U.S. Chemical Safety Board, and the industry, they examined the safety of Steelworker-represented refineries using HF alkylation.

The results are shocking. Over a five-year period, the refineries in the study experienced 131 HF releases or near misses and committed hundreds of violations of the OSHA rule regulating highly hazardous operations. Most alarming, for a risk that demands very effective controls, the vast majority of refineries did not reach that level.

Fortunately, HF alkylation can be entirely eliminated. The industry has the technology and expertise. It certainly has the money. It lacks only the will. And if it cannot find the will voluntarily, it must be forced by government action.

This is truly a risk too great.

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The report is available at:
http://assets.usw.org/resources/hse/pdf/A-Risk-Too-Great.pdf

A NOTE ON NOTES: References are at the end of the report, and are designated by numbers. Footnotes, which further explain the text, are on the same page as text to which they refer, and are designated by letters.

A Risk Too Great

Hydrofluoric Acid in U.S. Refineries

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EXECUTIVE SUMMARY

Background: Fifty U.S. oil refineries use large volumes of highly concentrated hydrofluoric acid (HF) as chemical catalysts in a process called alkylation. Alkylation creates additives that boost the octane of gasoline. On average, these 50 refineries each store 212,000 pounds of HF.[a]

If released in the atmosphere, HF rapidly forms dense vapor clouds that hover near land and can travel great distances. Like other powerful acids, HF can cause deep severe burns and damage the eyes, skin, nose, throat and respiratory system. But the fluoride ion is also poisonous. Entering the body through a burn or by the lungs, it can cause internal damage throughout the body. At high enough exposures, HF can kill. The Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) regulate HF as *highly toxic*.

EPA requires companies using or storing highly toxic chemicals to gauge how far a worst case release might travel and how many people might be in harm's way. For HF releases from U.S. refineries, the range is three to 25 miles, depending mostly on the amount stored. Twenty-six million people live within the vulnerable zone, many in urban areas like Philadelphia, Memphis, Salt Lake City, and the Houston – Galveston corridor that would be impossible to evacuate quickly in the event of a major release. No other chemical operation puts as many people at risk.

The Survey: How well are refineries managing the risk of an HF release? To answer this question, a research team from the United Steelworkers, the Tony Mazzocchi Center and the New Perspectives Consulting Group developed a 198 question survey that focused on four key issues: incident prevention; incident and near miss experiences; incident mitigation systems, and emergency preparedness and response. Though not directly addressed in the survey, a fifth issue included in this report is safe staffing.

Workers in 28 of the 50 refineries using HF alkylation are represented by the United Steelworkers. Local unions in 23 of those refineries formed site survey teams and completed the survey, for a response rate of 82 percent. Combined, the 23 study refineries produce 3.3 million barrels of finished petroleum products per day and have over 5.3 million pounds of HF on site. These 23 refineries put approximately 12,000 workers and 13 million community members at risk of exposure from an HF release.

What the survey found:

- Within a recent five-year span, study refineries had 293 violations of OSHA's Process Safety Management (PSM) Standard regulating highly hazardous chemical operations.[b]
- Over three-quarters of the site survey teams reported at least one HF-related incident or near miss in the previous three years. These totaled 131 HF-related incidents or near

[a] Data gathered at U.S. EPA Headquarters by staff from the Center for Public Integrity in October 2010.
[b] This does not include the BP refinery in Texas City that received intense OSHA scrutiny following major catastrophic accidents including the 2005 disaster that killed 15 workers. That site had 593 violations. Texas City is also the refinery that stores the largest amount of HF.

misses. Among 16 sites reporting their most serious or potentially serious HF-related events, all reported the events either *did* or *could have* caused injuries to workers on-site, and half indicated that these events could have caused injuries to people in the community.

- A chemical as lethal as HF demands the most effective safety systems. Yet more than half of the site survey teams reported that 26 out of 32 safety systems were *less than very effective* in three critical areas -- maintaining the integrity of HF alkylation processes, maintaining the integrity of related processes such as storage and transfer, and emergency mitigation. For the remaining six systems examined, a majority rated them as *very effective.*
- Almost two-thirds reported their sites were *less than very prepared* with emergency personal protective equipment for on-site workers who might need it during a release.
- Site survey teams rated preparedness for HF-related emergencies for four groups of workers: on-site emergency responders; off-site emergency responders; on-site nursing and medical personnel, and first receivers (e.g., hospital workers). More than half of the sites rated each worker group *less than very prepared* for an on-site emergency. Sites were assessed to be even less prepared for a larger release spreading into the surrounding community.
- Although the survey did not include questions on staffing, a number of site survey teams commented that staffing levels were too low to ensure the safe operation of alkylation units.

Alternatives to HF: There are other ways to perform alkylation in an oil refinery. Some refineries use a modified form of HF containing a chemical which renders it less volatile. Others use sulfuric acid instead of HF. Both methods have their drawbacks, and both are hazardous, although not as hazardous as alkylation using unmodified HF. Far safer alternatives exist for catalyzing alkylation reactions. They use either solid catalysts or liquid ionic catalysts. Both these safer alkylation catalysts have been demonstrated successful at the pilot stage, and, for liquid ionic, in production. Releases of either of these alternative catalysts would be relatively benign, especially in comparison to HF. Still, no U.S. refinery has yet converted to these alternatives.

Conclusions: There must be fundamental change in the oil industry's use of HF. The long-term solution is to replace HF alkylation with safer systems not requiring the use of so toxic a chemical. In the meantime, existing alkylation units can and must be made safer.

In particular, the industry should:

1. Commit to ending the use of HF alkylation and replacing it with safer alternatives as soon as possible.
2. Develop, build and test pilot alkylation units using safer chemicals and processes, sharing lessons from those operations to speed the transition to full-scale safer alternative alkylation processes across the industry.

3. Work cooperatively with unions and other stakeholders to educate site workers, on- and off-site emergency responders and receivers, and the public about the dangers of HF.
4. Make existing HF alkylation processes systems safer by improving process integrity, mitigation systems, and emergency response, and by converting to the use of modified-HF.
5. Create an open and transparent system for reporting HF-related releases, near misses and process upsets, both within and outside the corporation, so that similar events can be avoided.
6. Work with the USW and other unions to promote effective process safety programs based on rigorous hazard identification and correction.
7. Increase staffing to a level that will be effective in preventing, preparing for, and responding to potential HF alkylation unit emergencies.

The government can facilitate this process through intensive inspections of HF alkylation units under OSHA's Process Safety Standard and the EPA Risk Management Program. HF alkylation as it is currently performed in U.S. refineries is a risk too great, but that risk can be reduced and ultimately eliminated.

A Risk Too Great
Hydrofluoric Acid in U.S. Refineries

INTRODUCTION AND BACKGROUND

Thousands of workers, millions of community members and vast stretches of air, land and water are at risk from oil companies' use of hydrofluoric acid (HF) at 50 U.S. refineries. In several cases, a single HF-using refinery puts hundreds of workers and more than one million community members at risk of devastating injuries and even death. This is a risk too great.

Where It All Begins

Clean-burning gasoline requires a high octane rating. Oil refineries achieve these ratings using additives produced in processes called *alkylation*. These alkylation processes work by using acid catalysts to modify petroleum feed materials to form what are called *alkylates*. Refineries blend these alkylates with other refining products to create gasoline for retail sale.

Alkylation: Extremely Hazardous Chemical Processes

Currently, U.S. refineries use two different processes and chemical catalysts for alkylation. One involves very large volumes of highly concentrated sulfuric acid (H_2SO_4). The other, the subject of this report, uses very large volumes of highly concentrated hydrofluoric acid (HF). Sulfuric acid alkylation processes are hazardous, but not as hazardous as HF alkylation. HF is much more dangerous when released because it readily forms dense, highly toxic vapor clouds that hover near land and can travel great distances. In contrast, sulfuric acid typically remains in a liquid state during upsets and releases.[a] And while both acids are highly corrosive, HF is also a systemic poison. Importantly, there are now alkylation catalysts and processes that are much safer than either sulfuric acid or HF. This report will address these innovations in later sections.

[a] HF has a boiling point of 67 °F and a vapor pressure of 783 mmHg. By comparison, sulfuric acid has a boiling point of 554 °F and a vapor pressure of 0.01 mmHg.

HF – Extremely Toxic

HF is a fast-acting acid and can cause deep, severe burns. Exposure can occur through inhalation and skin contact. HF can permanently damage the eyes, skin, nose, throat, respiratory system and bones. The fluoride ion can enter the body when HF is inhaled or through a skin burn, where it can interfere with calcium metabolism and cause death by cardiac arrest. (See Appendix A: HF Hazards)

Both the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) regulate HF as *highly toxic*. The quantities of HF stored in the 50 U.S. refineries that use it for alkylation ranges from 5,200 to 870,000 pounds. The average per refinery is 212,000 pounds; the median, 150,000 pounds.[1]

Of special importance to these refineries is the concept of *process safety*. Process safety is the art and science of preventing fires, explosions and major releases of dangerous chemicals from tanks, vessels and piping where they are used or stored. OSHA covers these refineries under its *Process Safety Management of Highly Hazardous Chemicals* (PSM) standard. This standard is designed to protect *workers* from catastrophic releases and exposures. EPA covers these same refineries under its *Risk Management Program* (RMP) rule. EPA's rule is designed to protect *communities* by preventing releases and preparing for emergency responses.

Figure 1. August 1986, an industry-sponsored controlled release of anhydrous hydrofluoric acid at a remote area of the Nevada Test Site. The seven minute test release created a hydrofluoric acid cloud over 10 feet high and visible from as far as ¾ of a mile.

Nevada Test Sites Studies

Scientific tests of HF releases conducted in 1986 in the Nevada desert surprised researchers when 100 percent of the released liquid HF formed dense, rolling clouds of toxic vapor (see sequence of photos in Figure 1). The clouds expanded rapidly and researchers measured dangerous concentrations at distances of three to six miles downwind. The tests showed that unless a refinery HF release is effectively mitigated it could place large numbers of refinery workers and large swaths of the surrounding communities in terrible danger.[2,3]

Guidelines, Mitigation and Modifications Not Enough

The American Petroleum Institute (API), an organization of petroleum companies, has a recommended practice titled Safe Operation of Hydrofluoric Acid Alkylation Units (RP 751).[4][a] The guidelines are useful – if followed. But like all API-recommended practices they are voluntary, although OSHA can sometimes use them to establish a violation of the PSM Standard. In addition, the guidelines were developed without the adequate involvement of key stakeholders such as refinery workers, labor unions or community residents and organizations.

The industry has tested and promoted mitigation systems to lessen the impacts of HF releases. These include water cannons, sprays and rapid systems for transferring HF from a compromised vessel. These systems would help contain a release, but they could fail or be overwhelmed in an emergency. (See Appendix A: HF Process Controls and Modifications.)

A small but growing percentage of HF-using refineries use *modified* HF. Modified HF has chemical additives such as sulfolane[b] that are intended to reduce the rate of HF vaporization. Theoretically, modification also reduces the distance that an HF plume would travel. However, modification of HF does not keep it from vaporizing and creating a traveling plume, nor does it reduce the toxicity of HF.[c] If the release was accompanied by a fire – and many refinery accidents involve fires – the vaporization of even modified HF would be greatly increased.

Lessons from the History of Chemical Disasters

A characteristic of previous major chemical disasters is that they occurred as the result of failures of multiple safety systems. Further, these disasters typically propagated and cascaded in ways that were not fully anticipated and were beyond the capacities of mitigation and emergency response systems. The Deep Water Horizon disaster that began April 20, 2010, in the Gulf of Mexico is a prime example. It immediately killed 11 workers, ignited a fire visible for dozens of miles, and sank a giant oil platform. BP and its contractors tried to activate the main control device, a blowout preventer, but it failed. It remained in a failed state and the disaster continued to unfold until the leak was stopped 86 days later. The disaster showed that the oil industry's prevention and response plans were completely inadequate.

The report of the National Commission on the BP/Deepwater Horizon Oil Spill and Offshore Drilling[5] repeated the finding made by the Columbia (Space Shuttle) Accident Investigation Board[6] in 2003 that "complex systems almost always fail in complex ways." (p. viii and p. 6 respectively) Further, the Deepwater Horizon Commission report stated, "An unfortunate lesson of the oil spill is that the nation was not well prepared for the possibility of widespread, adverse effects on human health and mental well-being, especially among a particularly vulnerable citizenry" (pp. 191-192).

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[a] The Recommended Practice addresses hazards management, operating procedures and worker protection, new construction, inspection and maintenance, transportation and inventory control, relief and utility systems, and mitigation options and techniques.

[b] Chemical name: tetrahydrothiophene 1,1-dioxide: boiling point 545 °F; 0.026 mmHg. The boiling point of modified HF (i.e., the mixture) has not been determined.

[c] The "Potential Health Hazards" sections of HF manufacturer Honeywell's Material Safety Data Sheets for a) Hydrofluoric Acid, Anhydrous and b) Modified Hydrofluoric acid are identical as are the "Emergency Overviews." http://www51.honeywell.com/sm/hfacid/common/documents/AHF_MSDS.pdf; (Last accessed March 12, 2013) http://www51.honeywell.com/sm/hfacid/common/documents/Modified-HF.pdf. (Last accessed March 12, 2013)

U.S. Workers, Communities and the Environment at Risk

Twenty-five oil companies use HF at 50 U.S. refineries. Collectively, these refineries put more than 26 million persons at risk from an HF release. Among these are 19 refineries in or near eight major metropolitan areas that put more than 22 million persons at risk. The USW represents approximately 7,000 workers at 28 of these refineries.

(See Appendix C: Table C1 and C2.)

The EPA, through its RMP rule, requires companies with greater than threshold quantities of specific chemicals to estimate of the size of the population at risk from a release. These estimates are made by drawing a circle on a map with the potential release point at the center. The population within the circle defined by a radius of the *endpoint distance* is that which is vulnerable in the event of a worst case HF release. The size of the circle depends on the amount of chemical, in this case HF, that would be released and how far it might travel in a "worst case" scenario as defined by EPA. Among the HF-using refineries in the United States, the median *endpoint distance*[a] for HF toxic worst case release is 15 miles (range of 3 mi. to 25 mi. for the 50 refineries). Forty-two of these refineries have an endpoint distance of greater than 10 miles with nearly half of those having an endpoint distance of greater than 20 miles.[b]

A Horrifying Scenario

Following 9/11, in his book <u>The Edge of Disaster: Rebuilding a Resilient Nation</u>, Stephen Flynn argued, "Our top national priority must be to ensure that our society and our infrastructure are resilient enough not to break under the strain of natural disasters or terrorist attacks"[7][c] (p. 110). In an article taken from his book, Flynn develops a disaster scenario at an HF-using refinery in a major metropolitan area. He describes events following an "entirely plausible" fictional attack on the refinery's HF tanks and a major release:

"Thousands of people are trapped in their cars as the

Figure 2. July 2009 hydrofluoric acid fire, explosion and release at the CITGO Corpus Christi Refinery.

[a] The distance beyond which specified harmful effects would no longer be felt.

[b] Fourteen of the refineries have an endpoint distance of 25 miles, the maximum of EPA's lookup tables and RMP*Comp software.

[c] Stephen Flynn, Ph.D. is a retired officer from the U.S. Coast Guard and an expert on homeland-security. He is now Professor in the Department of Political Science at Northeastern University and Founding Co-Director, George J. Kostas Research Institute for Homeland Security.

> hydrofluoric cloud drifts over them, burning their eyes and eyelids. Soon, their lungs become inflamed and congested, depriving them of oxygen and leading to seizures. Most die within ten hours."[8]

Variations of this scenario might be applicable at any one of the 50 HF-using refineries in the United States.

In addition to the resiliency Flynn calls for, the nation's refining infrastructure also needs to be resilient enough not to break under the strain of unplanned and unintended systems failures during the course of normal operations, startups and shut downs. These are far more common than natural disasters and terrorist attacks.

The Record

Catastrophic Chemical Accidents and Process Safety Systems

The underlying or root causes of most chemical process accidents are deficiencies in the management of process safety systems. Management of these safety systems is the foundation for OSHA's PSM standard, the U.S. EPA's RMP rule, and internationally, the European Union's Seveso II Directive. Nonetheless, according to former U.S. Chemical Safety Board member Dr. Irv Rosenthal and others, writing in the journal *Process Safety Progress*, these requirements have been insufficient to stem the tide of accidents.[9] These risk experts stated, "the less than expected decrease in accident incidence has occurred because the newly adopted regulations have not resulted in the hoped for adoption of 'effective' process safety management systems by industry" (p. 136).

Refinery Disasters – Infrequent But Not Rare

The infrequency of major catastrophic accidents in the refining industry can foster the belief that the probability of these events is so low that "it can't happen." This has given rise to labeling these types of accidents *low probability–high consequence* (LP–HC). Having done extensive research in this arena, the EPA's James C. Belke stated:

> "From the perspective of the individual facility manager, catastrophic events are so rare that they may appear to be essentially impossible, and the circumstances and causes of an accident at a distant facility in a different industry sector may seem irrelevant"[10] (p. 7).

Thus, while the cumulative risk from dozens of refineries is substantially higher, there is a potential for complacency or overconfidence of management at individual refineries.

In 2000, Belke authored an EPA study using RMP incident data from 1994 to1999.[11] That study documented that oil refineries had nearly twice as many accidents as any other RMP industry. One hundred and one of these were HF incidents. That study also revealed HF ranked third among regulated chemicals in the number of process release incidents.

Industry Reports on Safety – No Assurance

An extensive study of process safety incidents by Michael R. Elliot and others[12] sheds additional light on refinery safety. The study found that there are no strong positive correlations between LP–HC incidents and regularly reported occupation illness and injuries (OII) or OII rates. Nonetheless, the refining industry commonly reports on these data as evidence of refinery safety. In May 2010, Deputy Assistant Secretary for Federal OSHA, Jordan Barab, addressed this and other issues in a speech before the National Safety Conference of the National Petroleum Refiners Association (NPRA).[13] He told the industry, "Stop boasting about your safety record [referring to OII rates] when you're literally putting out fires. You're only undermining your credibility."

Barab also spoke in broad terms about the energy industry's record on major accidents:

> "OSHA is particularly concerned about the recent number of serious incidents at refineries that have scalded, burned or struck down your fellow workers. We are tracking these catastrophes and looking for trends -- including problems resulting from aging facilities."

In 2007, OSHA instituted a National Emphasis Program (NEP) to "reduce or eliminate workplace hazards associated with the catastrophic release of highly hazardous chemicals at petroleum refineries."[14] This greatly increased the number of OSHA inspections at refineries that were focused on process safety and its PSM standard. Nonetheless, three years later, OSHA's Barab was moved to express that he was, "deeply troubled by the significant lack of compliance we are finding in our inspections and with the number of serious refinery problems that continue to occur."[13]

In April 2011, Dr. Rafael Moure-Eraso, Chairperson of U.S. Chemical Safety Board (CSB) used the one-year anniversary of the 2010 Tesoro refinery disaster in Anacortes, Wash., to assess the status of the U.S. refining industry. He said, "Serious incidents at refineries continue to occur with alarming frequency."[15] The trail of U.S. refinery disasters and non-compliance with regulations is a potent reminder of the potential for catastrophe. (See Appendix A: Major Oil Industry Incidents, and HF Alkylation Unit Incidents.)

USW Study Confirms Industry Unprepared to Prevent or Respond to Refinery Incidents

Following the 2005 BP Texas City Refinery disaster, the USW conducted a nationwide study titled, Beyond Texas City: The State of Process Safety In The Unionized U.S. Oil Refining Industry.[16] This study examined the extent of highly hazardous conditions like those that contributed to the Texas City disaster at 51 unionized refineries. The study found that these highly hazardous conditions continued to be pervasive. Further, it found that these conditions had often resulted in incidents or near misses. Training was found to be insufficient and less than a third said their refineries were reported to be *very prepared* to respond safely to hazardous materials emergencies. The study concluded that the refining industry is ripe for future disasters.

Doing More with Less? Understaffing Is Unsafe

Examination of the BP Texas City Disaster Looks at Refinery Staffing

The 2005 BP Texas City disaster surfaced the critically interconnected issues of refinery understaffing and process safety. The Baker Panel, proposed by the CSB and headed by former White House Chief of Staff, James Baker, studied process safety management at five U.S. BP refineries. The Baker Panel study found that understaffing was a serious safety problem, common for routine operations, and existed for upset conditions and emergencies. Understaffing was identified among maintenance personnel, operators, chief operators and supervisors and was recognized by both hourly workers and management. The study noted that this understaffing resulted in unsafe performance of jobs at the refineries. Understaffing was also linked to inexperienced supervisors, low morale, poor communication, delayed responses to needs, inability to supervise contractors properly, interference with training, and slowed hazard assessments and investigations.[17]

While there are no regulations in the United States for governing staffing levels at refineries, the nuclear industry, one with similar disaster potential to refineries with large quantities of HF, provides some guidance. The U.S. Nuclear Regulatory Commission (NRC) in its *Guidance for Staffing Exemption Requests* provides prescriptive regulations for qualifications and staffing levels (e.g., enumerating specific staffing requirements for senior operators and operators for a given number of operating units).[18,a] In addition, the NRC recognizes that these prescriptions may not be adequate to address certain design features and operations. As a result, the NRC has more detailed regulations in its *Guidance* that requires a task analysis of "risk-significant human actions; difficult tasks identified through the operating experience review; a range of procedure-guided tasks that are well defined by normal, abnormal, emergency, alarm response, and test procedures" and knowledge-based tasks, human decision-making and interactions, and frequent and infrequent tasks (p. II 3-2).

Circadian, a global leader in providing guidance on 24/7 workplace performance and safety solutions, recently published a white paper on safe staffing levels. In that report Circadian stated, "Understaffing is a major contributor to not only fatigue and human error, but also to the health, safety, performance and quality of life" of employees[19] (p. 15). Accordingly, based on extensive field study, they posited that an overall overtime rate of 20 percent is "arguably unsafe to operate because of the significantly increased risk of human error. This is particularly true with night shifts, rotating schedules and/or long, irregular hours." (p. 13)

The United Kingdom's Health and Safety Executive (the counterpart to U.S. OSHA) provides further guidance. It established its Staffing Levels and Task Organization Technical Assistance Guide (TAG 061) in part on deficiencies in staffing and task organization identified at Three Mile Island, Chernobyl, BP Texas City and the Challenger Space Shuttle.[20] TAG 061 addresses staffing and task organization of licensed nuclear facilities in accordance with the requirements of the International Atomic Energy Agency (IAEA) Requirements and Guides. (See Appendix A: Technical Assessment Guide (TAG) 061: Staffing Levels and Task Organisation.)

Recently, the oil industry attempted to address staffing through the 2010 American Petroleum Institute Recommended Practice 755, "Fatigue Risk Management System," developed pursuant to a recommendation from the U.S. Chemical Safety and Hazard Investigation Board. Although the CSB requested that the USW and API work together on the issue, and the API promised a "consensus" process, in the end the API insisted on a process through which the union was consistently outvoted on important issues. The union eventually left the discussions in frustration. Although better than nothing, RP 755 is a weak standard, with numerous loopholes and provisions open to interpretation. Like all API Recommended Practices, it is voluntary. So far, it has had little impact on staffing levels.

[a] Minimum Requirements Per Shift for On-Site Staffing of Nuclear Power Units by Operators and Senior Operators Licensed Under 10 CFR Part 55 (with allowance for temporary deviations).

Safer Alternatives

Chemists and engineers have come up with a number of ways to make hazardous chemical operations not just safer, but safer at their core. These approaches are called *inherently safer technologies* (IST). First and foremost among these is replacing the dangerous chemicals or processes in use with ones that are safer. Substitution of a less dangerous chemical for a highly toxic one is a long-held, widely accepted best practice in occupational and environmental health. It is also one promoted by the American Institute of Chemical Engineers (AIChE), and its Center for Chemical Process Safety. AIChE, a largely industry-based professional group, has published and promoted the concept of inherently safer design in chemical process industries like oil refining.[21, 22] Fortunately, inherently safer technologies exist for alkylation.

An *ionic liquid alkylation* process has been successfully developed, piloted and put into production. This method is inherently safer than HF alkylation processes. It is also safer than sulfuric alkylation processes. Using ionic liquid alkylation, Chinese refiners[23] have successfully produced alkylates in both pilot and production phases. These alkylates are reported to compare favorably with those produced by HF and sulfuric acid processes. In contrast to alkylates produced with HF and sulfuric acid, these alkylates are produced without the dangers to workers, communities and the environment posed by current processes.[24] With ionic liquid alkylation, the large volumes of HF and sulfuric acid would be gone. Also removed would be the risks they pose to the environment, tens of thousands of workers and millions of community members surrounding refineries.

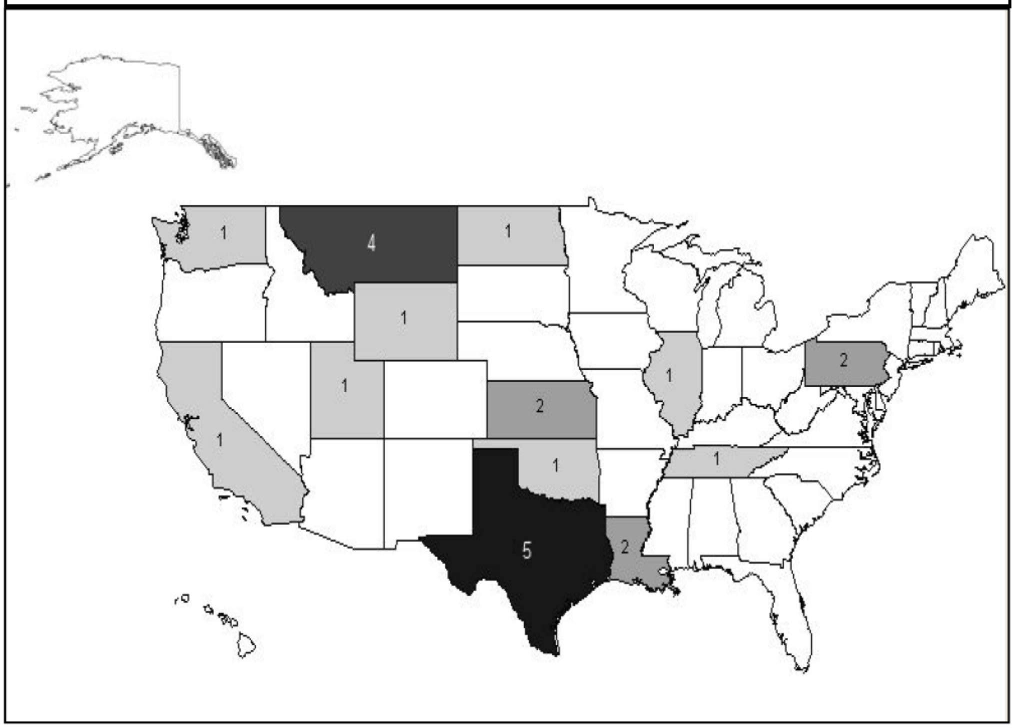
Solid acid catalyst (SAC) alkylation systems are another alternative to HF and sulfuric acid alkylation. In 2004, a consortium of companies announced that they had one and a half years of documented operating performance using a solid acid catalyst (SAC) system. This system also eliminates the use of large quantities of HF and sulfuric acid.

Some have suggested sulfuric acid processes, already widely used in dozens of U.S. refineries, should be considered as a safer alternative to HF alkylation. While sulfuric acid is much safer than HF, it still poses substantial hazards for workers, community members and the environment. (For more see an additional USW report the Sulfuric Acid Alkylation to be released later in 2013.)

THE USW SURVEY

In late 2010, a survey questionnaire was developed by a team of refinery workers, health and safety specialists, and professional survey researchers. The questionnaire was sent to 61 USW refinery local unions with alkylation processes using either hydrofluoric acid (HF) or sulfuric acid in the United States. Twenty-eight of these refineries used HF. Among these, 23 site survey teams returned questionnaires for a response rate of 82 percent. This report is about findings from these 23 refineries. (Findings for the refineries using sulfuric acid for alkylation will be presented in a companion report.) Figure 3 shows the states where the 23 responding HF refineries were located.

Figure 3. Number of Responding U.S. Refinery Sites Using HF in Alkylation (n = 23)



The 198-item questionnaire addressed the safe operation HF alkylation units, and the procedures in place to prevent and mitigate releases. Researchers requested that each responding local union create a multi-disciplinary site survey team made up of local union members in six specific roles. These roles included: 1) local union leadership, 2) those with specific health and safety responsibilities, 3) alkylation unit operators, 4) maintenance workers, 5) those on process hazard analysis (PHA) teams, and 6) emergency responders. The range of members participating on each of these 23 site survey teams ranged from 63 percent of those who had served on PHA teams, to 95 percent each for those who were local union leadership or operators, and 100 percent for those with specific health and safety responsibilities. (See Appendix B: Table B1.)

The Study Refineries

Production

Combined, the 23 study refineries with HF alkylation units produced 3.3 million barrels of finished petroleum products per day with an average production of 145,000 barrels per day per refinery.

Quantities of HF

The 23 refineries in this study collectively had over 5 million pounds of HF on site. The quantities of HF per refinery ranged from 5,200 pounds to 870,000 pounds with an average of 233,000 pounds.[a] These data were gathered from refining company reports to EPA as part of its Risk Management Program (RMP) rule. Refineries covered under EPA's RMP are required to implement chemical accident prevention and preparedness measures, and to submit summary reports to the government when quantities of listed highly hazardous chemicals, in this case HF, exceed the regulatory threshold. These reports contain information about the quantities of chemicals on site as well as the potential consequences of accident release scenarios.

Additional information is available from OSHA inspection data that identified violations of its Process Safety Management (PSM) Standard (29 CFR 1910.119). The standard is the counterpart to EPA's RMP regulation; it regulates key process safety systems to prevent workers from being injured or made ill at sites with very large quantities of highly hazardous substances.

Potentially Affected Populations

The potentially affected populations for possible worst case releases of HF in the communities surrounding the 23 study refineries range from 20,000 persons to over 3 million persons. In total, over 13 million community members are potentially at risk of exposure to highly toxic HF from the 23 refineries studied.[I]

OSHA Violations Found During OSHA Process Safety Management Inspections at Study Refineries

Among the 23 study refineries with HF alkylation units, 21 had OSHA PSM violations within the five years previous to February 2011. [b] Among 20 study refineries, there were 293 violations – an average of 21 per refinery, and a range of from 1 to 35 violations. This does not include the BP refinery in Texas City that received intense OSHA scrutiny following major catastrophic accidents including the 2005 disaster. That site, an outlier in terms of data from other refineries, had 593 violations.

Profits Among Companies Operating Study Refineries

One potential obstacle to finding and correcting process safety vulnerabilities or in replacing existing systems and chemicals with safer ones is financial resources. Accordingly, the 2010 gross operating profits for the publicly held corporations operating 18 of the study refineries

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[a] Data gathered at U.S. EPA Headquarters by staff from the Center for Public Integrity in October 2010.
[b] Data extracted from the OSHA's IMIS Database by the staff of the Center for Public Integrity, February, 2011. (http://www.osha.gov/pls/imis/establishment.html). PSM violations are rom all inspections during the previous five years including, but not limited to OSHA National Emphasis Program (NEP) inspections.

were obtained. These 18 refineries were operated by eight oil companies. In total, these eight companies had gross operating profits in 2011 of approximately $150 billion.[a]

[a] Data from Market Watch. http://www.marketwatch.com

SURVEY FINDINGS

1. How the Results Are Reported

A major release of HF from a refinery would be catastrophic. Systems whose failures could result in catastrophe demand the highest level of safety. Few airline passengers or government regulators would tolerate airline safety systems that were judged to be *somewhat effective* rather than *very effective.* Likewise, workers, community residents and the natural environment deserve safety systems for refinery processes that are *very effective*. This is especially so when it comes to preventing and responding to potential releases of highly hazardous chemicals like HF. Many of the questions in this survey asked whether refinery safety systems were *very effective*, *somewhat effective*, *somewhat ineffective*, or *very ineffective*. In these cases, *very effective* was the standard we used in this report. Therefore, this report compared safety systems that were judged *very effective* with all those judged to be of lower effectiveness. When making these comparisons we use the phrase "*less than very effective.*" We also use this standard when we assess other measures such as *confidence* and *preparedness*.

2. HF Alkylation Process Safety Systems: Preparedness to Prevent Disaster

The safety of process operations at refineries is governed by what are known as process safety systems. These systems must be in place to operate safely in normal and abnormal conditions and must be able to quickly and effectively mitigate process upsets, leaks, fires and other emergency conditions. The safety of alkylation units depends on the effectiveness of individual component systems within the process unit and their functioning as interdependent parts of an integrated whole. With very large quantities of highly hazardous materials, these systems need to operate at peak performance. The 23 site survey response teams rated 32 process safety systems related to HF alkylation units. These assessments of HF alkylation safety systems are presented in three groups. The first two groups of process safety systems are aimed at prevention:

A. Effectiveness of safety systems for maintaining the integrity of *HF alkylation processes* (nine systems)
B. Effectiveness of safety systems for *HF-related processes, storage, and transfer systems*, *taken as a whole* (11 systems)

These two groups will be discussed in this section. The third group was:

C. Effectiveness of HF emergency mitigation and response systems (12 systems)

This group will be discussed in the later section — *Prepared to Respond*.

A. Effectiveness of Safety Systems for Maintaining the Integrity of HF Alkylation Processes

Site survey teams rated the nine systems for maintaining the integrity of *HF alkylation processing* as follows:

- For five systems ranked least effective – sewer systems, mechanical integrity of piping, mechanical integrity of pumps valves, seals and vents; maintenance; and integrity of instrumentation – 65 percent to 79 percent of site survey teams rated them as less than *very effective* (22 percent to 35 percent *very effective*). From 26 percent to 44 percent of sites rated them as *ineffective*.

- For three process systems – corrosion monitoring, mechanical integrity of pressurized tanks and vessels, and inspection and testing – approximately half (from 52 percent to 56 percent) site survey teams rated them as less than *very effective* (39 percent to 48 percent *very effective*). From 4 percent to 13 percent of sites rated them as *ineffective*.
- For the only system that fewer than half of the site survey teams rated less than *very effective* was – mechanical integrity of atmospheric tanks – 44 percent rated this system less than *very effective* (56 percent *very effective*). Six percent (6 percent) rated this system *ineffective*.

(See Appendix B: Table B2.)

B. Effectiveness of Safety Systems for HF-Related Processes, Storage, and Transfer Systems, Taken as a Whole

Site survey teams provided overall ratings for a group of 11 safety systems that focused on process, storage, and transfer systems related to HF alkylation. These ratings follow:

- For three systems ranked least effective – audit programs, maintenance, and health hazard information and education for site personnel *outside* of HF alkylation units – 78 percent to 82 percent of site survey teams rated them as less than *very effective* (9 percent to 22 percent *very effective*). From 26 percent to 39 percent were rated *ineffective*.
- For six more highly ranked systems – operating manuals and procedures; utility systems; HF unit pre-start-up safety reviews; process hazard analyses (PHAs); leak detection and repair, and strictly controlled access to HF alkylation units key to preventing HF incidents – 57 percent to 69 percent of site survey teams rated them less than *very effective* (26 percent to 43 percent *very effective*). From 9 percent to 35 percent rated them *ineffective*.[a]
- For only two of the safety systems – health hazard information and education for personnel *within* HF alkylation units, and controlled relief and neutralization systems – less than half of the site survey teams (35 percent and 44 percent respectively) rated them as less than *very effective* (65 percent to 52 percent *very effective* respectively).

(See Appendix B: Table B3.)

3. HF Alkylation Unit Incidents and Near Misses

One way to assess the safety of alkylation units is to examine HF-related incident and near miss histories of these processes. The following summarizes site survey team reports of HF-related incidents and near misses.

- Over three-quarters of site survey teams (18 sites or 78 percent) reported at least one HF-related incident or near miss in the previous three years. Five sites (22 percent) reported that they had no HF-related incidents or near misses.

[a] For one system, controlled access, 4% said they do not have this. We included this 4% in both "less than *very effective*" and the "*ineffective*" groupings.

- The 18 sites with HF-related events reported a total of 131 incidents or near misses – 115 events related to HF alkylation processing and 16 events related to HF storage or transfer. This was an average of 7.3 events per site over the three year period, or 2.4 HF-related events per site per year.

Site survey teams provided further details about the most important HF incident or near miss (usually the one that was most serious or potentially serious). Of the 18 sites with events, 89 percent (16 sites) reported incidents as most important and the other two sites reported near misses as most important. Nearly all (17 sites or 94 percent) reported that these events involved alkylation process unit events while 17 percent (3 sites) also involved on-site HF storage, and 11 percent involved both off-loading and on-site transfer of HF (2 sites). Among these events, 83 percent involved spills or releases (15 events) and 17 percent involved fires or explosions (3 events). Site survey teams all reported the events either *did* or *could have* caused injuries to workers on-site. Half (9 sites) indicated that these events could have caused injuries to people in the community. While none reported fatalities related to these events, the number of injuries reported ranged from none to 13. In total, 24 workers were injured. Twenty-two (22) of the injured received first aid and 16 received treatment in emergency rooms. Six were admitted to hospitals for their injuries.

4. Prepared to Respond

A. Effectiveness of HF Emergency Mitigation and Response Systems

A similar picture of deficiency emerged when examining the third set of process safety systems that focused on HF emergency mitigation and response related to potential HF releases. The ratings for these 12 systems follow:

- For the five systems ranked least effective – off-site alarms and notification systems; utility back-up systems; emergency field drills; safe havens for employees needing refuge from HF releases, and diking systems to contain spills – 74 percent to 86 percent rated them less than *very effective* (9 percent to 22 percent *very effective*). From 39 percent to 48 percent rated them *ineffective* or *don't have*.[a]
- For four additional mitigation and response systems – chemical neutralization systems; fire suppression systems; remotely operated block valves for isolating HF units, and water curtain and deluge systems – 56 percent to 69 percent of site survey teams rated them less than *very effective* (32 percent to 43 percent *very effective*). From 8 percent to 28 percent rated them *ineffective* or *don't have*.[b]
- For only three systems – overall emergency shutdown and isolation systems, on-site alarms, and emergency rapid transfer systems for HF – less than half (40 percent to 43 percent) rated them less than *very effective* (52 percent to 57 percent *very effective*).

(See Appendix B: Table B4.)

[a] These include 35 percent *don't have* for off-site alarms, 22 percent for safe havens, 17 percent for utility back-up, and 13 percent for both emergency field drills and for diking. *Don't have* responses are included in *ineffective* and less than *very effective* ratings.
[b] These include 23 percent *don't have* for chemical neutralization systems, 9 percent *don't have* for fire suppression systems, 4 percent *don't have* for overall emergency shutdown and isolation systems. *Don't have* responses are included in *ineffective* and less than *very effective* ratings.

An HF release might come about as a result of a fire or explosion. Refinery water supplies need to be sufficient to simultaneously generate fire-fighting foam, cool overheating vessels and piping, (possibly in multiple units) and to operate HF water mitigation systems to suppress HF vapors.

- When asked about adequacy of water supplies for both these purposes, 30 percent reported that their sites *did not have* adequate supplies and 17 percent said *don't know*. A slight majority, 52 percent reported that their sites had adequate water supplies.

B. Emergency Responder Preparedness

Should HF containment systems fail, employees at the site must rapidly perform safe and orderly shutdown, mitigation and evacuation. Accordingly, the survey asked about necessary personal protective equipment (PPE) for every employee who might need it in an HF emergency. Approximately two-thirds of site survey teams (65 percent) reported their sites were less than *very prepared* with PPE (35 percent *very prepared*). More than one in three sites (39 percent) reported that the refinery was *unprepared* with PPE.

(See Appendix B: Table B5.)

The survey also assessed overall preparedness of four key groups of workers that would need to respond if there was an HF release at a refinery:

a) The refinery's on-site emergency responders
b) Local community's off-site emergency responders
c) On-site nursing and other medical personnel
d) Local hospitals (or first receivers)

Furthermore, the survey examined this preparedness for three different levels of possible refinery HF releases:

- Releases limited to a work area where fewer than 10 workers may be seriously exposed
- Releases that spread across the whole refinery where dozens of workers may be seriously exposed
- Releases that extend outside the refinery where community members may be seriously exposed

In combination, these four worker groups and these three distinct levels of potential HF releases constituted 12 categories of preparedness. These ratings have added importance when considering that 78 percent of the study refineries reported 131 HF-related incidents or near misses in the previous 36 months. Further, half the site survey teams that reported on their sites' most important incident said the events could have caused injuries to people in the community.

(See Appendix B: Table B6 for the data described below.) [a]

[a] In reporting of data for each of the work groups, the *don't have* responses are included in the categories of less than *very prepared* and *unprepared*.

a) Refinery's on-site emergency responders

- For **HF releases limited to a work area**, 57 percent reported that on-site emergency responders were less than *very prepared* (43 percent *very prepared*). More than one in five (22 percent) rated on-site responders *unprepared*.
- For **HF releases across the refinery**, 79 percent reported that these on-site responders were less than *very prepared* (22 percent *very prepared*). Again, 22 percent rated on-site responders *unprepared*.
- For **HF releases into the community**, 70 percent rated these responders were less than *very prepared* (22 percent *very prepared*). Nearly half (48 percent) rated them *unprepared*.

These data show declining levels of preparedness with the increased scope of HF releases. The lowest levels of preparedness were reported for potential releases into the community. This trend of lower levels of preparedness for increasing levels of potential HF releases was reported for the other three key groups of workers: off-site emergency responders, on-site nursing and other medical personnel, and local hospitals' first receivers. These are shown below.

b) Local community's off-site emergency responders

- For **HF releases limited to a work area**, 60 percent reported off-site emergency responders were less than *very prepared* (17 percent *very prepared*). Thirty percent (30 percent) rated them *unprepared* or *don't have* and 22 percent reported *don't know*.
- For **HF releases across the refinery**, 78 percent reported off-site responders were less than *very prepared* (9 percent *very prepared*). Almost half (48 percent) rated them *unprepared* or *don't have* and 13 percent reported *don't know*.
- For **HF releases into the community**, 73 percent reported these off-site responders were less than *very prepared* (4 percent *very prepared*). Approximately half (51 percent) rated them *unprepared* or *don't have* and 22 percent reported *don't know*.

c) On-site nursing and other medical personnel

- For **HF releases limited to a work area**, 69 percent reported on-site medical personnel were less than *very prepared* (30 percent very prepared). Thirty percent (30 percent) rated them *unprepared* or *don't have*.
- For **HF releases across the refinery**, 81 percent reported on-site medical personnel were less than *very prepared* (17 percent very prepared). Slightly over half (51 percent) rated these personnel as *unprepared* or *don't have*.
- For **HF releases into the community**, 78 percent reported on-site medical personnel were less than *very prepared* (13 percent very prepared). Over half (61 percent) rated these personnel *unprepared* or *don't have* and 9 percent reported *don't know*.

d) Local hospitals (or first receivers)

- For **HF releases limited to a work area**, 61 percent reported local hospitals or first receivers were less than *very prepar*ed (26 percent *very prepared*). About one in three (31 percent) rated first receivers *unprepared* and 13 percent said *don't know*.
- For **HF releases across the refinery**, 60 percent reported local hospitals or first receivers were less than *very prepared* (17 percent *very prepared*). Forty-three percent (43 percent) rated them *unprepared* and 22 percent said *don't know*.
- For **HF releases into the community**, 57 percent reported local hospitals or first receivers were less than *very prepared* (13 percent *very prepared*). Forty-four percent (44 percent) rated them *unprepared* and 30 percent said *don't know*.

5. Emergency Response Training

Prevention and preparedness for HF incidents depend on effective training. To assess prevention and preparedness training, the survey asked site survey teams how confident they were that two groups – the site's hourly work force, and the site's emergency response (ER) teams – had received the ER training they needed to respond safely to an HF release. The survey assessed this confidence for two levels of HF incidents – one in a work area where fewer than 10 workers may be seriously exposed, and one across the whole plant where dozens of workers may be seriously exposed. This assessment was limited to the two worker groups and the two levels of releases about which the site survey team would have information sufficient to make a judgment. (See Appendix B: Table B7.)

The Hourly Workforce

- For **HF releases limited to a work area**, 74 percent were less than *very confident* that the hourly work force had received training they needed to respond safely to an HF release (26 percent *very confident)*. Approximately one in four (26 percent) were *not confident* that this level of training had been achieved.
- For **HF releases across the refinery**, 95 percent were less than *very confident* (4 percent *very confident)*. Approximately half (52 percent) were *not confident*.

Site's Emergency Response Teams

- For **HF releases limited to a work area**, 79 percent were less than *very confident* that the site's team had received the needed training to respond safely to an HF release (22 percent *very confident)*. Approximately one in five (18 percent) were *not confident* that this level of training had been achieved.
- For **HF releases across the refinery**, 82 percent were less than *very confident* (17 percent *very confident)* that the site's ER team had received the needed training. Approximately one-third (34 percent) were *not confident*.

These data continued the trend noted above with diminished levels of confidence in training when considering an incident affecting the whole refinery as compared to an incident restricted to a single work area.

Need for More Training Related to HF Releases, Fires or Explosions

Large majorities of the site survey teams reported a need at their sites for additional training in both HF-related *prevention* and *emergency response*.

The Hourly Work Force

- For **preventing** HF releases or related fires or explosions, 64 percent reported the hourly work force needed more training.
- For **responding**, 83 percent reported the need for more training.

The Site's Emergency Response Teams

- For **preventing** HF releases or related fires or explosions, 78 percent reported a need for more training.
- For **responding**, 96 percent reported a need for more training.

(See Appendix B: Table B8.)

6. Staffing

The survey did not ask specific questions about staffing levels. Safe staffing is an issue not confined to alkylation units, and it will be dealt with in a future report. However, the survey included an area for comments, and a number of site survey teams wrote that staffing levels were too low to ensure safe operation and effective emergency response. The following quote exemplifies these issues:

> Staffing in the alkylation unit is lacking to the point where there are not enough qualified employees to cover the shifts. Training and break-in times have been cut to a minimum to compensate for a lack of staffing. There are only a few employees in the unit with more than a year or two [of] experience.

SUMMARY AND CONCLUSIONS

The potential impact of a large-scale HF release in a heavily populated area is so great that it may be impossible for any refiner or community to be fully prepared. Even highly effective systems sometimes fail. It would take multiple failures to trigger a major release, but the lesson of catastrophic accidents from Bhopal to the Deepwater Horizon is that multiple failures can occur. Roll the dice enough times and even the most unlikely combinations come up. The 50 American refineries using HF roll the dice every day.

Yet if the possibility of an HF disaster cannot be eliminated, it can certainly be reduced. The data presented here show that neither mandatory government regulations nor voluntary industry guidelines have convinced refiners to implement the highly effective safety systems demanded by a chemical as lethal as HF. Numerous accidents have breached one or more lines of defense. The OSHA Process Safety Management Standard is a minimum legal requirement; refineries handling HF should do much more. But OSHA has found violations of the standard in almost every refinery it has inspected. The most compelling data come from the knowledgeable and experienced refinery workers who operate HF alkylation units, or who would be expected to respond to an emergency. Their overwhelming verdict is that the current measures preventing and mitigating a major HF release are simply not good enough.

This survey shows:

- Inadequate systems to safely operate and maintain HF alkylation, storage and transfer units, to respond to emergencies and to mitigate releases.
- Inadequate preparation, training and drills for on-site and off-site first responders and first receivers.
- Diminishing levels of preparedness for increasingly severe accidents.
- Concern over insufficient staff for safe operation.

The only certain way to eliminate the risk of a catastrophic HF release is to eliminate HF. Safer alternatives exist, and are described in the first section of this report. Until that can be done, the safety of existing HF units must be improved.

Recommendations: Seven Steps to Safer Refineries

The USW calls on refining companies using HF to commit to seven steps.

1. **Educate Workers and the Public About the Dangers of HF.** Work with refinery workers, their unions, contract workers, first responders and first receivers, hospitals, municipal, state and federal agencies, and community and environmental groups regarding the health hazards of hydrofluoric acid including the potential consequences of minor and major releases both on- and off-site.

2. **Investigate and Learn about Safer Alternatives to HF**. Work with EPA, Homeland Security, university researchers, and domestic and foreign companies to learn from sites

using safer alternative alkylation processes in order to develop the necessary competencies for transitioning to safer alternatives to HF alkylation.

3. **Commit to Ending HF Use.** Commit to the goal of replacing all HF-using alkylation processes with safer alternatives as soon as possible.
4. **Pilot Test Alternative Solutions.** Each refining company should develop and build a test pilot alkylation reaction section. These pilot operations should use at least one of the existing safer alternative methods in at least one of their refineries. Such methods include solid acid and liquid ionic catalyst processes. They do not include modified HF or sulfuric acid which, although safer, are not safe enough and which need no pilot studies.
5. **Share Lessons to Speed Effective Transition.** Share lessons learned from these pilot operations across the industry with workers, their unions and with surrounding communities. The entire industry is needed to help move development of these alternatives forward across U.S. refining.
6. **Make Existing Operations Much Safer.** Until HF alkylation processes are replaced:
    a. Work with workers and their unions and apply all necessary corporate resources to ensure that all alkylation unit process and mitigation systems are in optimal working order, regularly inspected and tested, and subjected to rigorous audits and preventative maintenance.
    b. Work with workers, their unions, fire, emergency response, first receivers, hospitals and community/municipal leaders to engage in an open process for developing, testing and critiquing prevention, preparedness and response capabilities including periodic on-site and off-site drills.
    c. At least annually, appraise all stakeholders both within and outside refineries with a site-based record of the level of process safety, including significant operational upsets and loss of primary containment incidents, equipment failures, etc.
    d. Transition existing HF units to modified HF until non-HF units come on line.
7. **Ensure Staffing to Sufficiently Prevent, Prepare and Respond.** As is common practice in other high hazard industries like the nuclear industry, refineries must staff processes with people in sufficient numbers and with qualifications, experience and competencies necessary to ensure optimal safety during all operations including emergencies.

The government can facilitate the transition to safer processes through rigorous enforcement and oversight. Several agencies have a role to play. OSHA can enforce its Process Safety Standard; EPA, its Risk Management Program. HF units could be attractive targets for terrorists. The Department of Homeland Security lacks the authority to require inherently safer processes, but it could at least ensure that site security is adequate. The U.S. Chemical Safety and Hazard Investigation Board could undertake to investigate all HF accidents, even those with only minor injuries, and could initiate a comprehensive study of HF alkylation. Some state and local governments have the authority to address plant safety and emergency response.

No federal agency currently requires industry to consider or adopt inherently safer technology. EPA probably has the authority to do so under Section 112(r)(1) of the Clean Air Act, and a growing coalition of environmental groups, unions and former EPA officials has urged the Agency to act. A similar coalition has lobbied Congress to include a requirement to consider inherently safer technology in the Chemical Facility Anti-Terrorism Standards legislation, so far without success.

Yet it should not take compulsion for the industry to do the right thing. Company profits may vary, but overall the oil companies are the richest in the history of the world. They maintain large research operations. An industry that can design and operate equipment to drill five miles into the earth under more than a mile of seawater can surely design and operate safe alkylation units. All that is lacking is the will.

A Risk Too Great
Hydrofluoric Acid in U.S. Refineries

The Appendices to the Report of the USW Refinery Research Action Project

United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union

Pittsburgh

April 2013

Appendix A
Background Information

APPENDIX A: BACKGROUND INFORMATION

HF Hazards

HF Toxicity: HF can cause deep tissue burns that may develop over 24 hours, and may initially go unnoticed. Skin coverage with HF of 25 square inches can be fatal. When HF gets into the body, it seeks out and reacts with the body's magnesium and calcium. A chemical antidote, calcium gluconate, can limit damage to health, but a knowledgeable medic or health practitioner must administer it as soon as possible after exposure. This may include skin or respiratory treatments.

HF Exposure Limits: The level of exposure considered immediately dangerous to life and health (IDLH) is 30 parts of HF to one million parts of air (30 ppm).[25] The National Institute for Occupational Safety and Health (NIOSH) sets Recommended Exposure Limits (RELs) and the Occupational Safety and Health Administration (OSHA) sets Permissible Exposure Limits (PELs). The NIOSH REL of 3 ppm (2.5 mg/m^3) averaged over eight hours is the same as the OSHA PEL. NIOSH also recommends a ceiling exposure of 6 ppm (5 mg/m3) averaged over 15 minutes.

HF Process Controls and Modifications

HF Mitigation Systems: Water sprays may provide partial removal of HF from a vapor cloud release (25 percent to 90 percent found in controlled studies);[a] however, efficiencies in actual release conditions cannot be expected to equal those in controlled experiments.[26, 27, 28] In addition, a release of HF at a high elevation may not be detected by sensors at or near ground level. Water supplies required for these systems can also be problematic. During an HF release at the CITGO, Corpus Christi, Texas, refinery in 2009, the water spray system failed to work properly. Besides requiring huge volumes of water, often times a failure in a refinery processing unit involves multiple events such as a fire or explosion concurrent with a release. These events can disable water delivery systems either with a pumping failure due to loss of electricity or steam or damage to pipes or hydrants. In addition, these water spray systems do not function until activated and delays between releases and activation may allow large quantities of HF to be released without mitigation.[b] The 1998 Congressional Report[26] said this about water spray systems:

> Several facilities are concerned that the mitigation systems pose unworkable design requirements, do not add significantly to the protection of the public, and that the systems have the potential to cause more harm than good. (p. 105)

De-inventory systems are used to remove and neutralize HF and hydrocarbons as quickly as possible following commencement of a release, typically into a large dump tank. These systems do not control or slow the rate of release, but attempt to remove, by transfer, the large volumes that are the source of the release. Further limitations include time to activation

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[a] There was a series of HF and water spray tests conducted at the Nevada Test Site in 1986 (the Goldfish Test series) and another series in 1988 conducted in a flow chamber (the Hawk Test series).

[b] API 751 states, "Early detection is critical in implementing mitigation measures for an HF alkylation unit," though it cannot be guaranteed.

following leak identification, maintenance and reliability issues, and potential failures of the de-inventory systems concurrent with failures that led to the release.

Modeling and related calculations have shown the limited potential of these three safety systems to prevent a release of HF (with or without hydrocarbons) from traveling long distances at high concentrations.[29]

Major Oil Industry Incidents

The following brief descriptions of oil industry incidents are those that have occurred in the last 10 years that demonstrate the catastrophic consequences of failed prevention and response systems.

- **Deep Water Horizon (Macondo):** As is well-known around the world, the explosions on the Deep Water Horizon on April 20, 2010, began with 126 platform workers, a refining company, an entire industry, and the U.S. government unprepared for an explosion that was to kill 11 workers and dump millions of gallons of crude oil into the Gulf of Mexico. According to the Presidential Commission that studied the disaster, events on the rig could be "traced to a series of identifiable mistakes … that reveal such systematic failures in risk management that they place in doubt the safety culture of the entire industry."[30] (p. vii) Further, Commissioners determined that the disaster, involved "risks for which neither industry nor government has been adequately prepared, but for which they can and must be prepared in the future." (p. vii)

  While the Deep Water Horizon event has been termed a "one off" event, something that does not have the likelihood to happen again, since April 20, 2010, Chevron has had a leak of similar characteristics off the coast of Brazil potentially releasing up to 3,000 barrels per day.[a] Chevron also had a rig burn off the coast of Nigeria for several weeks.[b] ConocoPhillips had a well failure in China, polluting over 6,200 square kilometers.[c] The website, http://home.versatel.nl/the_sims/rig/index.htm, provides a listing of rig explosions and fires that portrays these oil company events as occurring with an alarming regularity prior to and following the Macondo blowout.
- **Tesoro Anacortes, Wash., Refinery:** On April 2, 2010, an explosion at a Tesoro refinery killed seven workers and caused the refinery to shut down operations for six months and uncovered other deficiencies in the mechanical integrity of equipment. The director of the Washington State Department of Labor and Industry (state OSHA) stated that, "The bottom line is this incident, the explosion and these deaths were preventable." The state OSHA fined Tesoro $2.39 million for violation of standards.[31]
- **BP Texas City:** On March 23, 2005, a fiery blast at the BP refinery in Texas City, Texas killed 15 workers, injured 180 others and caused major alarm in the community. According to the U.S. Chemical Safety and Hazard Investigation Board (CSB), the agency charged with investigating and making recommendations for safer operation of facilities using highly hazardous chemicals, the incident led to financial losses exceeding $1.5 billion."[32] (p. 17) The incident resulted in over 300 citations for OSHA violations resulting in a record fine of $21 million.[33]
- **Self-reported Fires, Multiple Locations:** The USW has tracked industry self-reported fires and collected data from local union reports for the last several years. The refining

[a] http://www.alternet.org/rss/breaking_news/734330/chevron_under_fire_over_size_of_brazil_oil_spill/ (Last accessed March 12, 2013)
[b] http://www.spill-international.com/news/id731-Rig_Blowout_and_Fire_in_Offshore_Nigeria.html (Last accessed March 12, 2013)
[c] http://www.china.org.cn/business/2012-01/25/content_24479642.htm (Last accessed March 12, 2013)

industry self-reported 41 fires in 2008, 45 fires in 2009, 53 fires in 2010, 47 fires in 2011, and 41 in 2012. The number of local union reported fires are substantially higher as often the industry only reports what is required by law or what can be seen outside the fence line. There are numerous smaller fires that have caused lesser amounts of damage, but which carry the potential to have been much more serious.

HF Alkylation Unit Incidents

The following are brief descriptions of U.S. refinery incidents involving hydrofluoric acid.

- **CITGO Corpus Christi, Texas:** On March 5, 2012, an HF release reported as between 300 and 500 pounds took place at a flange that has had leaks reported back as far as September of 2011. The line had been temporarily repaired with clamps on several occasions while CITGO continued to operate.
- **Marathon Canton, Ohio:** On February 28, 2011, equipment failure caused this refinery to leak what the company estimated to be 145 pounds of hydrofluoric acid. Workers were evacuated and one worker was hospitalized. According to FireDirect, “Over the last five years, the Ohio refinery has been cited more often than all but three other refineries using HF for failing to manage hazardous processes.”[34]
- **CITGO Corpus Christi, Texas:** On July 19, 2009, an explosion and fire in the alkylation unit at the CITGO refinery severely injured one worker and burned for two days. Originally CITGO estimated a release of 30 pounds based on ground-level on-site monitoring. According to the CSB, within hours 42,000 pounds of HF was released and the water spray system designed to mitigate or “knock down” the HF vapors was depleted. The refinery had to switch to a supplemental saltwater system from the nearby channel, but transfer piping ruptured and pumps failed. According to the CSB investigation, about 10 percent of the estimated 42,000 pounds of HF released traveled beyond the refinery fence line. Fortunately, due to weather conditions, the plume went into an unpopulated channel. The CSB called for third party safety auditors to examine CITGO’s HF alkylation units at its Texas and Illinois refineries.[35]
- **Sunoco (Delta) Philadelphia, Pa.:** On March 11, 2009, a release of HF sent 13 contract workers to area hospitals because of exposure to a 22 pound release. Four Philadelphia area hazmat crews responded to the incident. OSHA cited the company for four "serious" violations related to the incident.
- **Fire at Giant Industries Refinery, New Mexico:** On April 8, 2004, maintenance workers set out to remove a defective pump in a hydrofluoric acid (HF) alkylation unit at the Ciniza oil refinery in Jamestown, N.M. A shut-off valve was in the open position and a release of flammable gasoline components caught fire. Six employees were injured. Four of these received burns requiring hospitalization. The incident resulted in the evacuation of non-essential employees as well as customers of a nearby commercial enterprise.[36]
- **Marathon Texas City, Texas:** On October 30, 1987 Marathon in Texas City, Texas, experienced the most potentially dangerous refinery release of HF vapors in U.S. history. A 50-square block area of the community around the refinery was evacuated and over 900 people received medical treatment for injuries. Wind direction prevented the incident from being much more disastrous.

Technical Assessment Guide (TAG) 061: Staffing Levels and Task Organisation[37]

In its TAG 061, the United Kingdom's Health and Safety Executive defines the Minimum Staff Complement as, "The number of qualified workers who must be present at all times to ensure safe operation of the nuclear facility and to ensure adequate emergency response capability." The TAG requires demonstration of adequate staffing for the licensee "to remain in control of activities that could impact on nuclear safety under all foreseeable circumstances throughout the life cycle of the facility" (p. 2). This means, "The licensee shall make and implement adequate arrangements for dealing with any accident or emergency arising on the site and their effects." (p. 3) As part of its Safety Assessment Principles the TAG states, "An organisation needs adequate human resources, which means having the necessary competences and knowledge in such numbers so as to maintain the capability to manage safety at all times, including during steady state conditions, periods of change and emergency situations." (p. 4) Further, concerning workload, the TAG states, "The workload of personnel required to fulfill safety-related actions should be analyzed and demonstrated to be reasonably achievable," and address the most resource intensive conditions feasible. Finally, the TAG calls for formal staffing assessments for *roles with high potential impact*, for staffing plans and implementation to be detailed and auditable, and for staffing adequacy to be demonstrated through operating experience and emergency exercises.

Appendix B
Tables of Findings Data

List of Tables

APPENDIX B: TABLES OF FINDINGS DATA

Table B1. Type of role/experience on site survey response teams	
Role in Refinery Work or Local Union	**Percent**
Officers and/or Executive Board members (n=23; 17% missing)	95%
Health and Safety Committee members, Health and Safety Reps., TOP Reps., and/or worker-trainers (n=23; 22% missing)	100%
Operators who work on alkylation unit(s) (n=23; 4% missing)	95%
Maintenance workers who work on alkylation unit(s) (n=23; 35% missing)	73%
Members who have served on a PHA team for alkylation unit(s) (n=23; 30% missing)	63%
Members who are on a refinery emergency response team (HAZMAT, fire brigade, etc.) (n=23; 27% missing)	88%

Table B2. Effectiveness of safety systems for maintaining the integrity of HF alkylation processes

<table>
<tr><th>Systems for HF Alkylation Processing</th><th>Very effective</th><th>Somewhat effective</th><th>Somewhat ineffective</th><th>Very ineffective</th><th>Don't Have</th><th>Don't Know</th></tr>
<tr><td rowspan="3">**Sewer systems** (n=23; 0% missing)</td><td rowspan="3">22%</td><td rowspan="2">35%</td><td>22%</td><td>22%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">44% Ineffective</td></tr>
<tr><td colspan="4">79% less than very effective</td></tr>
<tr><td rowspan="3">**Mechanical integrity of piping** (n=23; 0% missing)</td><td rowspan="3">22%</td><td rowspan="2">52%</td><td>26%</td><td>0%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">26% Ineffective</td></tr>
<tr><td colspan="4">78% less than very effective</td></tr>
<tr><td rowspan="3">**Mechanical integrity of pumps, valves, seals, vents, etc.** (n=23; 0% missing)</td><td rowspan="3">30%</td><td rowspan="2">39%</td><td>30%</td><td>0%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">30% Ineffective</td></tr>
<tr><td colspan="4">69% less than very effective</td></tr>
<tr><td rowspan="3">**Maintenance** (for example, preventative, repair) (n=23; 0% missing)</td><td rowspan="3">30%</td><td rowspan="2">39%</td><td>22%</td><td>9%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">31% Ineffective</td></tr>
<tr><td colspan="4">70% less than very effective</td></tr>
<tr><td rowspan="3">**Integrity of instrumentation** (n=23; 0% missing)</td><td rowspan="3">35%</td><td rowspan="2">39%</td><td>26%</td><td>0%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">26% Ineffective</td></tr>
<tr><td colspan="4">65% less than very effective</td></tr>
<tr><td rowspan="3">**Corrosion monitoring** (n=23; 0% missing)</td><td rowspan="3">39%</td><td rowspan="2">52%</td><td>4%</td><td>0%</td><td>0%</td><td rowspan="3">4%</td></tr>
<tr><td colspan="3">4% Ineffective</td></tr>
<tr><td colspan="4">56% less than very effective</td></tr>
<tr><td rowspan="3">**Mechanical integrity of pressured tanks, vessels** (n=23; 4% missing)</td><td rowspan="3">45%</td><td rowspan="2">50%</td><td>5%</td><td>0%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">5% Ineffective</td></tr>
<tr><td colspan="4">55% less than very effective</td></tr>
<tr><td rowspan="3">**Inspection and testing** (n=23; 0% missing)</td><td rowspan="3">48%</td><td rowspan="2">39%</td><td>13%</td><td>0%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">13% Ineffective</td></tr>
<tr><td colspan="4">52% less than very effective</td></tr>
<tr><td rowspan="3">**Mechanical integrity of atmospheric tanks, vessels*** (n=16; 9% missing)</td><td rowspan="3">56%</td><td rowspan="2">38%</td><td>6%</td><td>0%</td><td>*</td><td rowspan="3">0%</td></tr>
<tr><td colspan="2">6% Ineffective</td><td></td></tr>
<tr><td colspan="4">44% less than very effective</td></tr>
</table>

*Only sites with “atmospheric tanks, vessels” are included; 22% said they *don’t have* atmospheric tanks, vessels.
Note: Percents may not add up to 100% due to rounding

<table>
<tr><th colspan="7">Table B3. Effectiveness of safety systems for HF-related processes, storage, and transfer systems, taken as a whole</th></tr>
<tr><th>Processes, Storage and Transfer Systems, Taken as a Whole</th><th>Very effective</th><th>Somewhat effective</th><th>Somewhat ineffective</th><th>Very ineffective</th><th>Don't Have</th><th>Don't Know</th></tr>
<tr><td rowspan="3">Audit programs (n=23; 0% missing)</td><td rowspan="3">9%</td><td rowspan="2">52%</td><td>13%</td><td>17%</td><td>0%</td><td rowspan="3">9%</td></tr>
<tr><td colspan="3">30% Ineffective</td></tr>
<tr><td colspan="4">82% less than very effective</td></tr>
<tr><td rowspan="3">Health hazard information and education for non-HF alkylation personnel (n=23; 0% missing)</td><td rowspan="3">17%</td><td rowspan="2">43%</td><td>30%</td><td>9%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">39% Ineffective</td></tr>
<tr><td colspan="4">82% less than very effective</td></tr>
<tr><td rowspan="3">Maintenance (preventative and repair) (n=23; 0% missing)</td><td rowspan="3">22%</td><td rowspan="2">52%</td><td>17%</td><td>9%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">26% Ineffective</td></tr>
<tr><td colspan="4">78% less than very effective</td></tr>
<tr><td rowspan="3">Operating manuals and procedures (n=23; 0% missing)</td><td rowspan="3">26%</td><td rowspan="2">48%</td><td>17%</td><td>4%</td><td>0%</td><td rowspan="3">4%</td></tr>
<tr><td colspan="3">21% Ineffective</td></tr>
<tr><td colspan="4">69% less than very effective</td></tr>
<tr><td rowspan="3">Utility systems (n=23; 0% missing)</td><td rowspan="3">35%</td><td rowspan="2">52%</td><td>4%</td><td>9%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">13% Ineffective</td></tr>
<tr><td colspan="4">65% less than very effective</td></tr>
<tr><td rowspan="3">Alkylation pre-start-up safety reviews (n=23; 0% missing)</td><td rowspan="3">35%</td><td rowspan="2">57%</td><td>0%</td><td>9%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">9% Ineffective</td></tr>
<tr><td colspan="4">66% less than very effective</td></tr>
<tr><td rowspan="3">Process hazard analysis (PHA) (n=23; 0% missing)</td><td rowspan="3">39%</td><td rowspan="2">43%</td><td>13%</td><td>4%</td><td>9%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">26% Ineffective/Don’t have</td></tr>
<tr><td colspan="4">69% less than very effective</td></tr>
<tr><td rowspan="3">Leak detection and repair (n=23; 0% missing)</td><td rowspan="3">39%</td><td rowspan="2">48%</td><td>9%</td><td>4%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">13% Ineffective</td></tr>
<tr><td colspan="4">61% less than very effective</td></tr>
<tr><td rowspan="3">Strictly controlled access to alkylation units (n=23; 0% missing)</td><td rowspan="3">43%</td><td rowspan="2">22%</td><td>9%</td><td>22%</td><td>4%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">35% Ineffective/Don’t have</td></tr>
<tr><td colspan="4">57% less than very effective</td></tr>
<tr><td rowspan="3">Controlled relief and neutralization systems (n=23; 0% missing)</td><td rowspan="3">52%</td><td rowspan="2">35%</td><td>0%</td><td>9%</td><td>0%</td><td rowspan="3">4%</td></tr>
<tr><td colspan="3">9% Ineffective</td></tr>
<tr><td colspan="4">44% less than very effective</td></tr>
<tr><td rowspan="3">Health hazard information and education for HF unit workers (n=23; 0% missing)</td><td rowspan="3">65%</td><td rowspan="2">22%</td><td>4%</td><td>9%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">13% Ineffective</td></tr>
<tr><td colspan="4">35% less than very effective</td></tr>
</table>

Note: Percents may not add up to 100% due to rounding

Table B4. Effectiveness of HF emergency mitigation and response systems

Emergency System	Very effective	Somewhat effective	Somewhat ineffective	Very ineffective	Don't Have	Ineffective/Don't have	Less than very effective	Don't Know
Alarms and notification systems – off-site (n=23; 0% missing)	9%	35%	9%	4%	35%	48% Ineffective/Don't have	83% Less than very effective	9%
Utility back-up systems (n=23; 0% missing)	13%	39%	13%	17%	17%	47% Ineffective/Don't have	86% Less than very effective	0%
Site's emergency field drills in preparing for an HF release up to and including a worst-case (n=23; 0% missing)	17%	30%	4%	26%	13%	43% Ineffective/Don't have	73% Less than very effective	9%
Safe havens (n=23; 0% missing)`	22%	30%	9%	13%	22%	44% Ineffective/Don't have	74% Less than very effective	4%
Diking (n=23; 0% missing)	22%	39%	13%	13%	13%	39% Ineffective/Don't have	78% Less than very effective	0%
Chemical neutralization (n=23; 4% missing)	32%	41%	0%	5%	23%	28% Ineffective/Don't have	69% Less than very effective	0%
Fire suppression (n=23; 0% missing)	39%	35%	17%	0%	9%	26% Ineffective/Don't have	61% Less than very effective	0%
Remotely operated block valves for unit isolation (n=23; 0% missing)	39%	52%	4%	4%	0%	8% Ineffective	60% Less than very effective	0%
Water mitigation, curtain /deluge (n=23; 0% missing)	43%	39%	13%	4%	0%	17% Ineffective	56% Less than very effective	0%
Overall emergency shutdown and isolation systems (n=23; 0% missing)	52%	35%	4%	4%	0%	8% Ineffective	43% Less than very effective	4%

Table B4. Effectiveness of HF emergency mitigation and response systems

Emergency System	Very effective	Somewhat effective	Somewhat ineffective	Very ineffective	Don't Have	Don't Know
Alarms and notification systems -- on-site (n=23; 0% missing)	57%	30%	9%	4%	0%	0%
			13% Ineffective			
		43% Less than very effective				
Emergency dump (catalyst/HF rapid transfer systems) (n=23; 0% missing)	57%	17%	0%	4%	9%	13%
			13% Ineffective/Don't have			
		40% Less than very effective				

Note: Percents may not add up to 100% due to rounding

Table B5. How prepared is the site regarding emergency personal protective equipment (PPE).

<table>
<tr><th></th><th>Very prepared</th><th>Somewhat prepared</th><th>Somewhat unprepared</th><th>Very unprepared</th><th>Don't Have</th><th>Don't Know</th></tr>
<tr><td rowspan="3">PPE for every site employee who may need it in an HF-related emergency (n=23; 0% missing)</td><td rowspan="3">35%</td><td rowspan="2">26%</td><td>17%</td><td>22%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">39% Unprepared</td></tr>
<tr><td colspan="4">65% <u>less than</u> very effective</td></tr>
</table>

Note: Percents may not add up to 100% due to rounding

<table>
<tr><th colspan="7">Table B6. How prepared is each group to respond to an HF release. (Scope listed)</th></tr>
<tr><th>Group</th><th>Very prepared</th><th>Somewhat prepared</th><th>Somewhat <u>un</u>prepared</th><th>Very <u>un</u>prepared</th><th>Don't Have</th><th>Don't Know</th></tr>
<tr><td colspan="7">In a work area (where fewer than 10 workers may be seriously exposed)</td></tr>
<tr><td rowspan="3">Local (off-site) emergency responders (n=23; 0% missing)</td><td rowspan="3">17%</td><td rowspan="2">30%</td><td>9%</td><td>17%</td><td>4%</td><td rowspan="3">22%</td></tr>
<tr><td colspan="3">30% Unprepared/Don't have</td></tr>
<tr><td colspan="4">60% <u>less than</u> very prepared</td></tr>
<tr><td rowspan="3">Local hospitals (n=23; 0% missing)</td><td rowspan="3">26%</td><td rowspan="2">30%</td><td>22%</td><td>9%</td><td>0%</td><td rowspan="3">13%</td></tr>
<tr><td colspan="3">31% Unprepared</td></tr>
<tr><td colspan="4">61% <u>less than</u> very prepared</td></tr>
<tr><td rowspan="3">Site's nursing and other medical personnel (n=23; 0% missing)</td><td rowspan="3">30%</td><td rowspan="2">39%</td><td>13%</td><td>13%</td><td>4%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">30% Unprepared/Don't have</td></tr>
<tr><td colspan="4">69% <u>less than</u> very prepared</td></tr>
<tr><td rowspan="3">Site's emergency response team, hazmat team, or fire brigade (n=23; 0% missing)</td><td rowspan="3">43%</td><td rowspan="2">35%</td><td>13%</td><td>9%</td><td>0%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">22% Unprepared</td></tr>
<tr><td colspan="4">57% <u>less than</u> very prepared</td></tr>
<tr><td colspan="7">Across the whole plant site (where dozens of workers may be seriously exposed)</td></tr>
<tr><td rowspan="3">Local (off-site) emergency responders (n=23; 0% missing)</td><td rowspan="3">9%</td><td rowspan="2">30%</td><td>22%</td><td>22%</td><td>4%</td><td rowspan="3">13%</td></tr>
<tr><td colspan="3">48% Unprepared/Don't have</td></tr>
<tr><td colspan="4">78% <u>less than</u> very prepared</td></tr>
<tr><td rowspan="3">Local hospitals (n=23; 0% missing)</td><td rowspan="3">17%</td><td rowspan="2">17%</td><td>30%</td><td>13%</td><td>0%</td><td rowspan="3">22%</td></tr>
<tr><td colspan="3">43% Unprepared</td></tr>
<tr><td colspan="4">60% <u>less than</u> very prepared</td></tr>
<tr><td rowspan="3">Site's nursing and other medical personnel (n=23; 0% missing)</td><td rowspan="3">17%</td><td rowspan="2">30%</td><td>30%</td><td>17%</td><td>4%</td><td rowspan="3">0%</td></tr>
<tr><td colspan="3">51% Unprepared/Don't have</td></tr>
<tr><td colspan="4">80% <u>less than</u> very prepared</td></tr>
<tr><td rowspan="3">Site's emergency response team, hazmat team, or fire brigade (n=23; 0% missing)</td><td rowspan="3">22%</td><td rowspan="2">57%</td><td>9%</td><td>13%</td><td>0%</td><td rowspan="2">0%</td></tr>
<tr><td colspan="3">22% Unprepared</td></tr>
<tr><td colspan="4">79% <u>less than</u> very prepared</td><td></td></tr>
</table>

<table>
<tr><th colspan="7">Table B6. How prepared is each group to respond to an HF release. (Scope listed)</th></tr>
<tr><th>Group</th><th>Very prepared</th><th>Somewhat prepared</th><th>Somewhat unprepared</th><th>Very unprepared</th><th>Don't Have</th><th>Don't Know</th></tr>
<tr><td colspan="7">In the community (where dozens of workers and community members may be seriously exposed)</td></tr>
<tr><td rowspan="3">Local (off-site) emergency responders (n=23; 0% missing)</td><td rowspan="3">4%</td><td rowspan="2">22%</td><td>17%</td><td>30%</td><td>4%</td><td rowspan="3">22%</td></tr>
<tr><td colspan="3">51% Unprepared/Don’t have</td></tr>
<tr><td colspan="4">73% less than very prepared</td></tr>
<tr><td rowspan="3">Local hospitals (n=23; 0% missing)</td><td rowspan="3">13%</td><td rowspan="2">13%</td><td>22%</td><td>22%</td><td>0%</td><td rowspan="3">30%</td></tr>
<tr><td colspan="3">44% Unprepared</td></tr>
<tr><td colspan="4">57% less than very prepared</td></tr>
<tr><td rowspan="3">Site’s nursing and other medical personnel (n=23; 0% missing)</td><td rowspan="3">13%</td><td rowspan="2">17%</td><td>22%</td><td>35%</td><td>4%</td><td rowspan="3">9%</td></tr>
<tr><td colspan="3">61% Unprepared/Don’t have</td></tr>
<tr><td colspan="4">78% less than very prepared</td></tr>
<tr><td rowspan="3">Site’s emergency response team, hazmat team, or fire brigade (n=23; 0% missing)</td><td rowspan="3">22%</td><td rowspan="2">22%</td><td>22%</td><td>26%</td><td>0%</td><td rowspan="3">9%</td></tr>
<tr><td colspan="3">48% Unprepared</td></tr>
<tr><td colspan="4">70% less than very prepared</td></tr>
</table>

Note: Percents may not add up to 100% due to rounding

Table B7. Confidence that the groups have received the training they need to respond safely to an HF release.				
	Very confident	**Somewhat confident**	**Somewhat not confident**	**Very not confident**
In a work area (where fewer than 10 workers may be seriously exposed)				
Hourly workforce (n=23; 0% missing)	26%	48%	17%	9%
			26% Not confident	
		74% Less than very confident		
Site's emergency response team, hazmat team, or fire brigade (n=23; 0% missing)	22%	61%	9%	9%
			18% Not confident	
		79% Less than very confident		
Across the whole plant site (where dozens of workers may be seriously exposed)				
Hourly workforce (n=23; 0% missing)	4%	43%	30%	22%
			52% Not confident	
		95% Less than very confident		
Site's emergency response team, hazmat team, or fire brigade (n=23; 0% missing)	17%	48%	17%	17%
			34% Not confident	
		82% Less than very confident		

Note: Percents may not add up to 100% due to rounding

Table B8. Need for additional training in HF hazard prevention		
	Yes	**No**
Hourly workforce		
Responding to HF releases or related fires or explosions (possibly involving other hazardous chemicals) (n=23; 0% missing)	83%	17%
Preventing HF releases or related fires or explosions (possibly involving other hazardous chemicals) (n=22; 4% missing)	64%	36%
Emergency response team, hazmat team, or fire brigade		
Responding to HF releases or related fires or explosions (possibly involving other hazardous chemicals) (n=23; 0% missing)	96%	4%
Preventing HF releases or related fires or explosions (possibly involving other hazardous chemicals) (n=23; 0% missing)	78%	22%

Note: Percents may not add up to 100% due to rounding

Appendix C:

HF Using Refineries and At Risk Locations and Populations

Table C1.* 50 HF-using Refiners and Locations and Size of Populations at Risk**

Oil Company	No. of HF Refineries		Refinery Locations	Number of persons at risk	
	Total	USW		Workers Represented by USW †	Community‡
Valero	8	2	Wilmington, CA; Ardmore, OK; Paulsboro, NJ; Memphis, TN (USW); Port Arthur, TX (USW); Texas City, TX; Corpus Christi, TX; Three Rivers, TX	583	5,575,700
Marathon	6	3	Robinson, IL; Catlettsburg, KY (USW); Garyville, LA; St. Paul Park, MN; Canton, OH (USW); Texas City, TX (USW)	779	4,448,700
ConocoPhillips††	7	5	Belle Chasse, LA (USW); Billings, MT (USW); Ponca City, OK (USW); Trainer, PA (USW); Borger, TX; Sweeny, TX; Ferndale, WA (USW)	1,069	3,655,800
CITGO	2	2	Lemont, IL (USW); Corpus Christi, TX (USW)	422	3,320,000
ExxonMobil	4	3	Torrance CA (USW); Channahon, IL; Chalmette, LA (USW); Billings, MT (USW)	750	2,414,600
Sunoco††	1	1	Philadelphia, PA (USW)	611	1,308,400
Murphy††	2	1	Meraux, LA (USW); Superior WI	168	1,236,000
ChevronTexaco	1	1	Salt Lake City, UT (USW)	115	1,100,000
Houston Refining	1	1	Pasadena, TX (USW)	476	650,000
BP	1	1	Texas City, TX (USW)	896	550,000
Placid Refining Co. LLC-Port Allen Refinery	1	0	Port Allen, LA	‡‡	440,200
Flying J	1	1	North Salt Lake, UT (USW)	95	376,000
Flint Hills Resources, LP-CC West Refinery	1	0	Corpus Christi, TX;	‡‡	349,900
Holly/Frontier	3	3	El Dorado, KS (USW); Woods Cross, UT (USW); Cheyenne, WY (USW)	465	308,100
CHS Laurel Refinery	1	1	Laurel, MT (USW)	163	85,000
Connacher Oil/ Montana Refining Co. Inc.	1	1	Great Falls, MT (USW)	48	69,000
Tesoro	1	1	Mandan, ND (USW)	132	68,000
Coffeyville Resources (CVR Energy)	1	0	Coffeyville, KS	‡‡	40,700
Wynnewood Refining Company	1	0	Wynnewood, OK	‡‡	40,000
Alon	1	0	Big Spring, TX	‡‡	38,000
Navajo Refining Company	1	0	Artesia, NM	‡‡	16,000
National Cooperative	1	1	McPherson, KS (USW)	132	20,100
Countrymark Co-op LLP	1	0	Mt. Vernon, IN	‡‡	8,000
Gallup Refinery	1	0	Jamestown, NM	‡‡	4,800
Wyoming Refining Company	1	0	Newcastle, WY	‡‡	3,100
Totals	**50**	**28**		**6,904**	**26,126,100**

*Data is in part from the Center for Public Integrity. **Ranked by number of community members at risk. USW indicates workers at the site are represented by USW. † Additional thousands of others non-represented employees are at risk. ‡ Reported by refining companies to EPA. ‡‡ Not USW, not available. †† Since data was collected the Conoco refinery in Trainer, PA was purchased by Delta Airlines and will be operated by a subsidiary, Monroe Energy; the Sonoco refinery has come under the ownership of Philadelphia Energy Solutions, a joint venture of the Carlyle Group and Sunoco; Calumet Lubricants purchased the Murphy Oil, Superior, WI refinery; and Valero Energy Corporation purchased the Murphy Oil, Meraux, LA refinery.

Table C2.* HF-using Refineries in Metropolitan Areas (Over 500,000 at risk)*

City/Area	Number of Refineries	Refinery Locations	No of community members at risk†	Refining Companies
Philadelphia‡	3	Paulsboro, NJ; Philadelphia, PA (USW); Trainer, PA (USW)	6,878,400	Valero, Sunoco,†† Conoco††
Chicago	2	Channahon, IL; Lemont, IL (USW)	4,075,900	Exxon, CITGO
New Orleans	4	Belle Chasse (USW), LA; Chalmette, LA; Garyville, LA; Meraux, LA (USW)	3,346,200	Conoco, Exxon, Marathon, Murphy††
Texas City	4	Texas City, TX (USW); Pasadena, TX (USW)	2,280,000	Crown, BP, Marathon, Valero
Minneapolis	1	St. Paul Park	2,200,000	Marathon
Salt Lake City	3	Salt Lake City, UT (USW); North Salt Lake, UT (USW); Woods Cross, UT (USW)	1,692,300	Chevron, Flying J, Holly/Frontier
Canton, OH	1	Canton, OH (USW)	940,000	Marathon
Memphis	1	Memphis, TN (USW)	792,000	Valero
Totals	**19**		**22,204,800**	

*Data is in part from the Center for Public Integrity. **Ranked by number of community members at risk. † Reported by Refining Companies to EPA. †† Since data was collected the Conoco refinery in Trainer, PA was purchased by Delta Airlines and will be operated by a subsidiary, Monroe Energy; the Sonoco refinery has come under the ownership of Philadelphia Energy Solutions, a joint venture of the Carlyle Group and Sunoco; and Valero Energy Corporation purchased the Murphy Oil, Meraux, LA refinery.

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The report is available at:
http://assets.usw.org/resources/hse/pdf/A-Risk-Too-Great.pdf

beyond TEXAS CITY

The State of Process Safety in the Unionized U.S. Oil Refining Industry

A Report on the USW Refinery Survey
October 2007

TONY MAZZOCCHI CENTER FOR HEALTH, SAFETY AND ENVIRONMENTAL EDUCATION
A PROJECT OF THE UNITED STEELWORKERS AND THE LABOR INSTITUTE

UNITED STEELWORKERS USW UNITY AND STRENGTH FOR WORKERS

New Perspectives CONSULTING GROUP INC

Beyond Texas City

The State of Process Safety in the Unionized U.S. Oil Refining Industry

A Report on the USW Refinery Survey

October 2007

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Bold indicates current or former oil refinery worker. Collectively, these workers represent over 200 years of refinery experience, much of that focused on refinery health and safety issues. USW is the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union

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Executive Summary

Introduction

On March 23, 2005, a fiery blast at the BP refinery in Texas City, Texas killed 15 workers, injured 180 others and caused major alarm in the community. According to the U.S. Chemical Safety and Hazard Investigation Board (CSB), the incident led to financial losses exceeding $1.5 billion."[1] (p. 17) The incident resulted in over 300 citations for OSHA violations resulting in a record fine of $21 million.[2] The magnitude of this catastrophe marks it as one of the most damaging process safety accidents in U.S. history. It was also the biggest industrial disaster since passage of the Occupational Safety and Health Administration's (OSHA's) 1992 standard on Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119).

In January 2006, nine months following the Texas City disaster, the Tony Mazzocchi Center for Health, Safety and Environmental Education[a] (TMC) sent a 64-item, mail-back survey to local unions at each of 71 United Steelworkers (USW)-represented refineries.

The survey sought to determine the extent to which conditions similar to those that led to the BP Texas City catastrophe exist at the nation's other refineries and what is being done to correct those conditions. Accordingly, it asked about conditions, processes, practices, and actions relevant to prevention of, preparedness for, and response to possible future incidents resulting in fires, explosions, or large releases of highly hazardous chemicals. Local union leaders were asked to engage persons from the local union who were knowledgeable about refinery health and safety issues to complete the survey sent to their site.

The findings that form the basis for this paper's conclusions on the "The State of Process Safety in the Unionized U.S. Oil Refining Industry" were obtained by means of a survey described below and a review of the literature which focuses on existing regulations, guidelines and lessons from previous refinery disasters.

The survey used in this study focused on four conditions and practices found to be key contributors to the occurrence of the 2005 Texas City accident and its terrible consequences. The four key contributors, hereinafter referred to as *highly hazardous conditions*, included: 1) use of atmospheric vents on process units, 2) failed management of

[a] The Tony Mazzocchi Center is a partnership between the United Steelworkers (USW) and the Labor Institute.

instrumentation and alarm systems, 3) siting of trailers and unprotected buildings near high risk process facilities, and 4) allowance of non-essential personnel in high risk areas during start-up and shutdown. (Of the four *highly hazardous conditions*, information and data on three (vents, trailers, and non-essential personnel) lend themselves most readily to survey measurement). Therefore, some findings focus on these three *highly hazardous conditions* while others focus on all four. Researchers also reviewed literature which focuses on existing regulations and guidelines and lessons from previous refinery disasters.

A participatory action research team carried out this study. The team included: USW rank and file workers, including nine current or former refinery workers; USW Health, Safety and Environment Department and TMC staff; USW International Union leadership; and education and evaluation consultants from New Perspectives Consulting Group and the Labor Institute.

The survey achieved a response rate of 72% (51 of 71 USW U.S. refinery sites). The 51 responding sites represented: 34% of the United States' 149 refineries and 49% of the U.S. refining capacity. Twenty-two (22) different refining companies in 19 U.S. states and one territory operated these refineries, including industry giants such as ExxonMobil and Shell-Motiva and independents such as Flying J.

Findings

Highly Hazardous Conditions Similar to Those Found at BP Texas City Are Pervasive in US Refineries: Ninety percent (90%) of the 51 refineries reported the presence of at least one of the three targeted *highly hazardous conditions* (43% reported three *highly hazardous conditions,* 35% reported two conditions, and 12% reported one *condition*). Seventy-eight percent (78%) placed trailers or other unprotected buildings in hazardous areas, 70% had non-essential personnel present in vulnerable areas during start-ups and shutdowns, and 66% had atmospheric vents on process units.

There Remains an Alarming Potential for Future Disasters: The findings indicate that the U.S. refinery industry remains plagued by the threat of refinery catastrophes like the fires and explosions that engulfed workers at BP's Texas City refinery – catastrophes that are preventable. More specifically, 61% of respondents (from 31 refineries) reported <u>at least one</u> incident or near miss involving at least one of the targeted four *highly hazardous conditions* in the past three years. One in ten sites experienced <u>one or more</u> incidents or near misses involving <u>all four</u> *highly hazardous conditions* (10% involving three conditions, 14% involving two conditions, and 27% involving one condition).

Industry Response Since Texas City Has Been Anemic: The heightened risks present during refinery process start-ups and shutdowns demand that all safety systems be highly reliable and at peak effectiveness. In contrast, findings from this study suggest that the stark and hard lessons from the myriad of refinery incidents and near misses prior to and including BP Texas City have been widely ignored by refiners.

The survey findings highlight that following the Texas City disaster a substantial majority of refineries with one or more of the four *highly hazardous conditions* either took *no action* or took actions judged <u>less than</u> *very effective* (*somewhat effective, somewhat <u>in</u>ef-*

fective, or *very ineffective*). For replacing atmospheric vents, 79% took *no action* or less than *very effective action*.[a] For improving management of instrumentation and alarms, 65% took *no action* or less than *very effective action*.[b] For removing trailers or other unprotected buildings, 59% took *no action* or less than *very effective action*.[c] For keeping non-essential personnel out of hazardous areas, 63% took *no action* or less than *very effective action*.[d]

The Letter and the Spirit of OSHA's Process Safety Standard Remain Unfulfilled: A solid majority of respondents individually rated each of 16 process safety systems for start-up or shutdowns as less than *very effective.* More than three-quarters of respondents rated 10 of the 16 systems as less than *very effective.* Further, 87% rated the overall management of process safety systems at their sites as less than *very effective*.[e]

Pre-start-up safety reviews are included in OSHA's Process Safety Management standard. The prevalence of the four *highly hazardous conditions* and related incidents and near misses during process start-ups and shutdowns, as reported by respondents, indicates that at many sites pre-start-up safety reviews lack the robustness necessary to ensure safe operation.

Inadequate Staffing and Poor Work Organization Increase the Risk of Catastrophic Accidents: *Work organization and staffing* was one of the 16 process safety systems for start-up and shutdowns examined. Virtually every safety system examined in this study is dependent on the presence of highly qualified employees in sufficient numbers to handle normal, abnormal, upset, and emergency situations. However, at almost nine out of 10 sites respondents rated work organization and staffing as less than *very effective.*[f]

Contractors are a very substantial part of the work force at most every refinery. The 15 workers who died in the BP Texas City disaster were all contractor workers. Lessons from previous disasters have shown that contractor workers need to play important roles in prevention. In this study the preparedness of contractor workers to contribute to incident prevention received the poorest ratings of any item in the survey.

Refineries are Not Sufficiently Prepared for Emergencies: It appears that the refining industry is under-prepared for hazardous materials emergencies. While 30% of re-

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[a] Respondents reported effectiveness of actions as follows: 3% *very effective,* 18% *somewhat effective*, 3% *somewhat ineffective*, 0% *very ineffective*. 58% took *no action*, and 18% reported *don't know* or data were missing.
[b] Respondents reported effectiveness of actions as follows: 12% *very effective,* 24% *somewhat effective*, 6% *somewhat ineffective*, 0% *very ineffective*. 35% took *no action*, and 24% reported *don't know* or data were missing.
[c] Respondents reported effectiveness of actions as follows: 38% *very effective,* 33% *somewhat effective*, 5% *somewhat ineffective*, 8% *very ineffective*. 13% took *no action*, and 5% reported *don't know* or data were missing.
[d] Respondents reported effectiveness of actions as follows: 23% *very effective,* 17% *somewhat effective*, 0% *somewhat ineffective*, 0% *very ineffective*. 46% took *no action*, and 14% reported *don't know* or data were missing.
[e] Respondents reported overall effectiveness of management of process safety systems as follows: 13% *very effective,* 66% *somewhat effective*, 17% *somewhat ineffective*, 4% *very ineffective*, 0% *don't know*.
[f] Respondents rated work organization and staffing as follows: 12% *very effective,* 33% *somewhat effective*, 43% *somewhat ineffective*, 12% *very ineffective,* 0% *don't know*, 0% missing.

spondents rated their sites as *very prepared,* some of the highest ratings in this entire study, the remaining 70% reported that their refineries were less than *very prepared.*[a]

Emergency response training and frequent drills are critical to having a work force prepared to respond to a hazardous materials incident. While nearly all study respondents reported that emergency response teams, hazmat teams, or fire brigades had received training at their sites in the previous 12 months, only 77% of sites reported emergency response training for the general plant population in the past year. Thus, workers at approximately one in four refineries labor in highly volatile situations without up-to-date training. Further, only one-quarter of respondents reported being *very confident* that the work force at their site had received the training it needed to respond safely to a serious hazardous materials incident or emergency.[b]

The Oil Industry Should Promptly Address Critical Deficiencies in Process Safety Management: Process changes, replacement of antiquated equipment, preventative maintenance, adequate staffing, and other measures necessary for high reliability and excellence in process safety all require financial investments. While oil refiners, like BP, are reporting enormous, record-breaking profits, the U.S. Chemical Safety and Hazard Investigation Board (CSB) recently reported that cost-cutting "impaired" process safety performance in Texas City.[1] The refinery industry must use its vast wealth to take responsibility for preventing future horrors such as the BP Texas City catastrophe.

Proactive OSHA Regulation and Enforcement Are Essential: In sharp contrast to other high hazard industries such as aerospace, aviation, and nuclear power which are specifically required to perform to very high standards, government regulators have not yet demanded that the refining industry invest the necessary resources to be fully protected and secured. For example, policymakers and the public would find it unacceptable if there were widespread reports from airline pilots or mechanics that take-offs and landings were occurring with less than fully effective critical safety systems. However, this study's findings suggest such "take-offs" and "landings" occur regularly at refineries, thereby threatening the lives of hundreds or thousands of workers, nearby community members and the environment. Given that petroleum refineries are a vital part of the nation's energy infrastructure, prompt government intervention including strengthened OSHA and EPA standards and rigorous enforcement must be put in place.

In particular, OSHA should update and strengthen its 1992 standard on "Process Safety Management of Highly Hazardous Chemicals" (29 CFR 1910.119). For example, facilities should be required to report to OSHA when their use of highly hazardous chemicals in large quantities meets the standards' provisions for coverage. The standard currently covers flammable, explosive and toxic chemicals, but not chemicals that can undergo a catastrophic runaway reaction. The CSB has recommended that OSHA correct this deficiency, but the Agency has taken no action. The rulemaking should also consider incorporating the process safety metrics and the safe siting guidelines currently under development. The Agency could also write many of the urgent and critical actions listed in the next section into regulatory language.

[a] Respondents reported preparedness to respond to a hazardous materials incident or emergency as follows: 30% *very prepared,* 58% *somewhat prepared*, 10% *somewhat unprepared*, 2% *very unprepared, 6%* missing.

[b] Respondents reported their confidence as follows: 25% *very confident,* 51% *somewhat confident*, 22% *somewhat unconfident*, 2% *very unconfident,* 4% missing.

Changes in other regulations would also be useful. In particular, all facilities that employ outside contractors should be required to keep a log of injuries and illnesses for all workers on the site. It is absurd that BP was not required to report any of the workers killed in its Texas City disaster on its log of occupational injuries and illnesses. This was the case because BP did not directly employ any of those killed—they were contractor employees.

Of course, OSHA standards are useless without strong enforcement. At the time of the BP disaster, OSHA had few inspectors trained to enforce its Process Safety Standard. The Agency has begun to train additional inspectors, but more could and needs to be done. Even with the additional inspectors, OSHA must commit to using the standard vigorously. Too often, OSHA measures its productivity by comparing the number of inspections and citations with the inspection time needed to generate them. However, process safety inspections are complicated and time consuming. As such, they do not fit well into this naïve measure of productivity. OSHA needs to ensure that it gives such inspections the time, resources and high priority they deserve.

The Oil Industry Should Promptly Address Critical Deficiencies in Process Safety Management: Process changes, replacement of antiquated equipment, preventative maintenance, adequate staffing, and other measures necessary for high reliability and excellence in process safety all require financial investments. While oil refiners, like BP, are reporting enormous, record-breaking profits, the U.S. Chemical Safety and Hazard Investigation Board (CSB) recently reported that cost-cutting "impaired" process safety performance in Texas City.[1] The refinery industry must use its vast wealth to take responsibility for preventing future horrors such as the BP Texas City catastrophe.

Thus, the findings of the USW Refinery Process Safety Survey document that critical process safety deficiencies are endemic within the industry and that many mirror those found at BP Texas City in March 2005. In order to prevent future similar incidents and to provide refinery workers, emergency responders, and surrounding communities with their rightful protection from harm, the USW asserts that the following actions are necessary.

The USW calls on the refining industry to initiate action immediately on the ten measures listed in the next section. These critical improvements will advance the pursuit of excellence in process safety management and protection of the nation's workers, infrastructure and security. To be fully effective, it is necessary for refiners to engage workers and their local and international union representatives in developing and implementing these improvements.

Urgent and Critical Actions

1. **Establish a Process Safety Team as part of the Health and Safety Committee at each refinery**, including representatives selected by the local union, to plan, review, monitor, and audit all process safety activities.
2. **Ensure that process hazard analyses (PHAs) exist for all potentially hazardous operations and that those PHAs are reviewed and revalidated at least every**

three years. Working PHA teams must have the authority to ensure that all recommendations are prioritized and receive timely action.

3. **Address the four *highly hazardous conditions* associated with the March 23, 2005 BP Texas City disaster:**
   a. **Eliminate all atmospheric vents on process units** that could release untreated explosive, flammable, or toxic materials to the atmosphere.
   b. **Manage instrumentation and alarms** in a manner that ensures that they are sufficient and functional for all anticipated potential conditions and that there are no start-ups without tested and documented functioning of these systems.
   c. **Create a definition of "safe siting"** that when followed will ensure that refiners locate all trailers or other unprotected buildings in areas that could not expose occupants to harm from explosions, fires, or toxic exposures. Work in creating this definition is currently under way through the American Petroleum Institute.
   d. **Ensure that all non-essential personnel are outside of hazardous areas** (vulnerability zones), especially during start-ups, shutdowns, or other unstable operating conditions.
4. **Develop and implement policies requiring full safety reviews prior to <u>all</u> process start-ups and scheduled shutdowns.**
5. **Provide adequate staffing** to ensure safe operation in all potential normal and abnormal operating circumstances. Staffing must ensure that all members of the work force are able to carry out their work alertly and without adverse health effects.

Necessary Supporting Actions

6. **Provide effective, participatory worker training and drills** in the areas of: a) process safety management, b) emergency preparedness and response, and c) pre-start-up and shutdown safety reviews. Selection and presentation of training must be carried out in conjunction with the union using its nationally recognized model programs.
7. **Ensure that all operating manuals and procedures are in optimum working order**, that is, in writing, up-to-date, understandable, functional, available and properly used for the safe operation of all processes. The manuals and procedures must cover normal, abnormal, upset, and emergency operating conditions, shut-downs and start-ups.
8. **Review and update management of change (MOC) procedures** to ensure that they meet the recommendations of the U.S. Chemical Safety Board.
9. **Implement an effective incident and near miss investigation program at each site** that involves workers and their unions in all phases of investigation and recommendations for improvement. The USW's Triangle of Prevention (TOP) Program is a model in operation at 15 U.S. refineries and nine other petrochemical facilities. (See Appendix A, Description of the USW Triangle of Prevention (TOP) Initiative)

10. **Develop and implement a national set of standardized process safety metrics and benchmarks** to assess leading and lagging indicators of process safety. The CSB has requested that the National Academy of Sciences convene a panel to consider such metrics. Preliminary work is also being done under the auspices of the Center for Chemical Process Safety.

The USW asserts that these essential actions build on existing reports and will strengthen their recommendations.

The potential for management to join labor in identifying and acting to solve process safety problems is evidenced by a 2007 joint initiative between the United Steelworkers and BP. This initiative expresses a commitment “to ensure the safest possible conditions for BP employees and neighbors of BP facilities” and is “based in part on the findings and recommendations of the BP US Refineries Independent Safety Review Panel, the preliminary reports of the U.S. Chemical Safety and Hazard Investigation Board, BP’s own investigations, and the experience of the USW.” The initiative addresses the immediate causes of the Texas City tragedy, the formation of process safety teams, accident and near-miss investigation, review of safe operating procedures, health and safety education, staffing and reasonable work hours, operator leadership, maintenance, teamwork and environmental protection for corporate neighbors and additional measures as identified. (See Appendix B, USW BP Joint Initiative on Health and Safety)

Introduction

On March 23, 2005, a fiery blast at the BP refinery in Texas City, Texas killed 15 workers, injured 180 others and caused major alarm in the community. According to the U.S. Chemical Safety and Hazard Investigation Board (CSB), the incident led to financial losses exceeding $1.5 billion."[1] (p. 17) The incident resulted in over 300 citations for OSHA violations resulting in a record fine of $21 million.[2] The magnitude of this catastrophe marks it as one of the greatest failures of process safety management in U.S. history. It was also the biggest industrial disaster since passage of the Occupational Safety and Health Administration's (OSHA's) 1992 standard on Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119).

This study focuses on the large segment of the U.S. refinery industry where the United Steelworkers (USW) is the bargaining agent for hourly workers (71 out of the 149 U.S. refineries). USW-represented sites refine approximately 66% of the U.S. refining capacity. The research team surveyed local union leaders at these refineries to gather perceptual information on the prevalence within the U.S. refinery industry of highly hazardous conditions and practices related to the 2005 Texas City disaster and on other prevention, preparedness, and response issues.

Preliminary findings from investigations and reports on the March 23, 2005 BP Texas City fires and explosions suggest that four *highly hazardous conditions* were among the key factors related to the restarting of the isomerization (isom) unit after it had been shut down for repairs.[3,a] These key factors were substantiated by the CSB in its 2007 final report.[1]

The four key issues, hereinafter referred to in this report as *highly hazardous conditions*, are as follows:

1. **Use of Atmospheric Vents on Process Units:** The use of process venting, including an antiquated blow-down drum system,[4] released untreated flammable, explosive, and toxic liquids and gases directly to the atmosphere.
2. **Failed Management of Instrumentation and Alarm Systems**: Inadequate management of instrumentation and alarm systemallowed process indicators and alarms to malfunction and pro

[a] Isomerization is a process that uses elevated temperatures and catalysts to rearrange molecules of crude distillation products to achieve higher octane. EPA. 1995. Profile of the Petroleum Refining Industry. Office of Compliance, Office of Enforcement and Compliance Assurance, U.S. Environmental Protection Agency, Washington, DC.

3. vided operators with faulty information on levels and product flows during the start-up of the isom unit.
4. **Siting Trailers Near Process Facilities**: The siting of trailers provided no protection to occupants near a processing unit and thereby exposed them to the release of toxic materials, fires, and explosions.
5. **Allowing Non-Essential Personnel in Vulnerable Areas During Start-Ups and Shutdowns**: The presence of non-essential personnel in close proximity to a hazardous processing unit during its start-up exposed them to the release of toxic materials, fires, and explosions.

In this report researchers address three key questions related to the March 23, 2005 BP Texas City disaster. The major focus of these questions is the *highly hazardous conditions* that contributed to the BP Texas City disaster. The key questions are:

A. To what extent do conditions similar to those that led to the BP Texas City catastrophe exist at the nation's other refineries, and what is being done to correct those conditions so that similar future disasters are prevented?
B. Are there regulations or guidelines that would, if applied, prevent or substantially mitigate such disasters?
C. Are there lessons that refiners should have learned from previous disasters that would have enabled them to eliminate conditions similar to those that led to the BP Texas City catastrophe?

The review of the literature below addresses the last two questions, which focus on existing regulations and guidelines and lessons from previous refinery disasters. Like BP Texas City, all U.S. refineries should have complied with these regulations and guidelines and learned and applied these lessons to protect workers, communities, and critical infrastructure.

,Chairman and Chief Executive Officer Carolyn Merritt of the U.S. Chemical Safety and Hazard Investigation Board (CSB) stated in her October 31, 2006 news conference:[5]

> Unfortunately, the weaknesses in design, equipment, programs, and safety investment that were identified in Texas City are not unique either to that refinery or to BP. Federal regulators and the industry itself should take prompt action to make sure that similar unsafe conditions do not exist elsewhere. (p.1)

Further, the blue ribbon BP U.S. Refineries Independent Safety Review Panel similarly noted:[6]

> While the panel made no findings about companies other than BP, the Panel is under no illusion that the deficiencies in process safety culture, management, or corporate oversight identified in the Panel's report are limited to BP. (p. 273)

The remainder of this report presents findings from the national study of USW-represented U.S. refineries. These findings answer the first question, above, about the extent to which the *highly hazardous conditions* exist at the nation's refineries and, thereby, threaten to contribute to future disasters similar to BP Texas City. This study further examines the extent to which the refining industry promptly acted to ensure that these conditions no longer existed elsewhere.

The participatory action research team that carried out this study was made up largely of members and leaders of the USW, primarily from the refining industry. Staff from the Tony Mazzocchi Center for Health, Safety and Environmental Education (TMC) and New Perspectives Consulting Group, Inc. led the team. The Tony Mazzocchi Center is a partnership between the USW and the Labor Institute.

Background

Refining: One of the Nation's Most Dangerous Industries

The U.S. Department of Labor (DOL) in reporting on the Phillips 66 catastrophe [7] identified refining as the petrochemical industry's most hazardous sector. Substantiating this claim, a U.S. Environmental Protection Agency (EPA) study of high volume chemical sites [8] found that refineries accounted for 10% of all chemical related accidents with nearly twice the number of any other industry.

Limited Adherence to Process Safety Guidelines and Regulations

The history of process safety management at high-hazard facilities prior to the March 2005 catastrophic accident at BP Texas City is marked by a trail of disasters.[9] Collectively, these disasters demonstrate the need for effective systems for chemical accident prevention. Aiming at disaster prevention, both governmental and non-governmental organizations established detailed regulations and guidelines. These have included:

- OSHA's standards on Hazardous Waste Operation and Emergency Response[10] and Process Safety Management of Highly Hazardous Chemicals,[11] and
- EPA's Risk Management Program[12]
- Numerous guidelines from national and international bodies and professional and industry-based organizations[13]

Together, these regulations and guidelines provide every refiner with mandates and directions necessary for effective process safety systems if refiners choose to comply.

In spite of this guidance, Rosenthal and others[14] have contended that, "the less than expected decrease in accident incidence has occurred because the newly adopted regulations have not resulted in the hoped for adoption of 'effective' process safety management systems by industry." (p. 136)

Lessons Left Unlearned

In the CSB's October 27, 2005 news release,[15] it noted that lessons from previous BP Texas City incidents would have helped correct flawed systems prior to the March 23, 2005 disaster had the company applied this knowledge. In an Organisation for Economic Cooperation and Development (OECD) report,[16] Rosenthal noted the importance of the concept of "lessons learned" by stating:

> While important lessons are constantly being learned, … it is clear that implementation of lessons already learned could have prevented the large majority of process accidents.
>
> Inadequately designed and/or executed Process Management Systems are the 'root cause' of the failure to effectively use lessons learned. (p. 12)

Rosenthal is describing dysfunctional organizational learning[17] related to process safety incidents. According to Argyris and Schön:[18]

> Organizational inquiry, consisting in actively constructing and sorting out puzzles generated in the process of probing, is essential to the firm's strategic conversation with its environment and central to fostering of strategic learning. (p. 259)

This type of strategic organizational learning is necessary if companies are to find solutions that truly solve underlying problems rather than those that are most convenient and acceptable to current ways of operating.

Marais and her co-authors[19] state:

> Safety goals often do not coincide with performance goals … and in fact often they conflict. In addition, while organizations often verbalize consensus about safety goals …, performance and decision making often departs from these public pronouncements. (pp 5-6)

Two sets of lessons critical for effective process safety have been available to U.S. refineries for organizational learning: 1) lessons that refineries should have learned and applied prior to the March 23, 2005 disaster at BP Texas City, and 2) lessons these organizations should have learned from that disaster and applied since. As early as October 2005, the U.S. CSB noted that its preliminary findings from the BP Texas City incident should be reviewed throughout the industry with the goal of achieving safer operations.[15]

In examining lessons available for learning prior to the Texas City disaster, a long list of petrochemical facility events has relevance. The following sections describe how these incidents relate directly to conditions contributing to the issues examined in the USW refinery survey.

Uncontrolled Atmospheric Release of Hazardous Materials

The 1989 Phillips 66 explosion;[7] the 1997 Shell Deer Park refinery disaster;[20] and the BP, 2000 Grangemouth (Scotland) incident [21] all involved the release of flammable or explosive process materials to the atmosphere. The massive Phillips explosions resulted from ignition of a release of polyethylene process gases during reactor maintenance and subsequent explosions of two isobutane storage tanks and a polyethylene reactor.[7] In the Shell disaster, a faulty check valve released flammable gases that resulted in an unconfined vapor cloud explosion.[20] The Grangemouth incident involved a significant leak of hydrocarbons from the Fluidized Catalytic Cracker Unit (FCCU or Cat Cracker) during start up procedures. A resulting vapor cloud ignited causing a serious fire.[21]

Following each of these incidents investigators made a number of recommendations directly relevant to the prevention of vapor cloud releases like those involved in the BP Texas City disaster. Included among these was the need for more thorough process hazard analyses (PHAs).[22]

Failing Instrumentation and Alarm Systems

Past petrochemical plant incidents have also made available important lessons related to instrumentation and alarm failures. The 1997 Tosco Avon Refinery explosion and fire; [23] the disaster at Equilon, Anacortes in 1998; [24] and a 2000 incident at BP Grangemouth provided examples of instrumentation and alarm failures that resulted in faulty readings, stop-gap control measures, and critical control decisions with limited information. Findings from reports on each of these incidents led to the dissemination of recommendations that were directly pertinent to the BP Texas City disaster.[25, 26, 27]

Unsafe Siting of Trailers and Unprotected Buildings

Siting issues related to the proximity of highly hazardous processes to the onsite work force was tragically evidenced at BP Texas City. Years before, the DOL reported on the Phillips 66 disaster [7] and addressed these same issues. Also directly related were the disasters at the Pennzoil Refinery (1995) [28] and the Tosco Avon Refinery (1997).[23] In the Pennzoil incident, EPA stated that:

> Equipment siting and containment was inadequate…. In addition, tool and work break trailers were spotted within a general containment area near the tanks. These trailers were destroyed by the liquid and fire. (p. iii)

In its report on the 1997 Tosco incident, the EPA[23] documented the following:

> Some of the injured were inside or near contractor trailers close to the Hydrocracker Unit. The blast from the explosion blew out the windows of one trailer and the flames prevented workers from exiting the trailer door. The workers climbed out of the trailer window facing away from the fire…. Some workers who were knocked down were in a tent receiving a safety orienta

> tion. Other personnel fell or tripped as they tried to run away from the explosion and fireball. (p. 22)

The Tosco and Pennzoil reports made siting recommendations directly applicable to the BP Texas City accident[29, 30] In addition, following that accident, the CSB called on the American Petroleum Institute (API) to update and improve its guidance for trailer siting at refineries and called on the National Petrochemical and Refiners Association (NPRA) to "immediately contact their members urging prompt action to ensure the safe placement of occupied trailers away from hazardous areas of process plants." (p. 2)[31]

Non-Essential Personnel in Hazardous Areas

The descriptions of the lessons learned related to the disasters at Phillips 66,[7] Pennzoil,[28] and Tosco[23] bear witness to the importance of limiting access in highly hazardous areas to only those persons who must be present. As noted in the EPA Tosco report, process hazard analyses (PHAs), if properly performed, should dictate the need to limit access of non-essential personnel. PHAs are hazard evaluations used in process safety involving a variety of specialized diagnostic methods.

Additional Process Systems Failures

The reports of these refinery disasters detail numerous other failures related to the 16 process safety systems examined in the USW survey. In the case of Phillips 66[7] DOL reported:

> Other failures involved were: safe operating procedures, permit systems, gas detection and alarm systems, control of ignition sources, ventilation system intakes for close proximity occupied buildings, and the fire protection system. (pp. 25-26)

DOL's statement regarding ventilation system intakes is especially important in relation to "blast resistant modules" being used at refineries. The modules are designed to resist outside explosions, but not the infiltration of toxic, flammable or explosive gases or vapors.

In the Phillips 66 case, OSHA also noted:

> Findings in the investigation of the Phillips Complex disaster support the conclusion that poor risk assessment and management, lack of redundant systems and fail-safe engineering, inadequate maintenance of equipment, poorly conceived operational or maintenance procedures, and incomplete employee training are the underlying factors that contribute to or heighten the consequences of an accident. (p. 62)

Although training alone cannot compensate for other inadequacies, high quality training that actively engages employees can act as a stimulus for critical assessment and action. This is noted by the United States Fire Association (USFA) in conjunction with the Department of Homeland Security (DHS) in its guidelines on process safety management training.[32] The importance of chemical disaster prevention training is further reinforced by the National Institute of Environmental Health Sciences (NIEHS) Worker Health and Safety Training Program (WETP).[33]

Following the Phillips 66 disaster, OSHA commissioned the John Gray Institute study on issues surrounding the extensive use of contract workers in the petrochemical industry. The Institute's report[34] suggested an increasing trend in the use of contractor workers with consequences evident in the report's human resource profile:

> Compared to the sample of direct-hire workers, contract workers are, on average, younger and less educated. The case studies also found that contract workers are more likely to have English language or communications difficulties. Contract workers also receive less safety training than direct-hire workers, are less likely to be unionized or covered by a labor-management safety and health committee, and less likely to participate in safety discussions with others on their site. (p. xvi)

In summary, there is a long and enduring pattern of companies within the refining industry choosing to ignore the lessons available for learning and willing to risk catastrophe rather than investing in the systems critical to keeping workers, communities, the environment, and company assets safe

Methods

Following the March 2005 BP disaster, the Mazzocchi Center conducted a survey of U.S. refineries where the USW represents workers. The survey sought to find out about conditions, processes, practices, and actions relevant to prevention, preparedness, and response to possible future incidents involving fires, explosions, or large releases of highly hazardous chemicals. More specifically, the 64-item, mail-back survey instrument asked about the following issues:

- Four targeted *highly hazardous conditions*, their prevalence, and company actions to correct them
- Emergency preparedness and response
- Process safety-related training
- Contract and company workers' preparedness to help prevent incidents
- Ratings of 16 process safety systems for start-ups and shut-downs, and
- Overall ratings of process safety systems.

The study used a participatory research methodology. [35, 36, 37] The participatory research team included:

- USW rank and file workers, primarily those employed at oil refineries
- USW Health, Safety and Environment Department staff
- USW International Union leadership including a vice president
- Education and evaluation consultants from New Perspectives Consulting Group and the Labor Institute.

(See Appendix C to view the USW Survey on Refinery Accident Prevention)

A subgroup of the participatory research team designed the survey instrument. After completion of data entry, cleaning, and tabulations, the team analyzed the resulting data and generated a preliminary report at an in-person working meeting. Follow-up consultations with the team were conducted via phone and email, including team review of report drafts for further comment. Members of the team reviewed this final report prior to its release.

In selecting sites to survey, the USW developed a target list of oil refinery sites based on the North American Industrial Classification System (NAICS) code 32411 and a listing of USW local unions/company sites. In January 2006, nine months following the Texas City disaster, researchers sent a packet of information to the local union presidents and recording secretaries at each of the 71 USW-represented refineries. The survey packet included a cover letter, a survey factsheet, an instruction sheet, and a mail-back oil refinery survey (one survey per site). Instructions asked the USW local union leadership to engage persons from the local union who were knowledgeable about refinery health and safety in completing the survey.

Researchers conducted follow-up by mail, email, and telephone to achieve a response rate of 72% (51 of 71 refinery sites). The responding local unions were from refineries in 19 U.S. states and one territory. (See Figure 1.)

Figure 1. U.S. States/Territories and Number of Refinery Sites Responding to Survey

State	No. Sites	State	No. Sites	State	No. Sites
AL	1	KS	1	OK	1
CA	8	KY	2	PA	1
CO	1	LA	5	TX	10
DE	1	MN	1	UT	4
HI	1	MT	4	VI	1
IL	1	ND	1	WA	2
IN	1	OH	4		

Twenty-two (22) refining companies operated the refineries at these sites. (See Figure 2.)

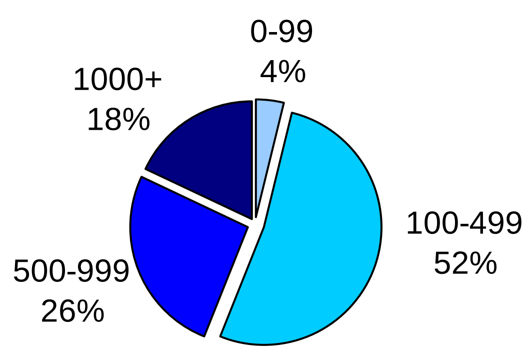
Figure 2. Refinery Companies Operating Survey Sites

BP	Flying J	Murphy Oil
CHS Coop	Frontier	Shell-Motiva
Chevron	Holly	Suncor
Citgo	Hovensa	Sunoco
Conoco-Phillips	Lyondell-Citgo*	Tesoro
Delek Refining	Marathon-Ashland	Total
ExxonMobil	Montana Refining	Valero
Flint Hills		

* Changed to Lyondell Houston Refining since survey

The size of the work force at the 51 responding refineries was predominantly mid-sized, that is, between 100 and 499 persons. (See Figure 3.)

Figure 3. Size of Workforce at USW Refinery Sites Responding to Survey



51 responses, 2% missing

In terms of the U.S. refining industry, the 51 responding sites represented 34% of the United States' 149 refineries. Further, these sites represented 49% of the U.S. refining capacity (8.7 million of the 17.8 million barrels per day).[38]

Results of the Survey

Pervasiveness of *Highly Hazardous Conditions* Similar to Those Found at BP Texas City

Investigators of the BP Texas City incident documented four *highly hazardous conditions* that contributed to that March 2005 catastrophe. These conditions included: 1) use of atmospheric vents on process units, 2) failed management of instrumentation and alarm systems, 3) siting of trailers and unprotected buildings near process facilities, and 4) allowing non-essential personnel in vulnerable areas during start-up and shutdown.[39] This survey explores all four of these *highly hazardous conditions*.

This sub-section focuses primarily on the three conditions that lend themselves well to survey measurement: atmospheric vents on process units, trailers and unprotected buildings near process facilities, and non-essential personnel in vulnerable areas during start-up and shutdown. Data about failed management of instrumentation and alarm systems findings are included in subsequent sub-sections.

When researchers examined the presence of these three *highly hazardous conditions* collectively, sites reported:

90% - had <u>one or more</u> *highly hazardous conditions* (46 of 51)

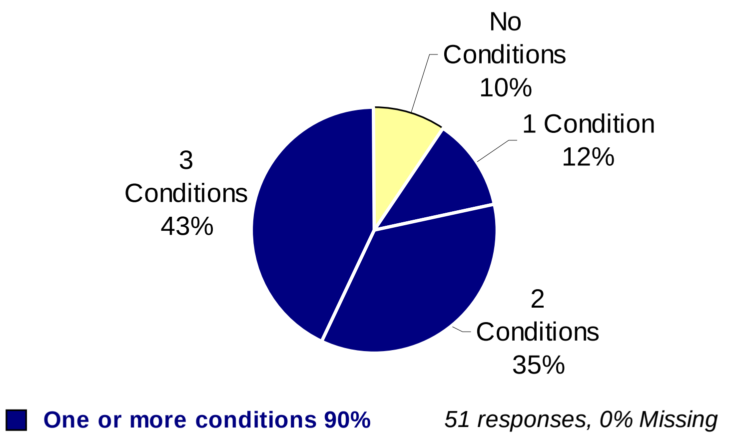
12% - had one

35% - had two

43% - had all three

(See Figure 4.)

Figure 4. Prevalence of *Highly Hazardous Conditions* at Refineries



The presence of the specific *highly hazardous conditions* among sites was as follows:

66% - had atmospheric vents on process units (33 of 50).

78% - placed trailers or other unprotected buildings in hazardous areas in the last 3 years (40 of 51).

70% - had non-essential personnel present in vulnerable areas during start-ups and shutdowns in the last 3 years (35 of 50)

A Closer Look by Highly Hazardous Conditions

Atmospheric Vents on Process Units: The following list presents the number of atmospheric vents on process units among the 33 sites reporting such vents:

58% - had 1-10 atmospheric vents

15% - had 11-30 atmospheric vents

27% - had 31 or more atmospheric vents

Respondents reported the presence of atmospheric vents on a wide range of process units.[40] Though not asked specifically about blow-down drums or stacks, 16 percent of respondents (5 of 33) that had reported the presence of atmospheric vents used open-ended questions to report that atmospherically vented blow-down drums were in use at their sites. There may have been more blow-down drums than those reported. An atmospherically vented blow-down drum was a key component of the process failures at the BP Texas City facility during the 2005 catastrophe.

Trailers and Other Unprotected Buildings: Over three-quarters (78%) of respondents (40 of 51) reported trailers or other unprotected buildings inside potentially hazardous areas in the last three years. Slightly fewer, 69% (35 of 51) reported that their company had formal written policies prohibiting the siting of trailers or other unprotected buildings in these areas (20% reported *no* policies and 12% *don't know*). The data neither indicated when these policies were established nor their content. Thus, these refinery policies may have been developed after the Texas City catastrophe, refineries may have been violating their own policies, and/or refinery policies may have permitted such siting.

The 40 sites that reported trailers or unprotected buildings in hazardous areas also reported the following numbers of these structures:

89% - 1-50 trailers or unprotected buildings

11% - 51 or more

Respondents reported trailers and other unprotected buildings were located near a wide variety of processing units, provided descriptions of locations, and described potential hazards.[41]

Non-Essential Personnel: Seventy percent (70%) of respondents (35 of 50) reported their sites engaged in process start-ups or shutdowns with non-essential personnel in vulnerable areas in the past three years (22% reported *no,* and 8% *don't know*). Fifty-four percent (54%) of respondents (27 of 50) reported the existence of formal written policies regarding the presence of non-essential personnel in areas vulnerable to a toxic or hazardous materials release, fire, or explosion during start-ups or shutdowns (26% reported *no* written policies, 20% *don't know*). The data neither indicated when these policies were established nor their content. Thus, these refinery policies may have been developed after the Texas City catastrophe, refineries may have been violating their own policies, and/or refinery policies may have permitted non-essential personnel in hazardous areas during start-up and shutdowns.

Reported Incidents or Near Misses

In addition to the presence of *highly hazardous conditions*, a large number of sites reported that there had been incidents or near misses connected to these conditions in the past three years:

61% - reported <u>one or more</u> incidents or near misses involving at least one *highly hazardous condition*

39% - reported <u>no</u> incidents or near misses for these conditions

The following details more specifically the percentage of sites experiencing <u>one or more</u> incidents or near misses involving one or more of the four *highly hazardous conditions*:

10% - <u>one or more</u> incidents or near misses involving <u>all four</u> *highly hazardous conditions*

10% - involving <u>three</u> *highly hazardous conditions*

14% - involving <u>two</u> *highly hazardous conditions*

27% - involving <u>one</u> *highly hazardous condition*

(See Figure 5.)

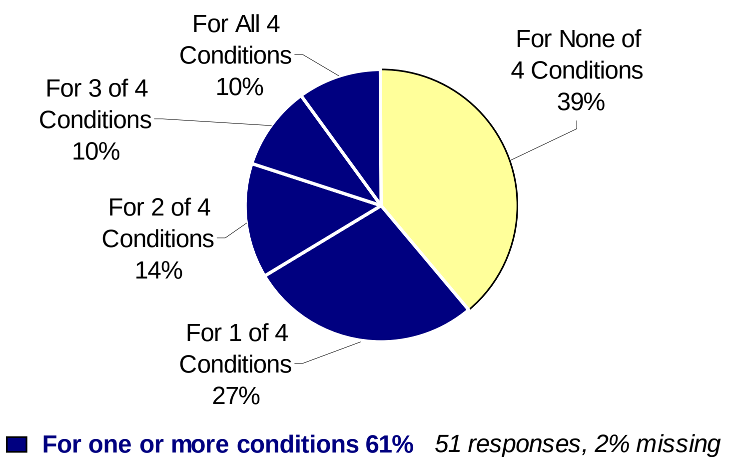


Figure 5. Reports of Incidents or Near Misses at Refineries Related to the Four *Highly Hazardous Conditions*

Incident or near miss figures related to the four *highly hazardous conditions* may be higher than reported here because a range of 18-31% of respondents reported *don't know*.

Examination of only those sites where *highly hazardous conditions* existed, with separate analyses for each of the four conditions, shows that between approximately one-third and one-half of respondents reported incidents or near misses involving those conditions as follows:

48% - incidents or near misses involving atmospheric vents on process units (16 of 33)

43% - involving management of instrumentation and alarm systems (21 of 49)

30% - involving trailers and other unprotected buildings near process units (12 of 40)

41% - involving non-essential personnel in hazardous areas during start-up or shutdown (14 of 34)

Descriptions of Incidents and Near Misses

The 31 sites reporting incidents or near misses involving one or more of the *highly hazardous conditions* provided descriptions of those events. Examples of the range of incident or near miss descriptions follow. Each description is from a different refinery.

- *[The] reformate level in [the] tower was at high levels during start-up. Operations management intentionally raised levels, which did not allow operations personnel to know where the levels were. This caused a release of reformate into other ar*

- *eas of [the] refinery. Non-essential personnel were in areas exposed to hazards….*
- *Multiple units upset several PSVs [Process Safety Valves] that go to [the] atmosphere [and they] lifted. [About] 40 people [were] at [the] refinery at [the] start of [the] event [and] 82,000 pounds of hydrocarbon [were] released to [the] atmosphere.*
- *Acid leak involved approximately 10+ people, most of whom were non-essential personnel. No injuries [occurred] but the potential for [a] disaster or a catastrophic event was there.*

The description that follows illustrates a problem with atmospheric vents on process units:

- *Isom [isomerization] flame radiant heat near coker… hydro cracker flame allowed liquid to flame tip. That caused fire at base.*

Respondents reported examples of failed management of instrumentation and alarm systems, such as:

- *A seal pot level indicator failure causing [a] liquefied petroleum gas [LPG] release and fire…. It was later discovered that the seal pot … was empty and [the] mechanical seal was leaking LPG - causing the fire…. Instruments were giving false readings [that were] nearly overlooked.*
- *Instruments were accurate but management wanted to ignore alarms. Union operators and front line supervisors refused to proceed and [insisted that we] find [the] problem.*
- *[We] always have near misses with instrumentation. [We] had a boiler failure with hydrogen sulfide release to [the] atmosphere with [a] contractor working in [a] process unit next to [the] release. [There were] no injuries. [The] contractors [were] instructed to evacuate to their safe area and work [was] stopped!*

Respondents reported examples of near misses and actual incidents during start-ups and shutdowns that involved trailers and unprotected buildings and non-essential personnel in vulnerable areas:

- *[There was an] explosion and fire in [a] process unit. [It] caused damage to a trailer roughly 30 feet to 40 feet away. [There were] no injuries. There have been issues with instrumentation that has failed or been inhibited.*
- *Trailers for t[urn]a[round are] set-up before units are shutdown and cleared of hydrocarbons. Non-essential personnel [are] allowed all over the unit while the unit is being shut down and started-up.*

- *[Our site] allowed non-essential personnel (approximately 200 contractors) in hazardous areas during shutdown and start-up. [The following units and hazardous materials were involved:] FCC [fluidized catalytic cracking unit], alky propane, butane, acid, caustic, gas oils, ammonia and hydrogen sulfide.*

One of the incidents reported was strikingly similar to the Texas City disaster, including the involvement of a blow-down drum. The respondent reported:

- *[During the] cat[alytic] cracker start-up we had their blow-down tower over-run. [It] caused a vapor cloud, [but there was] no ignition source.*

Company Actions

The survey solicited answers from all respondents about company actions to ensure that instrumentation and alarms functioned properly following the March 2005 BP Texas City catastrophe. In addition, for those sites where respondents indicated the presence of the remaining three *highly hazardous conditions,* the survey solicited responses regarding company actions to address these conditions. As highlighted below, "actions" ranged from audits to actual changes in conditions. Respondents reported the companies at their sites acted to:

32% - replace atmospheric vents on process units with safer venting systems.[a]

52% - ensure that instrumentation and alarms function properly.[b]

88% - move trailers or other unprotected buildings outside of potentially hazardous areas.[a]

46% - ensure that all non-essential personnel are at a safe distance during a process start-up or shutdown.[a]

As highlighted below, these actions were reportedly of varied effectiveness in correcting the problems at hand.

Effectiveness of Company Actions: The respondents who reported that their companies took action to address the *highly hazardous conditions* were then asked to rate their perceptions regarding the effectiveness of these actions.

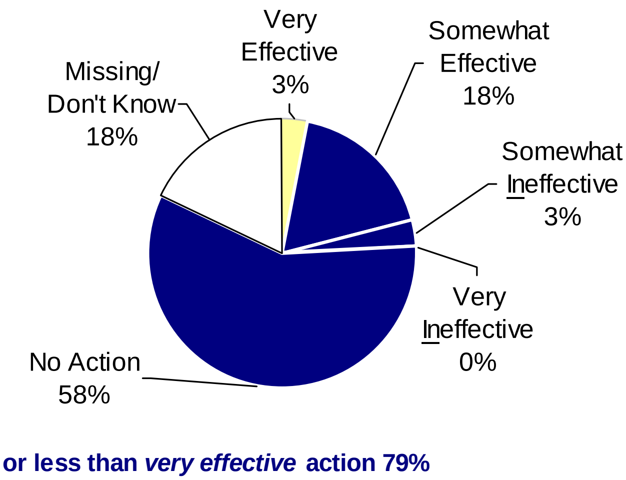
To present a more complete picture of company action and inaction concerning the four *highly hazardous conditions,* researchers combined data from two different groups of questions. These included the data regarding company actions to address the *highly hazard*

[a] Analysis includes only those sites where respondents reported the presence of the *highly hazardous condition*.
[b] Analysis includes all sites.

ous conditions (*yes, no, don't know*), and the data on the level of effectiveness of those actions (*very effective action*, *somewhat effective action*, *somewhat ineffective action*, *very ineffective action*). The combined categories include *no action, don't know,*[a] and all of the effectiveness ratings about the actions. Accordingly, all responses in this subsection include only those sites at which the respondents reported the presence of the four targeted *highly hazardous conditions*.

Assuming that the four *highly hazardous conditions* require *very effective action*, the dark shading is used in the charts below, and throughout this report, to indicate data in the categories of *no action* and less than *very effective* action. In summary, 59-79% of respondents indicated that either no action or less than *very effective action* was taken related to each of the conditions, with an additional 5-24% of respondents falling in the *don't know* or missing categories. (See Figures 6-9.)

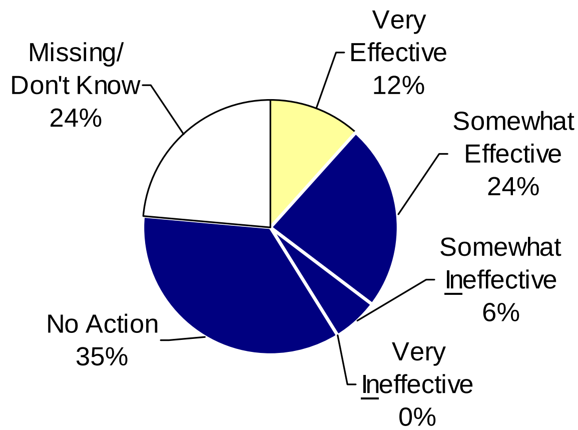
Figure 6. Replacing Atmospheric Vents: Action and Effectiveness



33 responses - limited to sites reporting atmoshpheric vents

[a] Charts on these questions combine *don't know* with *missing* responses.

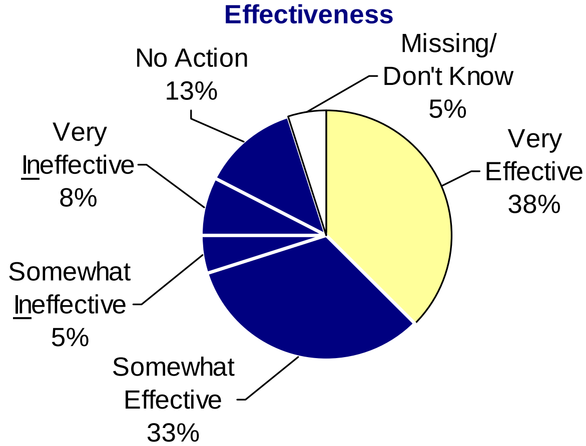
Figure 7. Managing Instrumentation and Alarms: Action and Effectiveness



■ ***No*, or less than *very effective* action 65%**

51 responses

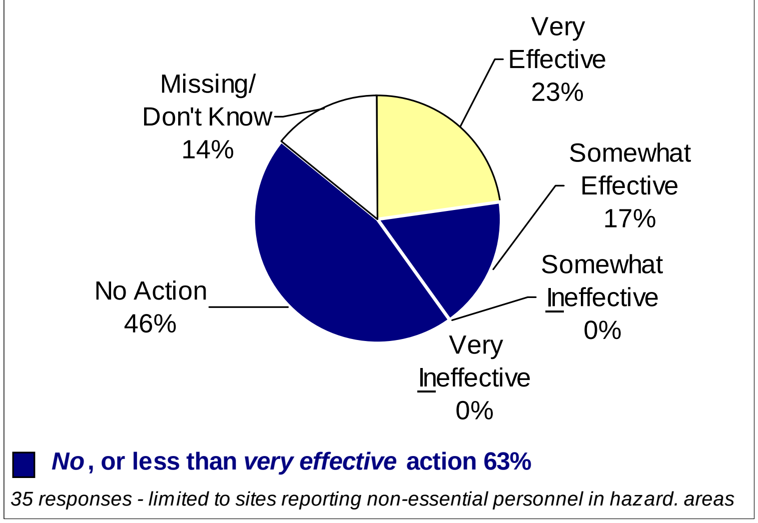
Figure 8. Removing Trailers and Other Unprotected Buildings: Action and Effectiveness



■ ***No*, or less than *very effective* action 59%**

40 responses - limited to sites reporting trailers/unprotected bldgs.

Figure 9. Keeping Non-essential Personnel Out of Hazardous Areas: Action and Effectiveness



Descriptions of Company Actions: Respondents from the 31 sites with atmospheric vents on process units reported three primary types of actions by the companies at their sites to replace those vents with safer ones, as follows:

- Acted to make changes
    - *[There] has been a concerted effort to tie all pump vents directly into flare system. [In addition] as situations arise and exchangers come out of service and vents are discovered, they are being plugged off.*
- Reviewed audits or risk assessments:
    - *Company has contacted engineering firms to study refinery needs….*
    - *Currently [they are] conduct[ing] risk assessment of the crude unit to evaluate if it is possible to put it to a close[d] system.*
    - *There was an audit to identify all hydrocarbons releasing to the atmosphere.*
- Changes underway or in process
    - *Capital projects to revise piping to [one] flare, [and] two more to be completed in 2006 … they [the company] are working to migrate. [The union leaders] do not know thetime frame for resolutions….*

- *Have started updating the flare system and tying atmospheric vents to the flare system.*
- *[The company has] … removed … [and] blinded off [a number of these vents].*

Overwhelmingly, in the area of management of instrumentation and alarms for start-ups and shutdowns, respondents described routine actions that did not indicate new actions or policies. In a number of cases respondents wrote that, “actions are not based on March 23, 2005” and then proceeded to describe routine company practices. However, some respondents reported actions that were intended to address instrumentation after the Texas City disaster. These actions included:

- *Increased preventive maintenance work on instrumentation, improved response on work orders, and improved program to input test and repair instrumentation.*
- *Developed critical safety device policy and it is now under review. Developing area electrical classification drawings for each process area, and [are] generating loop drawings for process instrumentation....*

A notable number of respondents reported that the company at their site had taken some actions to move trailers or other unprotected buildings outside potentially hazardous areas or had developed or revised policies or procedures regarding trailer siting, for example:

Company moved trailers several months later, after making a new parking lot that would hold the trailers.

- *They moved all of them (trailers) to a central location out of blast zones.*
- *Developing written policy to ensure trailers are greater than [a certain number of] feet from process units.*

There were frequent reports of no action at all, the presence of other unprotected buildings, not completing trailer removal, and the introduction and use of blast/explosion resistant trailers, for example:

- *[While] all trailers have been moved away from process units, blast zones still have unprotected buildings, [or] offices inside process units [which are in the] blast zones.*
- *Relocated most contractors to a safer location, [but] did not move some of the trailers and storage buildings used by employees.*

- *The company has purchased "blast resistant" trailers with no windows.*
- *Developed plans for installing "blast resistant modules" for operator shelters and turn-around trailers.*

Finally, regarding company action addressing non-essential personnel in vulnerable areas, respondents reported that many employers reviewed, revised, or developed policies limiting access of non-essential personnel in hazardous areas, for example:

- *[Have a] procedure in place to minimize non-essential personnel and also better communication and planning to alert employees to start-up and shutdown times and schedules.*
- *Company's using improved communication during start-up and shutdown including posters and taping off an area.*

Training Received: The survey asked respondents about the percentage of the work force the company had trained about the four *highly hazardous conditions* since the March 2005 BP explosion. Only those sites where respondents reported the presence of the *highly hazardous condition* are included in this analysis. Researchers assumed that it would be at these sites that the training would be most needed and relevant. For ease of reporting, researchers created four categories: 1) 0% of the work force trained, 2) 1 to 50% of the work force trained, 3) 51 to 100% of the work force trained, and 4) don't know.

A range of 30 to 42% of sites reported no training of the work force depending on the *highly hazardous condition.* Almost as many sites reported *don't know*, with a range of 21 to 42%. Where companies did conduct training on these conditions, 12 to 16% of sites trained half or less of the work force and 3 to 26% of sites trained more than half. The area of least training was atmospheric vents on process units (15% of sites conducted any training).

In open-ended replies respondents described the training approaches and target audiences on which companies focused regarding preventing catastrophic events involving the four *highly hazardous conditions*. Training approaches included computer based training and testing, emails, tailgate and safety meetings, and meetings prior to start-ups and shutdowns. Few described classroom-based health and safety training. In addition respondent comments suggested that managers had received more training than hourly workers. The following comments illustrate:

- *The company has used computer based-training and testing to educate operators about instrumentation that is critical to [the] operation.*

- *Emails have been sent and procedures discussed before unit shutdown.*
- *Operator to operator training.*
- *[There was a] discussion between first line supervisor[s] … and operations personnel. [They] referenced [the] Health Safety and Environment training manual, [but there] were no handouts, just [an] oral presentation for [the] location of temporary buildings.*
- *[A] small percent of operations folks have been involved in safety meetings that contained the above topics. Formal training since 3/23/05 [the date of the BP catastrophe] has not happened.*
- *The management group was trained about vent problems and trailer siting.*

Need for Additional Training: Again, only those sites where respondents reported the presence of the *highly hazardous condition* are included in this analysis. Researchers assumed that it would be at these sites that the training would be most needed and relevant. More than half of the respondents reported that workers at their sites needed additional training about each of the four *highly hazardous conditions* targeted in this survey. The reports of sites needing training on *highly hazardous* conditions included:

81% - on atmospheric vents on process units

57% - on instrumentation and alarms systems

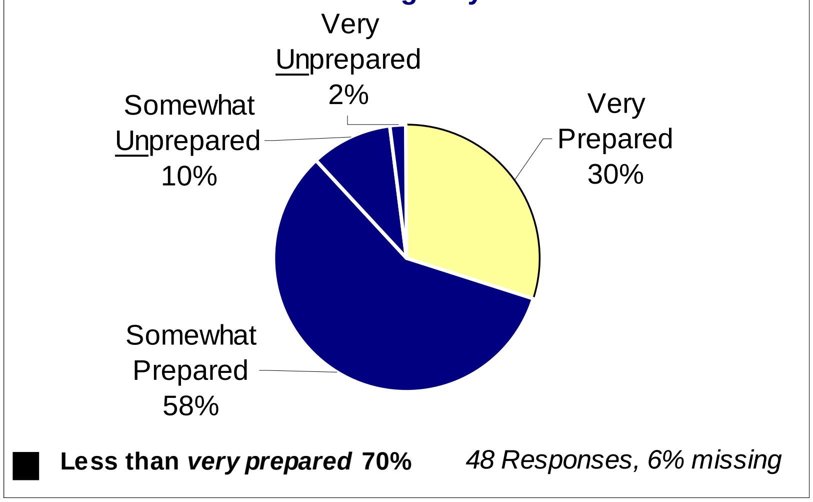
62% - on trailers or other unprotected buildings

88% - on non-essential personnel in hazardous areas

Emergency Prevention, Preparedness and Response

Respondents were asked how well prepared their worksites were to respond safely to a serious hazardous materials incident or emergency. Less than one-third (30%) reported that their sites were *very prepared.* In other words, 70% of respondents said their worksite was <u>less than</u> *very prepared.* Assuming that the hazardous conditions at refineries require the work force to be *very prepared* to respond to incidents, the dark shading on the charts below indicates data in the categories of <u>less than</u> *very prepared*. (See Figure 10.)

Figure 10. Overall Worksite Preparedness to Respond to a Hazardous Materials Incident or Emergency



Actions to Improve Emergency Preparedness and Response: Those surveyed were asked if the company had taken action since the BP Texas City disaster to improve emergency preparedness and response. Respondents reported company actions to improve emergency preparedness and response as follows:

46% - had taken action

38% - had not taken action

16% - don't know

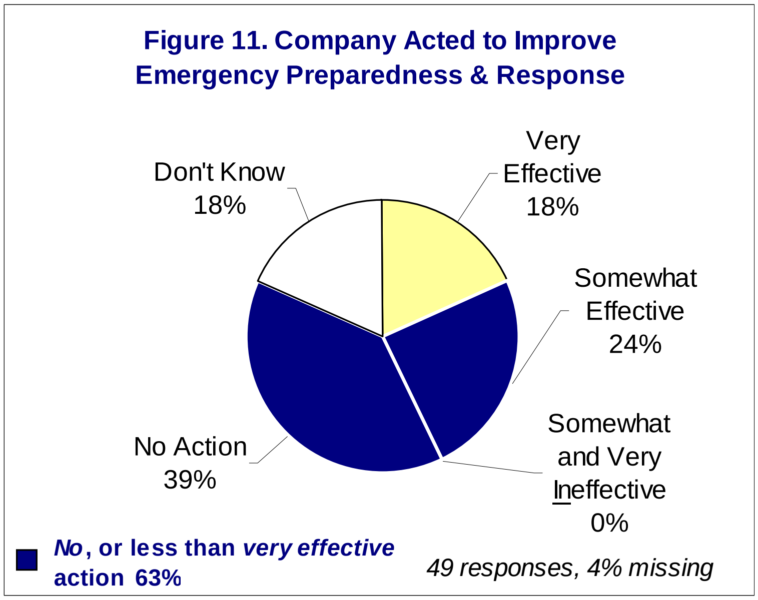
For the 23 sites where company action was reported, respondents described: 1) upgrading equipment that could support an emergency response including fire trucks and alarms, 2) improving emergency response training for the fire brigade and, in some cases, for other employees, and 3) holding drills. The 23 sites also rated the effectiveness of their company's actions to improve emergency preparedness and response as follows:

41% - action taken was *very effective*

55% - action taken was *somewhat effective*

5% - don't know

To present a more complete picture of company action as well as inaction concerning the improvements of emergency preparedness and response, researchers, again, combined data from two different groups of questions. These included the data on whether the company acted to improve emergency preparedness (*yes, no, don't know*) and the data on the level of effectiveness of company actions (*very effective action*, *somewhat effective action*, *somewhat* *ineffective action*, *very ineffective action*). The combined categories include *no action* and *don't know,* and all of the effectiveness ratings about the actions. (See Figure 11.)



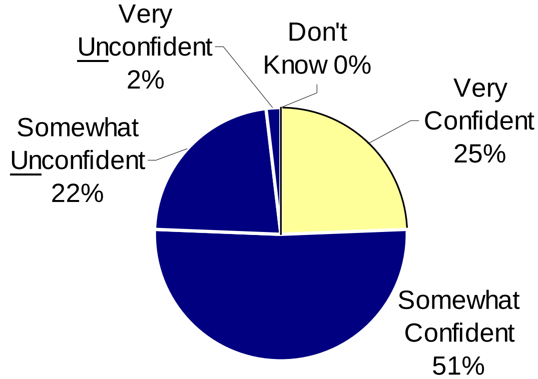
Emergency Response Training Recipients*:* The survey asked respondents about which groups of workers had received emergency response training in the last 12 months. Respondents reported the following:

96% - emergency response team, hazmat team, or fire brigade at the site had received training

77% - general plant population at the site had received training

Confidence in Training: The survey sought to learn how confident respondents were that the work force had received the training it needed to respond safely to a serious hazardous materials incident or emergency. While one-quarter said they were *very confident,* three-quarters stated that they were less than *very confident* (*somewhat confident, somewhat and very unconfident*). (See Figure 12.)

Figure 12. Confidence Workforce Has Received Training It Needs to Respond Safely to a Serious Hazardous Materials Incident or Emergency



Less than *very confident* 75%   *49 Responses, 4% missing*

Company and Contractor Preparedness to Help Prevent Hazardous Materials Incidents

When describing how prepared routine maintenance and turnaround or overhaul workers were to help prevent hazardous materials incidents, notable differences emerged when comparing contract and company workers. Overall, respondents reported that company workers were much better prepared than contract workers to help prevent hazardous materials incidents. For contract workers, 94% of responding sites reported that routine maintenance workers were less than *very prepared* (6% *very prepared*). Similarly, for turnaround/overhaul contract workers, 100% of responding sites reported these workers were less than *very prepared* (0% *very prepared*). In contrast, approximately one-third (31% and 32%) rated company maintenance workers *very prepared* for the same two types of work.

Company and Union Initiatives to Work On Issues Covered In Survey

Researchers asked whether the union and/or the company had undertaken initiatives to improve policies, training, procedures, or conditions related to the four *highly hazardous conditions* targeted in the USW survey since the March 23, 2005 BP Texas City refinery explosion. Respondents reported the following types of initiatives:

30% - BOTH union and company initiative[42]

34% - local union initiative ONLY

6% - company initiative ONLY

30% - NO INITIATIVE by either union or company

Process Safety Management

Respondents rated 16 systems related to process start-ups and shutdowns. (See Figure 13.)

Figure 13. Process Safety Systems Rated for Start-Ups and Shutdowns

1. Design and Engineering	2. Monitoring and Measurement Systems
3. Work Organization and Staffing Levels	4. Alarm and Notification Systems
5. Managing the Change of Systems	6. Process Hazard Analyses (PHAs)
7. Inspection and Testing	8. Operating Manuals and Procedures
9. Relief and Check Valve Systems	10. Training
11. Systems for Containing Hazardous Materials	12. Emergency Preparedness and Response
13. Emergency Shutdown and Isolation Systems	14. Communication Systems within the Plant
15. Fire and Chemical Suppression Systems	16. Communication Systems for Outside the Plant

For only one of the 16 process safety systems examined — *emergency preparedness and response* — did more than one-third (34%) of respondents rate the system as *very effective*. Even for this system, 64% of respondents rated it as less than *very effective* for start-ups and shutdowns. For 10 of the 16 systems, more than three-quarters of respondents rated them less than *very effective*. For example, for training, 90% rated this system as less than *very effective*. (See figure 14 below).

Other systems for which more than three-quarters of respondents rated the system as less than *very effective* for start-ups and shutdowns included:

88% - Work organization and staffing

86% - Design and engineering of systems

81% - Managing the change of systems (MOC)

78% - Emergency shutdown and isolation systems

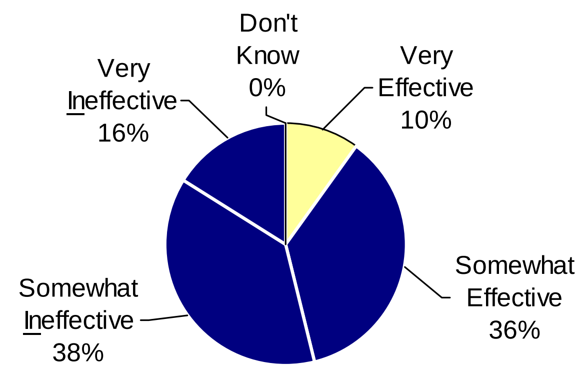
- Alarm and notification systems

- Process hazard analysis (PHA)

76% - Communication systems within the plant
- Monitoring and measurement systems
- Systems for containing hazardous materials

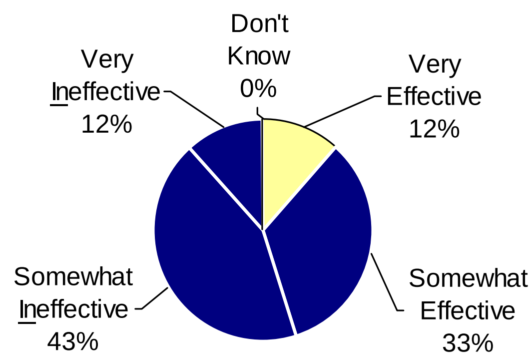
(See figures 15 to 23 below.)

Figure 14. Effectiveness of Training for Start-ups and Shut-downns



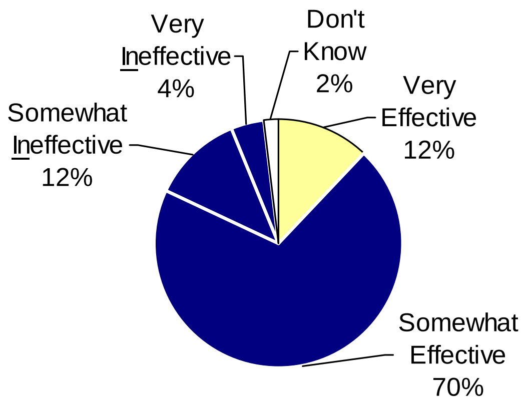
Less than *Very Effective* 90% *50 responses, 2% missing*

Figure 15. Effectiveness of Work Organization and Staffing Levels for Start-ups and Shut-downs



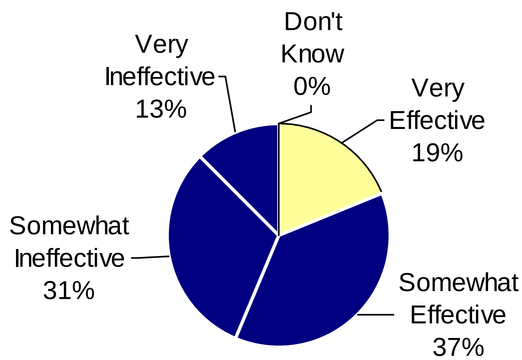
Less than *Very Effective* 88% *51 responses, 0% missing*

Figure 16. Effectiveness of
Design and Engineering
for Start-ups and Shut-downs



Less than *Very Effective* 86% *51 responses, 0% missing*

Figure 17. Effectiveness of
Managing the Change of Systems
for Start-ups and Shut-downs



Less than *Very Effective* 81% *49 responses, 4% missing*

Figure 18. Effectiveness of Emergency Shutdown and Isolation Systems for Start-ups and Shut-downs

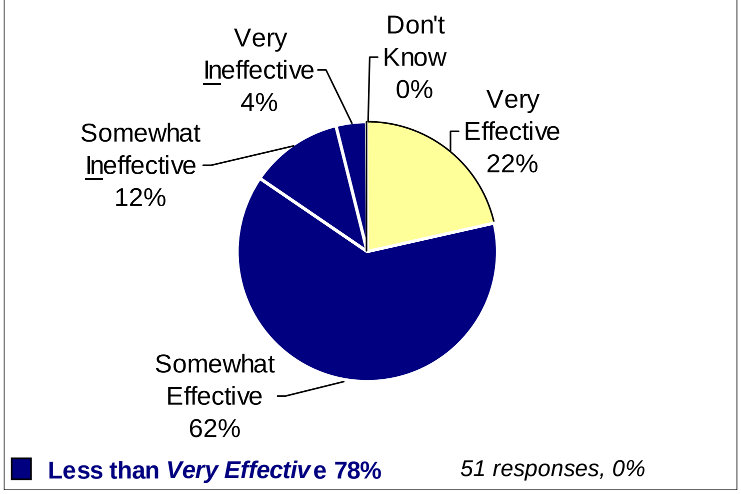


Figure 19. Effectiveness of Alarm and Notification Systems for Start-ups and Shut-downs

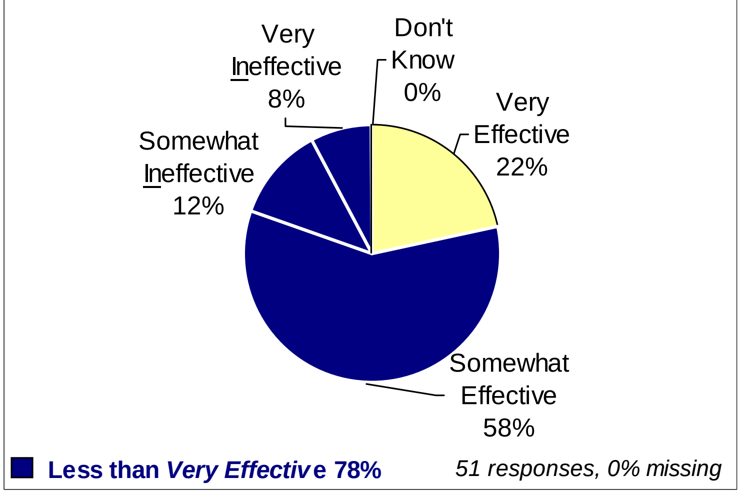
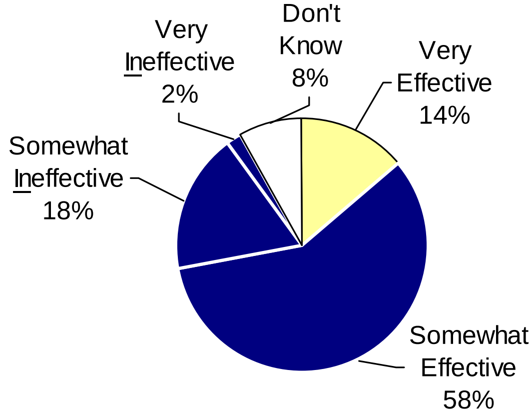
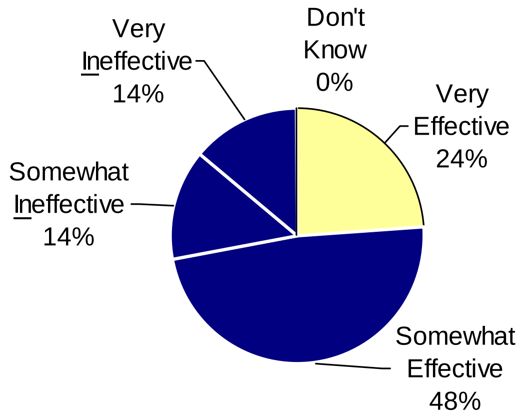


Figure 20. Effectiveness of
Process Hazard Analyses (PHAs)
for Start-ups and Shut-downs



Less than *Very Effective* 78% *51 responses, 0% missing*

Figure 21. Effectiveness of
Communication Systems within the Plant
for Start-ups and Shut-downs



Less than *Very Effective* 76% *50 reaponses, 2% missing*

Figure 22. Effectiveness of Monitoring, and Measurement Systems for Start-ups and Shut-downs

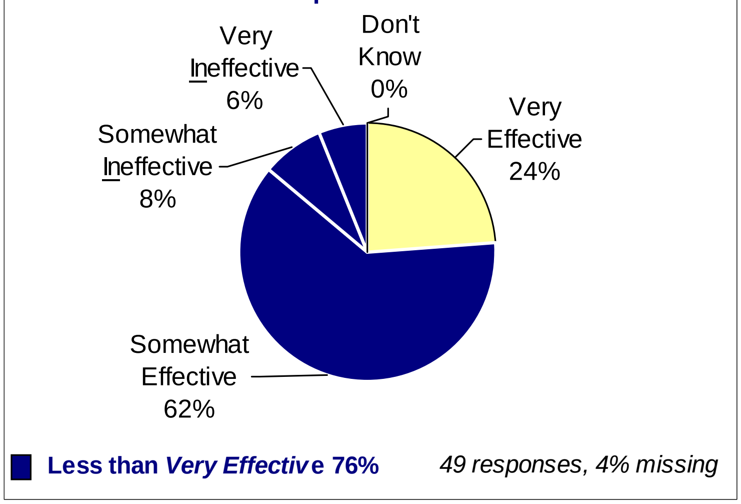
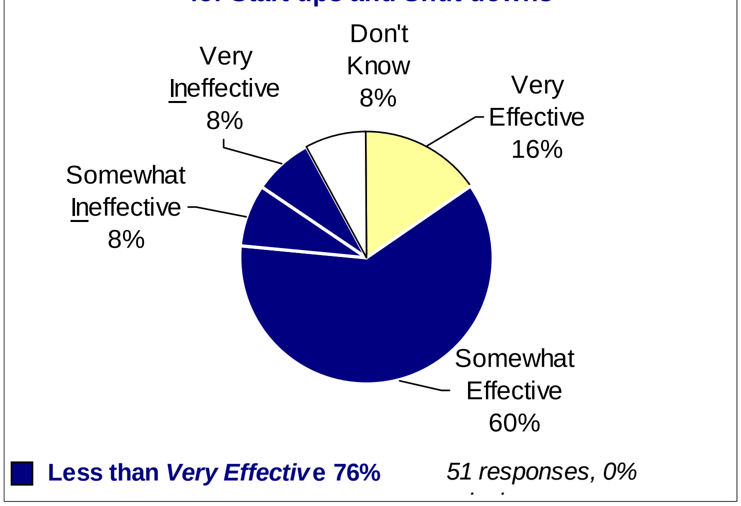


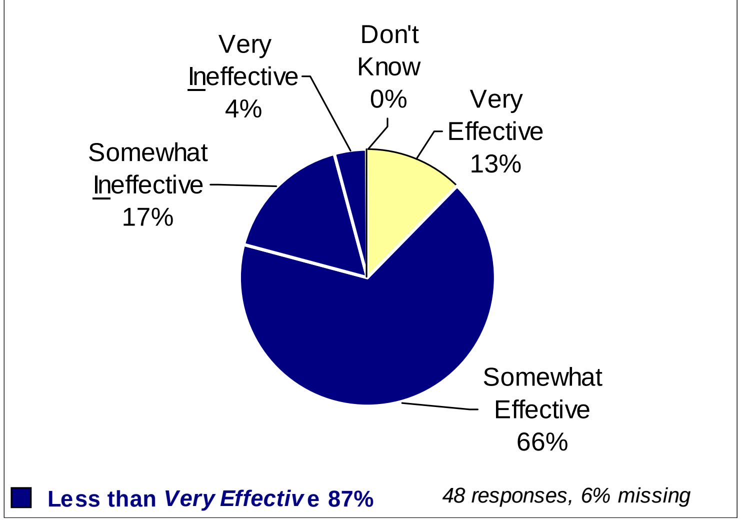
Figure 23. Effectiveness of Systems for Containing Hazardous Materials for Start-ups and Shut-downs



Overall Management of Process Safety Systems

In addition to asking respondents about specific process safety systems for start-ups and shutdowns, the survey asked respondents to rate the overall management of process safety systems at the refinery. Thirteen percent rated it is as *very effective*. Nearly 9 of 10 (87%) rated the overall management of process safety systems at their refineries as less than *very effective.* (See Figure 24.)

Figure 24. Overall Effectiveness of Management of Process Safety Systems



Study Limitations

The findings of this study may be limited because many of the study's findings provide respondent perceptions rather than independent assessments (e.g., regarding effectiveness, preparedness, confidence in systems, or employer actions). Further, findings from this study cannot be generalized beyond those sites that participated in the study.

While these findings cannot be taken to represent conditions at refineries that are not included in this study, it may be appropriate to consider that refineries with union representation have greater organizational mechanisms and resources, such as joint-labor management health and safety committees, full and part-time local union health and safety representatives and international union health and safety staffs and programs, with which to positively affect process safety. Accordingly, the findings from this study may be able to be considered "best case" findings.

Discussion and Conclusions

Highly Hazardous Conditions Similar to Those Found at BP Texas City Are Pervasive in US Refineries

Ninety percent of the 51 refineries reported the presence of at least one of these three *highly hazardous conditions* (43% reported three *highly hazardous conditions,* 35% reported two conditions, and 12% reported one condition). Two-thirds or more of the respondents reported the presence of each of these three *highly hazardous conditions* in the last three years (78% placed trailers or other unprotected buildings in hazardous areas, 70% had non-essential personnel present in vulnerable areas during start-ups and shutdowns, and 66% had atmospheric vents on process units).

There Remains an Alarming Potential for Future Disasters

The findings indicate that the U.S. refinery industry remains plagued by the threat of refinery catastrophes like the fires and explosions that engulfed workers at BP's Texas City refinery—catastrophes that are preventable. Moreover, 61% of respondents from these sites reported at least one incident or near miss involving at least one of the targeted four *highly hazardous conditions* in the past three years. Of these incidents 10% - involved all four *highly hazardous conditions* (10% involved three conditions, 14% involved two conditions, and 27% involved one condition).

Industry Response Since Texas City Has Been Anemic

Stark and hard lessons from the myriad of refinery incidents and near misses prior to BP Texas City have been explicitly outlined but have largely been ignored. Following each catastrophe, refinery workers, their union, and occupational health professionals hoped and expected that there would be a flurry of activity to improve process safety in areas that prompted the disaster. However, even the most recent disaster in Texas City, the worst since passage of the OSHA Act and the Process Safety Management Standard, reportedly yielded either widespread inaction or insufficient action — each of which threatens more catastrophes.

The survey findings highlight that following the Texas City disaster a substantial majority of refineries with one or more of the four *highly hazardous conditions* either took *no action* or took actions judged less than *very effective*. Consistent with this inaction, a sizeable number of sites that had these *highly hazardous conditions* reported an absence of training regarding the prevention of catastrophic events. In addition, a majority of these same sites reported a need for such training. Indicating a lack of local union involvement, a substantial minority of responding sites stated they did not know if the company had provided training on these conditions.

In spite of these findings, there was a glimmer of hope among the widespread reports of faulty systems, insufficient action, and an industry penchant for risk taking. There is evidence from this study that refineries with identified problems can take very effective action on critical health and safety issues, although to date most have not. These positive reports, though limited, provide the beginnings of benchmarks for the rest of the industry.

The Letter and the Spirit of OSHA's Process Safety Standard Remain Unfulfilled

The study findings demonstrate that for the refining industry, the letter and spirit of OSHA's Process Safety Management of Highly Hazardous Chemicals standard remain unfulfilled. The heightened risks present during refinery process start-ups and shutdowns demand that these systems be highly reliable and at peak effectiveness. Pre-start-up safety reviews are an essential tool for identifying and correcting an array of potentially disastrous refinery conditions and are included in the Process Safety Management standard.

The prevalence of the four *highly hazardous conditions* and related incidents and near misses during the process start-ups and shutdowns, as reported by respondents, indicates that at many sites these reviews lack the robustness intended in the Process Safety standard. A solid majority of respondents individually rated each of 16 process safety systems used during start-ups and shutdowns as less than *very effective.* More than three-quarters of respondents rated 10 of the 16 systems as less than *very effective.* And further, 87% rated the overall management of process safety systems at their sites as less than *very effective*.

With very infrequent OSHA inspections,[43] the refining industry has been left largely to voluntary self-regulation, thus undermining a necessary driving force for highly effective process safety systems. The absence of OSHA enforcement has facilitated management decisions that undermine the health and safety of workers, communities and the environment. Decisions made by oil companies, based in part on inadequate trade association guidelines,[44, 45] have led to the widespread presence of the *highly hazardous* conditions targeted in this study.

Inadequate Staffing and Poor Work Organization Increase the Risk of Catastrophic Accidents

Virtually every safety system examined in this study is highly dependent on the presence of highly qualified employees in sufficient numbers to handle normal, abnormal, and emergency situations. This is not the picture painted by this study's findings. Almost nine out of ten respondents rated work organization and staffing as less than *very effective.* These findings are consistent with problems of staffing, work organization and hours of work reported by the CSB[1] and the BP U.S. Refineries Independent Safety Review Panel[6] regarding the 2005 BP Texas City disaster.

Contractors and those who work for them are a very substantial part of the workforce at most every refinery. The 15 workers who died in the BP Texas City disaster were all contract workers. Although these 15 were not engaged in activities that contributed to the BP incident, lessons from previous disasters have shown that contractors need to play important roles in prevention. In this study, the preparedness of contractors to contribute to incident prevention received the poorest ratings of any item in the survey.

Refineries are Not Sufficiently Prepared for Emergencies

Taken together, the hazards and risks outlined in the history of refinery disasters along with respondents' reports in this study amplify to extraordinary proportions the need for very effective emergency preparedness and response. However, it appears that the refining industry is under prepared for these emergencies. While 30% of respondents rated their sites as *very prepared,* some of the highest ratings in this entire study, the remaining 70% reported that their refineries were less than *very prepared.*

Emergency response training and frequent drills are critical to having a workforce prepared to respond to a hazardous materials incident. While nearly all of the study respondents reported training at their sites in the previous 12 months for emergency response or hazmat teams or fire brigades, only 77% of sites reported emergency response training for the general plant population in the past year. Thus, the data show that workers at approximately one in four refineries labor in highly volatile situations without up-to-date training. Further, only one-quarter of respondents reported being *very confident* that the workforce at their site had received the training it needed to respond safely to a serious hazardous materials incident or emergency.

Proactive OSHA Regulation and Enforcement Are Essential: In sharp contrast to other high hazard industries such as aerospace, aviation, and nuclear power which are specifically required to perform to very high standards, government regulators have not yet demanded that the refining industry invest the necessary resources to be fully protected and secured. For example, policymakers and the public would find it unacceptable if there were widespread reports from airline pilots or mechanics that take-offs and landings were occurring with less than fully effective critical safety systems. However, this study's findings suggest such "take-offs" and "landings" occur regularly at refineries, thereby threatening the lives of hundreds or thousands of workers, nearby community members and the environment. Given that petroleum refineries are a vital part of the nation's energy infrastructure, prompt government intervention including strengthened OSHA standards and rigorous enforcement must be put in place.

In particular, OSHA should update and strengthen its 1992 standard on "Process Safety Management of Highly Hazardous Chemicals" (29 CFR 1910.119). For example, facilities should be required to report to OSHA when their use of highly hazardous chemicals in large quantities meets the standards' provisions for coverage. The standard currently covers flammable, explosive and toxic chemicals, but not chemicals that can undergo a catastrophic runaway reaction. The CSB has recommended that OSHA correct this deficiency, but the Agency has taken no action. The rulemaking should also consider incorporating the process safety metrics and the safe siting guidelines currently under development. The Agency could also write many of the urgent and critical actions listed in the next section into regulatory language.

Changes in other regulations would also be useful. In particular, all facilities that employ outside contractors should be required to keep a log of injuries and illnesses for all workers on the site. It was absurd that BP was not required to report any of the workers killed in its Texas City disaster on its log of occupational injuries and illnesses. This was the case because BP did not directly employ any of those killed—they were contractor employees.

Of course, OSHA standards are useless without strong enforcement. At the time of the BP disaster, OSHA had few inspectors trained to enforce its Process Safety Standard. The Agency has begun to train additional inspectors, but more could and needs to be done. Even with the additional inspectors, OSHA must commit to using the standard vigorously. Too often, OSHA measures its productivity by comparing the number of inspections and citations with the inspection time needed to generate them. However, process safety inspections are complicated and time consuming. As such, they do not fit well into this naïve measure of productivity. OSHA needs to ensure that it gives such inspections the time, resources and high priority they deserve.

The Oil Industry Should Promptly Address Critical Deficiencies in Process Safety Management

Process changes, replacement of antiquated equipment, preventative maintenance, adequate staffing, and other measures required for high reliability and excellence in process safety all require financial investment. Oil refiners, like BP, are reporting enormous, record breaking profits. Yet in the face of increased earnings, the

Chemical Safety Review Board recently reported that cost-cutting played a major role in undermining process safety in Texas City.[1] Too often, the vast wealth of the refinery industry has remained sequestered from the responsibility to prevent future horrors like that which took place March 23, 2005.

The study findings document that critical process safety deficiencies are endemic within the industry. Preliminary studies about the March 23, 2005 BP Texas City disaster indicate that an extraordinary number of the industry-wide deficiencies found in this study mirror those found at BP.

In order to prevent similar incidents in the future and to provide refinery workers, emergency responders, and surrounding communities with their rightful protection from harm, the USW asserts that the following actions are necessary.

Essential Actions

The USW calls on the refining industry to initiate action immediately on the ten measures listed below. These critical improvements will advance the pursuit of excellence in process safety management and protection of the nation's workers, infrastructure and security. To be fully effective, it is necessary for refineries to work with workers and their local and international union representatives to develop and implement these improvements.

Urgent and Critical Actions

1. **Establish a Process Safety Team as part of the Health and Safety Committee at each refinery**, including representatives selected by the local union, to plan, review, monitor, and audit all process safety activities including the following additional nine essential actions.

   At a minimum, the Process Safety Team must include union-appointed members including, but not limited to: a) Lead Operators, b) one or more maintenance workers, and c) local union health and safety leaders (for example, Process Safety Representatives, Health and Safety Representatives, or Health and Safety Committee members). Process Safety Representatives are envisioned as additional local union health and safety representatives with specific duties related solely to process safety.

   To be effective, management must provide all Process Safety Team members, including union-selected representatives, with training in topics related to process safety management. This training must be sufficient to provide team members with a working knowledge of process safety management concepts, issues, regulations, and standards sufficient for them to carry out their responsibilities on the team. This training should include, but not be limited to, all elements of OSHA's Process Safety Management Standard (1910.119) including pre-start-up (and shutdown) safety review, OSHA's Hazardous Waste Operations and Emergency Response Standard (1910.120), essential actions covered in this section, and other specific topics as needed, such as, how to read piping and instrument diagrams (P&IDs). At a minimum, there must be 160 hours of initial training and 80 hours of advanced and/or refresher training annually. The union shall have the right to select the training for its members on the team.

2. **Ensure that process hazard analyses (PHAs) exist for all potentially hazardous operations and that PHAs are reviewed and revalidated at least every three years.** In addi

tion to engaging the Process Safety Team in this work, working PHA teams must include workers with both experience-based process expertise and knowledge in the specific process hazard analysis methodologies used in the PHA. The teams must also have information and the authority to ensure that all recommendations arising from a PHA are prioritized and receive timely action.

At a minimum, the PHA revalidation process must include: a) a critical review of all underlying assumptions, b) review of all changes since the previous analysis, c) review of relevant incident and near miss histories, d) application of relevant lessons learned, and e) a review of all managed changes (MOCs). Every incident must initiate a review of an existing PHA to determine if there were inadequacies or there are needed improvements. The Process Safety Team or its designees must be involved in all PHA development and revalidation. All action items must be followed to completion in a specified time frame.

3. **Address the four *highly hazardous conditions* associated with the March 23, 2005 BP Texas City disaster:**

   a. **Eliminate all atmospheric vents on process units** that could release untreated explosive, flammable, or toxic materials to the atmosphere. This must include all "blow-down" systems that could release overflows directly to the atmosphere (see CSB recommendaitons[1]).

      As soon as is possible, management must assess all vents for their potential to release directly to the atmosphere and connect all atmospheric vents to systems that treat or control the hazards (such as scrubbers or flares) in order that the vents no longer pose a threat of releasing untreated explosives, flammables, or toxic chemicals directly to the atmosphere.

   b. **Manage instrumentation and alarms** in a manner that ensures that they are sufficient and functional for all anticipated potential conditions and that there are no start-ups without tested and documented functioning of all process instrumentation and alarms (including calibrations and checks of interlocks). The Process Safety Team must oversee this testing and documentation. To this end, it is necessary that the Process Safety Team review all relevant process hazard analyses (PHAs) prior to any planned start-up or shutdown to ensure that instrumentation and alarms are sufficient and functional for all anticipated potential conditions including emergencies.

      There must be redundancy in safety-critical instrumentation.

c. **Create a definition of "safe siting"** that when followed will ensure that refiners locate all trailers or other unprotected buildings in areas that could not expose occupants to harm from explosions, fires, or toxic exposures.[46] Work in creating this definition is currently under way through the American Petroleum Institute.

This recommendation is consistent with that made by the CSB in October 2005[47] In addition to the relocation of trailers and other unprotected buildings, refiners should:

- Immediately cease reliance on American Petroleum Institute's (API) Recommended Practice (RP) 752, Management of Hazards Associated with Location of Process Plant Buildings.[48] As demonstrated by the BP Texas City disaster, this Recommended Practice is inadequate for the establishment of minimum safe distances for trailers or other unprotected buildings. The guidelines to replace this document must be acceptable to all stakeholders including workers and their unions.
- Blast Resistant Modules (BRMs) are not to be used in lieu of trailers such that they would put occupants at risk for injuries or adverse health effects from: a) explosions (possibly resulting in impacts or rollovers), b) fires, or c) exposures to toxic chemicals. For operations personnel, BRMs shall be located only in areas where they will provide protections equal to or greater than those provided by properly designed and situated stationary control rooms.

d. **Ensure that all non-essential personnel are outside of hazardous areas** (vulnerability zones), especially during start-ups, shutdowns, or other unstable operating conditions.

All refineries need to immediately review current policies and implement changes as necessary to ensure that non-essential personnel are outside of hazardous areas where there is any possibility that process malfunctions could expose them to explosions, fires, or toxic exposures. This must include those exposures that could be associated with start-ups, shutdowns, or other unstable process operating conditions. More specifically, all non-essential workers, including maintenance and contract workers, should be documented to be out of hazardous areas prior to start-up.

4. **Develop and implement policies requiring full safety reviews prior to <u>all</u> process start-ups and scheduled shutdowns.** The preexisting OSHA requirement for process safety reviews for start-ups must be expanded to cover shutdowns. In addition, the requirement for such reviews must <u>not</u> be limited to

new or modified processes, that is, reviews must occur for every start-up or scheduled shutdown. (See endnote for items to be included in reviews) [49] All reviews must include the Process Safety Team.

5. **Provide adequate staffing** to ensure safe operation in all potential operating circumstances including day-to-day operations, start-ups, shutdowns, abnormal conditions and upsets, and emergencies. Staffing must ensure that all members of the workforce are able to carry out their work alertly and without adverse health effects. A primary method for achieving adequate staffing must be the filling of all open positions on shift-team rosters. This must include staffing sufficient to prevent position vacancies due to staff reassignments to special projects or to off-unit positions such as unit trainers as well as vacations and anticipated levels for temporary absences due to illness and family emergencies. Safe staffing must include limits on the number of consecutive work days and hours, as agreed upon through negotiations with the union. The USW supports the recommendations of the BP U.S. Refineries Independent Safety Review Panel[6] and the U.S. Chemical Safety Board in relation to staffing and fatigue prevention.[1] Adequate staffing must include each of the following:

    - There must be sufficient staffing, including personnel having special skills and qualifications, to handle process systems in both normal and abnormal circumstances including emergencies. This is especially so for the greater risks involved in start-ups and shut-downs. At a minimum, there should be double staffing for all start-ups and shutdowns. Critical maintenance personnel must be on standby and fire and rescue teams must be alerted for all start-ups and shutdowns.

    - There should be duty limits negotiated with the union that are informed by current research, guidelines and regulations in other industries (for example, aviation, trucking, or railway) related to safety and health, hours of work, and shifts and limits.

    - Contract workers must be strictly limited to those who have demonstrated sufficient knowledge, experience, technical and communication skills, and training to ensure they can effectively contribute to refinery accident prevention. Prior to the hiring of contractors, management must have evidence that such competence exists. Management must only engage full-time employees (rather than contractors) in safety-critical process operations.

- The Process Safety Team must have a say concerning work organization and staffing as they affect process safety. The team must also have a role in monitoring the safety performance of all contract personnel as it pertains to process safety.

Necessary Supporting Actions

6. **Provide effective, participatory worker training and drills** in the areas of: a) process safety management, b) emergency preparedness and response, and c) pre-start-up and shutdown safety reviews. Training must be tailored to meet the needs of both the general plant population and those in specialized process safety roles. Selection and presentation of training must be carried out in conjunction with the union using its nationally recognized model programs. The recommendation is consistent with the BP U.S. Refineries Independent Safety Review Panel's call for the development of process safety knowledge and expertise.[6]

   Participatory process safety-related training and drills for both the general plant population and those in specialized process safety-related roles must include:

   - **Process safety management training and drills** must be sufficient for workers to gain knowledge and skills necessary for them to safely carry out their responsibilities related to process safety. This training must include, but not be limited to, the elements of OSHA's Process Safety Management Standard (1910.119) and other process safety-related subjects covered in this report. At a minimum, there must be 40 hours of initial training and 16 hours of refresher training annually for the general plant population. For Health and Safety Committee members, union officers, and stewards, there should be 80 hours of initial training and 16 hours of refresher training annually. There must be pre-start-up (and shutdown) safety review training and drills for all those who will have roles in these activities or have the potential to affect, or be affected by, these activities.
   - **Emergency preparedness and response training and drills**. At a minimum, there must be 80 hours of initial and 40 hours of annual advanced and/or refresher training for all fire brigade, hazmat team, or other workers with emergency response duties above the OSHA 1910.120 Awareness Level. There must be at least 24 hours of initial training and eight hours of refresher training annually for the general plant population.

Training listed above for Process Safety Team members may be used to satisfy these training requirements.

7. **Ensure that all operating manuals and procedures are in optimum working order**, that is, in writing, up-to-date, understandable, functional, available and properly used for the safe operation of all processes. The manuals and procedures must cover normal, abnormal, upset, and emergency operating conditions, shut-downs and start-ups.[50]

   Management must ensure that written operating procedures for the safe operation of all processes are available and followed. This must be so in regard to both normal and abnormal operating conditions as well as emergencies. The operating procedures must be understandable and functional and must include limits for process variables and abnormal situation management (ASM) (e.g., actions required when there are instrumentation failures, abnormal readings, or other unforeseen circumstances, including emergency shutdowns). Operating procedures must include variance protocols and procedures for any deviations, including management of change procedures as well as when to request an updated hazard analysis.[24]

   - A team of operators, maintenance staff, and others with roles in the process must be involved in the periodic review and modification of all procedures. Procedures must be kept up-to-date and take into account any significant changes in plant design, operation, near misses or incidents experienced in the process in question, or lessons learned from similar operations.
   - All those involved in the oversight or execution of the procedures must receive initial and periodic training, including simulations, sufficient to ensure that they can play required roles in the procedures. This is consistent with the CSB recommendation on training.[1] The training and simulations must emphasize safety critical factors, especially as they relate to prevention of releases of hazardous chemicals, fires, and explosions. Training must also include operations during abnormal conditions, emergency operations, protection of personnel, and any modifications to the process or procedures. Those trained must also have a role in identifying and addressing weaknesses in procedures and in establishing their practicality.

8. **Review and update management of change (MOC) procedures** (including organizational, personnel, and process changes) to ensure that these procedures meet the requirements of OSHA 1910.119 and recommendations of the U.S.

9. Chemical Safety Board[1, 24] including that the Center for Chemical Process Safety issue new MOC guidelines. The Process Safety Team or its designees must be involved in all MOCs.

10. **Implement an effective incident and near miss investigation program at each site** that involves workers and their unions in all phases of investigation and recommendations for improvement. The USW's Triangle of Prevention (TOP) Program is a model in operation at 15 U.S. refineries and nine other petrochemical facilities. (See Appendix A, Description of the USW Triangle of Prevention (TOP) Initiative)

    The Process Safety Team must be involved in investigating all incidents and near- misses including identified process safety hazards. The investigation program needs to include root cause analysis, recommendations for correcting identified causes using a hierarchical safety systems approach, tracking of corrections to completion, and dissemination of findings including all lessons learned. The metrics driving this program must be actual improvements made and hazards eliminated or diminished rather than recommendations or activities.

11. **Develop and implement a national set of standardized process safety metrics and benchmarks** to assess leading and lagging indicators of process safety that can help ensure that sites are able to identify and correct deficiencies and improve programs, thereby preventing process safety incidents. Workers and their unions should play a major role in both development and implementation of these metrics.

    Metrics systems to assess leading and lagging indicators of process safety should be consistent with initiatives by the United Kingdom's Health and Safety Executive[51] and the Center for Chemical Process Safety (CCPS)[52] as well as the recommendations of the BP U.S. Refineries Independent Safety Review Panel[6] and the U.S. Chemical Safety Board.[1] The systems of metrics and benchmarks must emphasize process safety performance indicators rather than those focused on personal injuries, and leading indicators of process safety performance above lagging ones. The process safety metrics must be used as tools to drive performance. The CSB has requested that the National Academy of Sciences convene a panel to consider such metrics. Preliminary work is also being done under the auspices of the Center for Chemical Process Safety.

The USW also supports recommendations made by the U.S. Chemical Safety and Hazards Investigation Board (CSB) for BP in its March 2007 report.[1] These recommendations must be reviewed and adopted as needed by every North American refinery.

The potential for management to join labor in identifying and acting to solve process safety problems is evidenced by a 2007 joint initiative between the United Steelworkers and BP.[53] This initiative, consistent with CSB recommendations, expresses a commitment "to ensure the safest possible conditions for BP employees and neighbors of BP facilities" and is "based in part on the findings and recommendations of the BP US Refineries Independent Safety Review Panel, the preliminary reports of the U.S. Chemical Safety and Hazard Investigation Board, BP's own investigations, and the experience of the USW." The initiative addresses the immediate causes of the Texas City tragedy, the formation of process safety teams, accident and near-miss investigation, review of safe operating procedures, health and safety education, staffing and reasonable work hours, operator leadership, maintenance, teamwork, environmental protection for corporate neighbors and additional measures as identified. The USW asserts that these essential actions build on existing reports and will strengthen their recommendations. (See a copy of the United Steelworkers and BP agreement in Appendix B) This agreement is also consistent with the recommendations of the BP U.S. Refineries Independent Safety Review Panel[6] (Baker Panel) calling for process safety leadership.

Further, the USW concurs with the Baker Panel regarding the need for leadership in process safety, an integrated and comprehensive process safety management system, process safety audit systems, and process safety culture.[6] It must be noted that the union, by necessity of its nature and mission, will have unique aspects to its perspective on these issues.

Appendix A.
Description of the USW Triangle of Prevention (TOP) Initiative

USW Triangle of Prevention Initiative—TOP

The United Steel Workers, through the USW Triangle of Prevention (TOP) Initiative, has proven that workers and their unions are critical partners in identifying and controlling workplace hazards. They do this as full participants in designing, developing, evaluating and maintaining TOP as a vital component of plant health, safety and environment.

The TOP Initiative seeks to identify and dismantle barriers to identifying and controlling workplace hazards. It does this by directly confronting two of the most serious obstacles: first, the blame culture that surrounds accident and near-miss reporting; and second, the lack of worker-friendly methodologies (tools) and training for uncovering and reporting workplace hazards.

TOP's approach incorporates a hierarchy of "systems of safety" for prevention. The Initiative uses the systems of safety hierarchy for identifying both failures and solutions affecting workplace health, safety and environment issues. The hierarchy begins at the highest level with 1) design and engineering, followed in descending order by, 2) maintenance and inspection, 3) mitigation, 4) warnings, 5) training and procedures, and 6) personal protective factors. Identifying and correcting hazards before accidents occur is the key to any health and safety program. The systems of safety approach accomplishes this by incorporating fundamental concepts and applying them to the practical, everyday operations in the workplace.

Within TOP, labor and management jointly use a rule-based investigation methodology based on logic tree diagramming to find root causes and systems failures. Investigation teams use this methodology to investigate all incidents and near misses at the worksite. After determining the root causes, the team develops recommendations for corrective actions using the hierarchical systems approach and tracks them to completion.

Every investigation provides the opportunity to learn. By applying solutions not only to the hazards investigated, but also to all similar conditions in the facility. TOP promotes continuous learning and improvement. The Initiative is designed so that every investigation has the potential to leverage improvements in other areas of the facility. Further, through its lessons learned component, TOP transmits these lessons to health and safety committees both within and across plants. Accordingly, employees at other sites and the USW International Union Health, Safety and Environment Department often learn from the information. TOP uses mini-training sessions, bulletin boards, tool-box safety meetings, personal testimony and more to transmit the lessons to everyone in a plant. Lessons learned may be shared with concerned parties outside the corporation, by mutual consent of the union and employer.

For too long the only metrics used to assess safety in the refining industry have been those related to "Personal Safety," e.g., the OSHA 300 Log. The refining industry has not developed or used effective metrics for "Process Safety." To solve this problem, the USW developed as part of TOP a broader index that measures injuries to people, harm to the environment and damage to equipment. The index also includes the ratio of completed versus uncompleted action items to indicate the efficiency of their implementation. The combination of these measurements yields a more accurate indication of the "health" of each site's health, safety, and environmental programs.

Appendix B.
USW BP Joint Initiative on Health and Safety

USW BP Joint Initiative on Health and Safety

BP and the United Steelworkers are determined to ensure the safest possible conditions for BP employees and neighbors of BP Refineries. To that end, BP will work with USW on a joint safety initiative, based in part on the findings and recommendations of the BP US Refineries Independent Safety Review Panel, the preliminary reports of the U.S. Chemical Safety and Hazard Investigation Board, BP's own investigations, and the experience of the USW.

1. BP will promptly address the immediate causes of the Texas City tragedy, throughout the corporation.
2. BP and the USW will establish joint process safety teams.
3. BP and the USW will establish a joint program for accident and near-miss investigations, and for reviewing safe operating procedures.
4. BP and the USW will work together to upgrade safety education programs.
5. BP will ensure that its facilities are adequately staffed and that employees have reasonable hours of work.
6. The Chief Operator position will be reestablished where it does not now exist, so long as it enhances safety in the refineries.
7. BP will ensure adequate internal maintenance forces.
8. BP will work with the USW and appropriate community officials and organizations to ensure that the corporation is a good environmental neighbor.
9. BP and the USW will define and ensure we have effective teamwork in the refineries.
10. BP and the USW will establish a structure for implementing and overseeing this initiative.

This is an agreement in principle; many details remain to be determined, and additional measures may be added later.

Appendix C.
USW Refinery Survey Questionnaire

USW Survey on Refinery Accident Prevention

Based on the Catastrophe at BP's Texas City Refinery March 23, 2005

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Preliminary Findings from the BP Texas City Disaster

On March 23, 2005 fires and explosions at BP's Texas City refinery killed 15 workers and injured over 170 others. Preliminary findings from the investigation of the disaster suggest that four factors played a major role in the isomerization unit explosions.

1. **A vent stack on a blow-down system.** The company used a vent stack on a blow-down system to relieve a build-up of pressure on a process unit. This vent system released flammable and explosive liquids and vapors directly to the atmosphere. This type of vent system is out-of-date and not as safe as systems that send materials to flares or other systems that contain and neutralize hazards.

2. **Management of instrumentation and alarm systems.** Key management systems were not working effectively. This allowed system indicators and alarms to malfunction and provide operators with faulty information.

3. **The safe siting of trailers.** The company sited trailers near a processing unit where workers were exposed to the release of hazardous materials, fires and explosions.

4. **Non-essential personnel.** The company started-up a processing unit containing flammable and explosive materials while non-essential personnel were in the area.

About This Survey

The questions in this survey focus on these and other safety and health systems at your worksite. We are sending this survey to all USW refinery locals. USW will use this information to:

a) assess the health and safety needs of refineries,

b) develop health and safety programs to meet those needs, and

c) provide information to organizations that may be able to affect refinery health and safety such as the U.S. Chemical Safety Board (CSB).

USW will group data from all sites together before it presents them in reports. While the Health and Safety Department may review and use data from individual sites, we will not identify any individual site data in the study reports we write.

If your local represents workers at more than one refinery, we need your local to **complete a separate questionnaire for each refinery**.

When answering the questions please make your marks dark and clear when selecting your choice. See the following example:

Yes	**No**
●	O

Section 1: Atmospheric Venting of Toxic or Hazardous Materials on Process Units

In this survey, when we say, "atmospheric vents,'' we mean:
- only vents on process units (not those on tank farm vessels)
- atmospheric vent stacks on blow-down systems, or
- other vent systems that could release untreated flammable, explosive, reactive, toxic or otherwise hazardous materials directly to the atmosphere.

1. Does your facility **use these types of atmospheric vents** (see note above)? Please mark one.

Yes	No	Don't Know
O	O	O

If you answered, **"No"** or **"Don't Know,"** please **skip to Section 2** on page 4.

If you answered, **"Yes,"** please **continue with question 2** below.

2. a. How many of these types of atmospheric vents are there at your worksite? Please mark one.

1 to 10	11 to 20	21 to 30	31 or more
O	O	O	O

b. In the box below, please **list the types of process units** at your worksite **that have these types of atmospheric vents**. If you need more space, use the back of this page and write "2. b." next to your response.

3. a. Since March 23, 2005 when the BP Texas City refinery exploded, **has the company at your site taken action** to replace atmospheric vents with safer venting systems? Please mark one.

Yes	**No**	**Don't Know**
O	O	O

If you answered, **"No"** or **"Don't Know,"** please **skip to Section 2** on page 4.

If you answered, **"Yes,"** please **continue with part b** of this question below**.**

b. In the box below, please **describe the company's actions** to replace atmospheric vents with safer venting systems. If you need more space, use the back of this page and write "3. b." next to your response.

c. Please think about the actions your company has taken at your worksite since the March 23, 2005 explosion at the BP Texas City refinery. **Overall, how effective have the company's actions been** in preventing a catastrophic event involving atmospheric vents?

Very effective	**Somewhat effective**	**Somewhat ineffective**	**Very ineffective**	**Don't know**
O	O	O	O	O

Section 2: Management of Instrumentation and Alarm Systems

4. **a.** Again, we are asking about company actions since the March 23, 2005 catastrophe at the BP Texas City refinery. In this question, we want to know about all instrumentation, including level indicators and alarms that would signal any abnormal or emergency conditions during process start-ups or shut-downs. **Has the company acted** to ensure that all instrumentation will function properly (that is, it has been inspected, maintained and tested)? Please mark one.

Yes	**No**	**Don't Know**
O	O	O

If you answered, **"No"** or **"Don't Know,"** please **skip to Section 3** on the next page.

If you answered, **"Yes,"** please **continue with part b** on this page.

b. Using the box below, please **describe the company's actions** since March 23, 2005 to improve the management of all instrumentation for start-ups and shut-downs, including level indicators and alarms. If you need more space, use the back of this page and write "4. b." next to your response.

c. Think about the actions your company has taken at your worksite since the March 23, 2005 explosion at the BP Texas City refinery. **Overall, how effective have the company's actions been** in ensuring that instrumentation will provide for safe start-ups and shut-downs? Please mark one.

Very effective	**Somewhat effective**	**Somewhat <u>in</u>effective**	**Very <u>in</u>effective**	**Don't know**
O	O	O	O	O

Section 3: Improper Siting of Trailers or Other Unprotected Buildings

In this survey, when we say, "trailers or other unprotected buildings inside potentially hazardous areas,'' we mean:

- those buildings where people work, meet or congregate, and
- siting of buildings in high hazard or vulnerability zones where occupants could be exposed to fires, explosions or releases of toxic or hazardous materials.

5. Does the company have **formal written policies** prohibiting the siting of trailers or other unprotected buildings inside potentially hazardous areas**?**

Yes	**No**	**Don't Know**
O	O	O

6. **In the past three years**, has the company **placed trailers or other unprotected buildings inside potentially hazardous areas**?

Yes	**No**	**Don't Know**
O	O	O

If you answered, **"No"** or **"Don't Know,"** please **skip to Section 4** on page 8.

If you answered, **"Yes,"** please **continue with question 7** on the next page.

7. For this question, again think about the past three years. Please use the lines below to **describe the following:**

- approximate number of trailers or other unprotected buildings the company placed inside potentially hazardous areas
- locations where the company placed these trailers or other unprotected buildings, and
- potential hazards and processes involved.

If you need more space, use the lower part of this page.

Trailers or Other Unprotected Buildings

Approximate Number	**Locations on Plant Site**	**Processes and Potential Hazards**
________	____________________	________________________________
________	____________________	________________________________
________	____________________	________________________________
________	____________________	________________________________
________	____________________	________________________________
________	____________________	________________________________
________	____________________	________________________________

8. **a.** Since the March 23, 2005 when the BP Texas City refinery exploded, **has the company taken action** to prevent a similar catastrophe by moving trailers or other unprotected buildings outside of potentially hazardous areas? Please mark one.

Yes	**No**	**Don't Know**
O	O	O

If you answered, **"No"** or **"Don't Know,"** please **skip to Section 4** on the next page.

If you answered, **"Yes,"** please **continue with part b** of this question below.

b. Using the box below, please **describe the company's actions** since March 23, 2005 to move trailers or other unprotected buildings outside potentially hazardous areas. If you need more space, use the back of this page and write "8. b." next to your response.

c. Think about the actions your company has taken at your worksite since the March 23, 2005 explosion at the BP Texas City refinery. **Overall, how effective have the company's actions been** in protecting workers in trailers or other unprotected buildings? Please mark one.

Very effective	**Somewhat effective**	**Somewhat <u>in</u>effective**	**Very <u>in</u>effective**	**Don't know**
O	O	O	O	O

Section 4: Non-Essential Personnel in Potentially Hazardous Areas During Process Start-Up or Shutdown

9. Does the company have **formal written policies regarding the presence of non-essential personnel** in areas where they could be vulnerable to a toxic or hazardous materials release, fire or explosion during a process start-up or shutdown?

Yes	**No**	**Don't Know**
O	O	O

10. In the past three years, has your site **engaged in process start-ups or shutdowns where non-essential personnel were in areas vulnerable** to a toxic or hazardous materials release, fire or explosion?

Yes	**No**	**Don't Know**
O	O	O

If you answered, **"No"** or **"Don't Know,"** please **skip to Section 5** on page 10.

If you answered, **"Yes,"** please **continue with the next question** below.

11. a. Since the March 23, 2005 BP Texas City refinery explosion, **has the company taken action** to ensure that all non-essential personnel are at a safe distance during a process start-up or shutdown of hazardous operating units? Please mark one.

Yes	**No**	**Don't Know**
O	O	O

If you answered, **"No"** or **"Don't Know,"** please **skip to Section 5** on page 10.

If you answered, **"Yes,"** please **continue by answering part b** of this question below.

b. Using the box below, please **describe the actions the company has taken** since March 23, 2005 BP explosion to ensure that all non-essential personnel are at a safe distance during a start-up or shutdown of hazardous operating units. If you need more space, use the back of this page and write "11.b." next to your response.

c. Think about the actions the company has taken at your worksite since the March 23, 2005 explosion at the BP Texas City refinery. **Overall, how effective have the company's actions been** in protecting non-essential personnel in areas near hazardous operating units during their start-up or shutdown? Please mark one.

Very effective	**Somewhat effective**	**Somewhat <u>in</u>effective**	**Very <u>in</u>effective**	**Don't Know**
O	O	O	O	O

Section 5: Working on the Issues Covered In This Survey

Please keep the following in mind for the next two questions.

When we say, "local union," we mean members of the executive board, health and safety committee, health and safety representatives, shop stewards, etc.

When we say, "issues covered in this survey," we mean:

1. Use of a vent stacks on blow-down systems or other vent systems that could release untreated hazardous materials directly to the atmosphere (on process units only).
2. Management of instrumentation and alarm systems for start-up and shut-down.
3. Having trailers or other unprotected buildings near a processing unit where workers could be exposed to the release of hazardous materials, fires and explosions.
4. Allowing non-essential personnel to be in an area during the start-up of a processing unit containing highly hazardous materials.

12. a. Since the March 23, 2005 BP Texas City refinery explosion, has the **company taken the initiative to work with the local union** regarding the company's plans or actions related to the issues covered in this survey. For example has the company: informed the local union, involved the local union in assessing the problems, or involved the local union in making recommendations to solve the problems?

Yes O

No O

If you answered, **"No,"** please **skip to question 13** on the next page.

If you answered, **"Yes,"** please **continue with part b of this question** below.

b. Please use the box below to **describe the company initiatives to work with the local union on issues covered in this survey**. If you need more space, use the back of this page and write "12. b." next to your response.

13. a. Since the March 23, 2005 BP Texas City refinery explosion, has the **local union initiated action** to try to get the company to improve policies, training, procedures or conditions regarding the issues covered in this survey?

Yes O

No O

If you answered, **"No,"** please **skip to question 14** below on this page.

If you answered, **"Yes,"** please **continue with part b** of this question below.

b. Please use the box below to **describe the actions the local union initiated**. If you need more space, use the back of this page and write "13.b." next to your response.

14. Now we want to know about the **use of union workers to lead or direct work on process units** at your facility. If union workers are in these roles, they may have the job titles of head operator, chief operator, lead operator, Stillman, or some other title.

Please indicate the practice at your facility regarding the use of union workers to lead or direct work on process units? **Please check only one response choice** that best fits your experience.

O Union workers currently lead or direct work on process units.

O Union workers previously led or directed work on process units, but these positions were discontinued in the year _______.

O Union workers have never led or directed work on process units.

O Other. Please explain: ____

____

15. a. Since the March 23, 2005 BP Texas City refinery explosion, **approximately what percentage of the workforce at your worksite has the company trained** about preventing a catastrophic event involving the issues covered in this survey? Please indicate the approximate percentage below. If none, write "0%."

Training Issue	**Approximate % trained**	**Don't Know**
I. Use of atmospheric vents	______ %	O
II. Management of instrumentation and alarm systems	______ %	O
III. Trailers of other unprotected buildings near processing units	______ %	O
IV. Allowing non-essential personnel in hazardous area during start-up or shutdown	______ %	O

If you wrote, **"0%,"** or chose, **"Don't Know"** <u>**for all four issues,**</u> please **skip to question 16** below on this page. **Otherwise, continue with part b** of this question.

b. Please use the box below to **describe the training** the company conducted about preventing a catastrophic event involving the issues covered in this survey. Include **who was trained** and on **what subjects**. If you need more space, use the back of this page and write "15. b." next to your response.

16. Do members of the **bargaining unit need additional training** on the issues listed below?

Need training on issues?	**Yes**	**No**	**Don't Know**
I. Use of atmospheric vents	O	O	O
II. Management of instrumentation and alarm systems	O	O	O
III. Trailers of other unprotected buildings near processing units	O	O	O
IV. Allowing non-essential personnel in hazardous areas during start-up or shutdown	O	O	O

17. a. In the past three years, has your worksite had **any incidents or near misses involving issues covered in this survey**?

Any incidents or near misses in past three years?	**Yes**	**No**	**Don't Know**
I. Use of atmospheric vents	O	O	O
II. Management of instrumentation and alarm systems	O	O	O
III. Trailers of other unprotected buildings near processing units	O	O	O
IV. Allowing non-essential personnel in hazardous areas during start-up or shutdown	O	O	O

If you answered, **"No"** or **"Don't Know" to <u>all four parts</u>**, please **skip to Section 6** on the next page.

If you answered, **"Yes" <u>to any part</u>**, please **continue with part b of this question** below.

b. In the box below, please **describe any incidents or near misses** at your worksite **in the past three years** involving the issues covered in this survey that could have or did create a catastrophic event. Please include:

- **issue involved** (for example, vents, unprotected buildings or non-essential personnel in hazardous areas during start-up of shut-down)
- **number of people** involved (or potentially involved)
- **process units and chemicals**
- **types and sizes of releases** (or what was nearly released)
- **number and types of injuries** (or potential injuries)
- **other important details**, such as, investigations, results, company or union actions.

If you need more space, use the back of this page and write "17. b." next to your response.

Section 6: Emergency Preparedness and Response

18. a. Since the March 23, 2005 explosion at the BP Texas City refinery, **has the company taken actions** to improve your worksite's **preparedness to respond** safely to serious hazardous materials incidents or emergencies? Please mark one.

Yes	**No**	**Don't Know**
O	O	O

If you answered, **"No"** or **"Don't Know,"** please **skip to question 19** on the next page.

If you answered, **"Yes,"** please **continue with part b** below.

b. Using the box below, please **describe the company's actions** since March 23, 2005 to improve emergency preparedness and response. If you need more space, use the back of this page and write "18. b." next to your response.

c. How effective have the actions taken by the company been in improving your worksite's emergency preparedness and response? Please mark one.

Very effective	**Somewhat effective**	**Somewhat <u>in</u>effective**	**Very <u>in</u>effective**	**Don't Know**
O	O	O	O	O

19. This question is about **emergency response training**. Each worker should have a designated role in emergency response. Those roles may include reporting an incident, safely exiting the plant, or serving on a emergency response team, hazmat team or fire brigade. Each worker should receive **training appropriate to his or her role**.

Thinking now about the past 12 months, have workers at your site received **training on responding safely to serious hazardous materials incidents or emergencies**? Please **mark all that apply**.

Did group receive emergency response training in last 12 months?	**Yes**	**No**	**Don't Know**
Emergency response team, hazmat team or fire brigade	O	O	O
General plant population	O	O	O
Other group. Please specify: ______________________	O		
Other group. Please specify: ______________________	O		

20. Thinking about the workforce overall, **how confident are you that the workforce has received the training it needs** to respond safely to serious hazardous materials incidents or emergencies? Please mark one.

Very confident	**Somewhat confident**	**Somewhat <u>un</u>confident**	**Very <u>un</u>confident**
O	O	O	O

21. Overall, **how well prepared is your worksite to respond safely** to a serious hazardous materials incident or emergency? Please mark one.

Very prepared	**Somewhat prepared**	**Somewhat <u>un</u>prepared**	**Very <u>un</u>prepared**
O	O	O	O

Section 7: Process Safety Management Systems

22. The following series asks about the effectiveness of a range of **safety systems to prevent or respond** to a toxic or hazardous materials release, fire or explosion. **Thinking just about process start-ups and shutdowns, overall, how effective is each system** listed below?

Effectiveness of safety systems for process start-ups and shut-downs

Process Safety Management Systems	Very effective	Somewhat effective	Somewhat ineffective	Very ineffective	Don't know
a. **Design and engineering** (equipment, processes, software, instrumentation, etc.)	O	O	O	O	O
b. **Work organization and staffing levels**	O	O	O	O	O
c. **Managing the change of systems** (equipment, materials, processes, personnel, etc.)	O	O	O	O	O
d. **Inspection and testing**	O	O	O	O	O
e. **Relief and check valve systems**	O	O	O	O	O
f. **Systems for containing hazardous materials**	O	O	O	O	O
g. **Emergency shutdown and isolation systems**	O	O	O	O	O
h. **Fire and chemical suppression systems**	O	O	O	O	O
i. **Monitoring, and measurement systems** (temperature, pressure, volume, flow, level, etc)	O	O	O	O	O
j. **Alarm and notification systems**	O	O	O	O	O

Effectiveness of safety systems for process start-ups and shut-downs

Process Safety Management Systems	Very effective	Somewhat effective	Somewhat ineffective	Very ineffective	Don't know
k. **Process Hazard Analyses (PHAs)** (providing needed information for other safety systems)	O	O	O	O	O
l. **Operating manuals and procedures**	O	O	O	O	O
m. **Training**	O	O	O	O	O
n. **Emergency preparedness and response**	O	O	O	O	O
o. **Communication systems within the plant**	O	O	O	O	O
p. **Communication systems for outside the plant** (communities, emergency agencies, hospitals, etc.)	O	O	O	O	O

23. This question is about the overall **management of process safety systems** at your facility. These safety systems include design and engineering, maintenance and inspection, mitigation devices, warning devices, training and procedures, and personal protective factors. **Overall, how effective is the management of process safety systems** at your facility.

Very effective	Somewhat effective	Somewhat ineffective	Very ineffective
O	O	O	O

Section 8: Contract Workers

24. Approximately, what percentage of the workforce at your site that conducts either **routine maintenance** or **turnarounds and overhauls** fits into the following four categories?

- **a. contract** employees who are not members of a union
- **b. contract** employees who are members of a union other than USW
- **c. company** employees who are USW members, or
- **d. company** employees who are members of a union other than USW

Please indicate the approximate percentages below. If none for any category, write "0%." The percentages for each category going across should add up to 100%. Please tell us about any exceptions on the back side of this sheet and write "24" next to your response.

	Contract Employees		Company Employees		
	Other union	Not union	USW members	Other union	
Example	10 %	10 %	75 %	5 %	= 100%
Routine Maintenance Workers	_____ %	_____ %	_____ %	_____ %	= 100%
Turnaround or Overhaul Workers	_____ %	_____ %	_____ %	_____ %	= 100%

25. In this question, we want you to consider four groups of workers who may be at your work-site. **How well prepared** is each of the groups of workers listed below **to help prevent hazardous materials incidents**? Please mark one for each group.

	Very prepared	Somewhat prepared	Somewhat unprepared	Very unprepared	Don't Know	Does not apply
Routine maintenance workers						
Contract employees	O	O	O	O	O	O
Company employees	O	O	O	O	O	O
Turnaround or over-haul workers						
Contract employees	O	O	O	O	O	O
Company employees	O	O	O	O	O	O

Section 9: Background Information

26. What is your USW local union number? _____________

27. What is the name of the company that operates the plant where you work?

____

28. Please list the location of your worksite. City: __________________________ State: ____

29. Please use the box below to list the major products at your refinery?

30. What is the size of the workforce at your worksite? Please mark one.

O	O	O	O
0-99	100-499	500-999	1,000+

Thank you for completing this survey!

References

[1] U.S. Chemical Safety and Hazard Investigation Board (CSB). 2007. Investigation Report: Refinery Explosion and Fire (15 Killed, 180 Injured). BP, Texas City, Texas, March 23, 2005. Washington, D.C.: CSB. March 2007.

[2] OSHA. 2005. OSHA Fines BP Products North America More Than $21 Million Following Texas City Explosion. September 22, 2005. http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=NEWS_RELEASES&p_id=11589

[3] CSB. 2006. CSB Investigation of BP Texas City Refinery Disaster Continues as Organizational Issues Are Probed. Washington, D.C.: CSB. October 30.

[4] The CSB's findings from its investigation of the 2005 BP Texas City disaster specifically identified among causes the presence of a blowdown drum that released flammable, explosive, and toxic materials directly to the atmosphere. In its October 31, 2006 recommendations it noted, "A properly designed flare system would safely contain discharged liquid in a disposal drum and burn flammable vapor preventing a hazardous release to atmosphere. Flares are the most frequently used disposal control equipment in the oil refining industry." (p.1) Further, its October 31, 2006 recommendations on blowdown drums called for the American Petroleum Institute (API) to "change its Recommended Practice 521, Guide for Pressure Relieving and Depressurizing Systems, to end the practice of using these devices without inherently safe flare systems. Still further it noted, "OSHA publishes PSM Compliance Guidelines that establish procedures for the enforcement of the standard. These guidelines call for inspections to ensure that 'destruct systems such as flares are in place and operating' and 'pressure relieve valves and rupture disks are properly designed and discharge to a safe area.'"

See: CSB. 2005. CSB Issues Preliminary Findings in BP Texas City Refinery Accident; Investigators Present Data in Public Meeting. Washington, D.C.: CSB. October 27.

CSB. 2006. CSB's Safety Recommendations on Blowdown Drums to the American Petroleum Institute and OSHA. Houston, Texas, October 31, 2006. http://www.csb.gov/news_releases/docs/API-OSHA_Recommendation.pdf

[5] CSB. 2006. News conference statements Carolyn Merritt, Chairman, U.S. Chemical Safety Board. October 31, 2006. Washington, D.C.

[6] Baker J. et al. 2007. The Report of The BP U.S. Refineries Independent Safety Review Panel. http://www.safetyreviewpanel.com/. January 30, 2007.

[7] U.S. Department of Labor (DOL). 1990. Phillips 66 Houston Chemical Complex Explosion and Fire: Implications for Safety and Health in the Petrochemical Industry. Washington, D.C.: US DOL, OSHA.

[8] Belke J. 2000. U.S. Environmental Protection Agency. "Chemical accident risks in U.S. industry: A preliminary analysis of accident risk data from U.S. hazardous facilities." September 25, 2000.

[9] Key landmines on this trail of process safety disasters include those at BP Flixborough, UK (1974); Industrie Chimiche Meda Societa Azionaria, Seveso, Italy (1976); Union Carbide in Bhopal, India (1984) and Institute, West Virginia (1985); and Phillips 66 in Texas (1989).
See: Health and Safety Executive (HSE). 2006. Flixborough (Nypro UK) Explosion 1st June 1974. http://www.hse.gov.uk/comah/sragtech/caseflixboroug74.htm. Health and Safety Executive (HSE). 2006. Icmesa chemical company, Seveso, Italy. 9th July 1976. http://www.hse.gov.uk/comah/sragtech/caseseveso76.htm. Health and Safety Executive (HSE). 2006. Union Carbide India Ltd, Bhopal, India. 3rd December 1984. http://www.hse.gov.uk/comah/sragtech/caseuncarbide84.htm. United Press International. 1985. OSHA cites Union Carbide with neglecting safety policy. Houston Chronicle, October 1, 1985.

[10] OSHA (Occupational Safety and Health Administration). 1994. Hazardous Waste Operations and Emergency Response. Final Rule. 29 CFR 1910.120. Federal Register, August 22, 1994 (59 FR 43268).

[11] OSHA (Occupational Safety and Health Administration). 1992. Process Safety Management of Highly Hazardous Chemicals. 29 CFR 1910.119. Fed Reg 57:6403.

[12] EPA. 1996. Accidental Release Prevention Requirements: Risk Management Programs Under the Clean Air Act, Section 112(r)(7), 40 CFR Part 68, Final Rules and Notice, 61 FR 31668, June 20, 1996.

[13] These include: Organisation for Economic Co-operation and Development's (OECD's)* Guiding Principles for Chemical Accident Prevention, Preparedness and Response and its related Guidance on Safety Performance Indicators, and European Seveso Directive II and its related Guidelines on a Major Accident Prevention Policy and Management Systems. More generally, the American National Standards Institute/American Industrial Hygiene Association (ANSI/AIHA) standard on Occupational Health and Safety Management Systems and the International Labour Organisation's (ILO's) Guidelines on Occupational Health and Safety Management Systems provide additional, broader guidance.

*The OECD is an international organization of 30 developed countries including the U.S. that "produces internationally agreed instruments, decisions and recommendations to promote rules of the game in areas where multilateral agreement is necessary for individual countries to make progress in a globalised economy," using, "dialogue, consensus, peer review and pressure." (http://www.oecd.org/about/0,2337,en_2649_201185 _1_1_1_1_1,00.html)

See:

OECD. 2003. OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response: Guidance for Industry (including Management and Labour), Public Authorities, Communities, and other Stakeholders (Second Edition). Paris, France: OECD Environmental, Health and Safety Publications.

OECD. 2005. Guidance on Safety Performance Indicators: Guidance for Industry, Public Authorities and Communities for Developing SPI Programmes related to Chemical Accident Prevention, Preparedness and Response. Paris, France: OECD Environmental, Health and Safety Publications.

Council Directive of 9 December 1996, On The Control Of Major-Accident Hazards Involving Dangerous Substances, (96/82/EC) Official Journal of the European Communities No L 10, 14.1.1997, pp. 13-33.

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[15] CSB. 2005. CSB Issues Preliminary Findings in BP Texas City Refinery Accident; Investigators Present Data in Public Meeting. Washington, D.C.: CSB. October 27.

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[20] EPA and OSHA. 1998. EPA/OSHA Joint Chemical Accident Investigation Report – Shell Chemical Company, Deer Park, Texas. EPA 550-R-98-005, U.S. Environmental Protection Agency.

[21] Health and Safety Executive (HSE). 2003. Major Incident Report Investigation, BP Grangemouth Scotland. Health and Safety Executive, London, August 18, 2003. The United Kingdom's Health and Safety Executive is the functional equivalent of U.S. OSHA.

[22] The OSHA/EPA 1998 report recommended that:

> The Shell Chemical Company and other companies that process flammable gases and volatile flammable liquids or liquefied gases must implement precautionary measures contained in OSHA's PSM standard and EPA's RMP rule to prevent flammable gas leaks from resulting in vapor cloud explosions. (p. v)
>
> Lessons learned from prior incidents involving [similar] … check valves … were not adequately identified, shared, and implemented. This prevented recognition and correction of the valve's design and manufacturing flaws … prior to the accident. (p. iii)
>
> The process hazards analysis (PHA) … was inadequate; the PHA did not identify the risks …, and consequently no steps were taken to mitigate those risks. (p. iii)

[23] EPA. 1998b. EPA Chemical Accident Investigation Report: Tosco Avon Refinery, Martinez, California. United Stated Environmental Protection Agency, Office of Solid Waste and Emergency Response (5104). EPA 550-R-98-009. November 1998.

[24] CSB. 2001. Management of Change. U.S. Chemical Safety and Hazard Investigation Board Safety Bulletin. No. 2001-04-SB, August 2001

[25] EPA's 1998 Tosco report recommended:

> Facilities should maintain equipment integrity and discontinue operation if integrity is compromised. (p. x)
>
> Industry in general, should examine the process parameters that are critical to safe operation and consider redundant instrumentation as a backup in case of instrument malfunction.
>
> Other industries should examine their process monitoring and control instrumentation to ensure that in emergency or upset situations, control room operators are appropriately notified of the status of critical parameters so the operator can take necessary steps to correct the situation. Safety critical alarms should be distinguished from other operational alarms. Alarms should be limited to the number that an operator can effectively monitor. However, ultimate plant safety should not solely rely on operator response to a control system alarm. (p. 72)

[26] The 2001 CSB report noted:

> Had the limitations of temperature-sensing devices been better understood, personnel may have realized that the low temperature readings were not representative of the hot core. It was assumed that the entire drum contents had cooled to safe levels …. (pp. 2-3)

[27] The 2003 HSE report recommended:

> The emergency shutdown of the 'light ends' section of the FCCU … (in particular the following): a) Installation of remotely operated shut-off valves (ROSOVs) to allow rapid remote isolation of significant process inventories in order to minimise the consequences of an uncontrolled leak and allow remote emergency shutdown of ancillary equipment, such as pumps. b) Safe means for emergency depressurisation of columns or vessels, where reasonably practicable. (p. 53)

[28] EPA. 1998a. EPA Chemical Accident Investigation Report: Pennzoil Product Company Refinery Rouseville, Pennsylvania. United States Environmental Protection Agency, Office of Solid Waste and Emergency Response (5104), EPA 550-R-98-001, March 1998.

[29] The 1998 EPA Tosco report recommendations included the statement:

> Facilities should use hazard assessment techniques to address the hazards associated with vehicular access and location of temporary work trailers in the vicinity of storage vessels. (p. iii)

[30] The EPA in its Pennzoil report recommended the following related to facility siting:

> PHA techniques can be used to evaluate the hazards associated with siting of equipment and work areas. Pennzoil and the other facilities can make use of these techniques in combination with industry codes and standards and regulatory requirements, to ensure that vehicular traffic is restricted from areas containing flammable materials, that work locations are properly evalu-

ated and isolated from potential process hazards and that these work locations do not impose hazards on the process (ignition sources). Further, accident history, the potential for leaks, spills, and vessel failures should be evaluated to determine the need for secondary containment or other impoundment as a means of preventing impact on other site areas. (pp. 22-23)

[31] CSB. 2005. CSB Issues Urgent Recommendations to U.S. Petrochemical Industry, Calls for Safer Placement of Trailers for Workers in Wake of BP Tragedy. CSB News Release. Washington, DC, October 25.

[32] USFA/DHS, 2004. Hazardous Materials and Terrorist Incident Prevention Curriculum Guidelines. www.usfa.dhs.gov/downloads/pdf/publications/hmep9-1801prevention.pdf

[33] NIEHS, 2006. Minimum Health and Safety Training Criteria: Guidance for Hazardous Waste Operations and Emergency Response (HAZWOPER), HAZWOPER-Supporting and All-Hazards Disaster Prevention, Preparedness & Response. Workshop Report. January 2006. Washington, D.C.: National Clearinghouse for Worker Safety and Health Training. (www.wetp.org)

[34] John Gray Institute. 1991. Managing Workplace Safety and Health: The Case of Contract Labor in the U.S. Petrochemical Industry. Beaumont, Texas: Lamar University.

[35] Israel BA, Checkoway B, Schulz A, Zimmerman M. 1994. Health education and community empowerment: conceptualizing and measuring perceptions of individual, organizational and community control. Health Education Quarterly 21:149–170.

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[37] Lippin TM, McQuiston TH, Bradley-Bull K, Burns-Johnson T, Cook L, Gill ML, Howard D, Seymour TA, Stephens D, Williams BK. 2006. Chemical Plants Remain Vulnerable to Terrorists: A Call to Action. Environmental Health Perspectives, 114:1307–1311.

[38] All figures based on "Total Operable Capacity - Atmospheric Crude Distillation Capacity" (barrels per calendar day). Refinery Capacity Data by individual refinery as of 01/01/2005. DOE Energy Information Administration.
http://www.eia.doe.gov/pub/oil_gas/petroleum/data_publications/refinery_capacity_data/data/refcap05.xls

[39] The phrase "atmospheric vents" when used in the USW Refinery Accident Prevention Survey and this report refers only to vents on process units (not those on tank farm vessels) and is limited to atmospheric vent stacks on blow-down systems, or other vent systems that could release untreated flammable, explosive, reactive, toxic, or otherwise hazardous materials directly to the atmosphere.

The phrase "management of instrumentation and alarm systems" when used in the USW Refinery Accident Prevention Survey and this report refers to all instrumentation, including level indicators and alarms, that would signal any abnormal or emergency conditions during process start-ups or shutdowns.

The phrase "trailers or other unprotected buildings inside potentially hazardous areas,'' when used in the USW Refinery Accident Prevention Survey and this report refers to those buildings where people work, meet, or congregate, and the siting of buildings in high hazard or vulnerability zones where occupants could be exposed to fires, explosions, or releases of toxic or hazardous materials.

The phrase "non-essential personnel in vulnerable areas during process start-up or shutdown" when used in the USW Refinery Accident Prevention Survey and this report refers to having non-essential personnel in areas where they could be vulnerable to a toxic or hazardous materials release, fire, or explosion during a process start-up or shutdown.

[40] Process units with atmospheric vents included: 42% on fluidized catalytic cracking units (FCCUs); 36% on crude units; 12% on coker units; and 32% on other types of process units. A sampling of other types of process units with atmospheric vents included: hydrocarbon distillation, furfural (furfuraldehyde), and cumene (isopropylbenzene) units.

[41] The locations reported for trailers and other unprotected buildings included: fluidized catalytic cracking, coker, crude, alkylation, isomerization, acid, hydrocracking, and distillation. Respondents' descriptions of locations for trailers and other unprotected buildings included: outside central control, scores and scores of trailers placed anywhere throughout the refinery, within 100' of process equip-

ment during start-up and shutdown, and various units for turnaround. Their descriptions of potential hazards in the vicinity of trailers and unprotected buildings included extreme flammability, explosion, benzene, methane, naphtha, hydrogen sulfide, sour water, butanes, propane, hydrogen, etc.

42 Examples of initiatives in the survey question included the company informing the local union, involving the local union in assessing the problems, or involving the local union in making recommendations to solve the problems.

43 See CSB. 2007. See pp. 20-21, 195-202.

44 The CSB in its 2007 Report (see 1 above) noted its previously issued recommendations including item 1.7.2.2 Trailer Siting Recommendtions:

> On October 25, 2005, the CSB issued two urgent safety recommendations. The first called on the American Petroleum Institute (API) to develop new guidelines to ensure that occupied trailers and similar temporary structures are placed safely away from hazardous areas of process plants; API agreed to develop new guidelines. A second recommendation to API and the National Petrochemical and Refiners Association (NPRA) called for both to issue a safety alert urging their members to take prompt action to ensure that trailers are safely located. API and NPRA published information on the two recommendations, referring to the CSB's call for industry to take prompt action to ensure the safe placement of occupied trailers away from hazardous areas of process plants.

45 The CSB in its 2007 Report (see 1 above) noted its previously issued recommendations including item 1.7.2.3 Blowdown Drum and Stack Recommendations:

> On October 31, 2006, the CSB issued two recommendations regarding the use of blowdown drums and stacks that handle flammables. The CSB recommended that API revise "Recommended Practice 521, Guide for Pressure Relieving and Depressuring Systems," to identify the hazards of this equipment, to address the need to adequately size disposal drums, and to urge the use of inherently safer alternatives such as flare systems.
>
> The CSB issued a recommendation to OSHA to conduct a national emphasis program for oil refineries focused on the hazards of blowdown drums and stacks that release flammables to the atmosphere and on inadequately sized disposal drums. The CSB further recommended that states that administer their own OSHA plan implement comparable emphasis programs within their jurisdictions.

46 U.S. Chemical Safety Board. 2006. CSB Releases Trailer Blast Damage Information from BP Texas City Accident. CSB News Release. Washington, DC, June 30, 2006. http://www.csb.gov/index.cfm?folder=news_releases&page=news&NEWS_ID=301.

47 CSB, October 25, 2005. The CSB's recommendation called on the American Petroleum Institute (API) to revise its Recommended Practice 752, "Management of Hazards Associated with Location of Process Plant Buildings" or issue a new Recommended Practice to ensure the safe placement of occupied trailers and similar temporary structures away from hazardous areas of process plants. It also called on API and the National Petrochemical and Refiners Association (NPRA) to Issue a safety alert to their membership to take prompt action to ensure the safe placement of occupied trailers away from hazardous areas of process plants. In it's 2007 report, the CSB noted that "API and NPRA published information on the two recommendations, referring to the CSB's call for industry to take prompt action to ensure the safe placement of occupied trailers away from hazardous areas of process plants." (p. 28)

48 API. 2003. Management of Hazards Associated with Location of Process Plant Buildings: API Recommended Practice 752. (2nd Edition). Washington, D.C.: API Publishing Services.

49 The following list was developed in large part by a team of USW refinery workers in developing curriculum on pre-start-up safety reviews (PSSRs). At a minimum, these reviews must certify that: a) all process hardware, software, and procedures are fully operational and sufficient for all foreseeable conditions including those that may be unique to start-ups, shutdowns, or emergencies; b) all hardware and piping have been direct examined to ensure that all lockout/tagout procedures have been successfully closed out and locks and tags removed; c) non-destructive testing of all lines has been undertaken including pressure testing and mechanical inspection of all gaskets and bolts; d) all management of change (MOC) reviews and actions have been completed including training for all persons

affected; e) start-up is aborted if there are more than three deviations; f) operating procedures match the condition of the process (i.e., account for variations in conditions following normal or emergency shutdowns); g) a dry run of start-up procedures has been performed; and h) community and emergency response agencies have been informed of impending start-up or shutdown.

[50] Written operating procedures must provide clear instructions for safely conducting activities involved in each covered process consistent with the process safety information and include steps for each operating phase; normal, temporary and emergency operations including start-ups and shut-downs; operating limits including avoidance of, consequences and corrections for deviations; safety and health considerations and exposure prevention.

[51] HSE, 2006. Managing Shiftwork. U.K. HSE Books.

[52] Center for Chemical Process Safety (CCPS). 2007. Guidelines for Measuring Process Safety Progress. American Institute of Chemical Engineers (AIChE): http://www.aiche.org/ccps/activeprojects/Pj192.aspx

[53] USW and BP. 2007. USW BP Joint Initiative On Health And Safety. USW: Pittsburgh, PA.