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

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New Perspectives
CONSULTING GROUP INC

Beyond Texas City

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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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Tony Mazzocchi Center, United Steelworkers, New Perspectives

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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 at least one 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 one or more incidents or near misses involving all four *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 less than *very effective* (*somewhat effective, somewhat inef-*

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-

[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.

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[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 all 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 shutdowns, 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.)

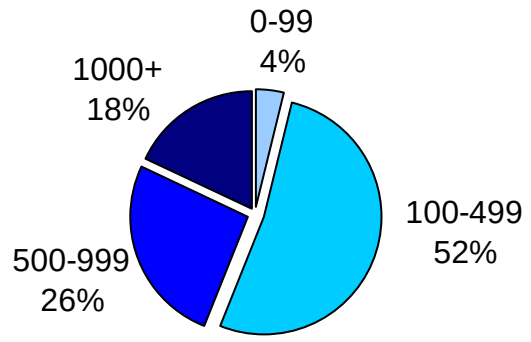
Figure 2. Refinery Companies Operating Survey Sites

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)

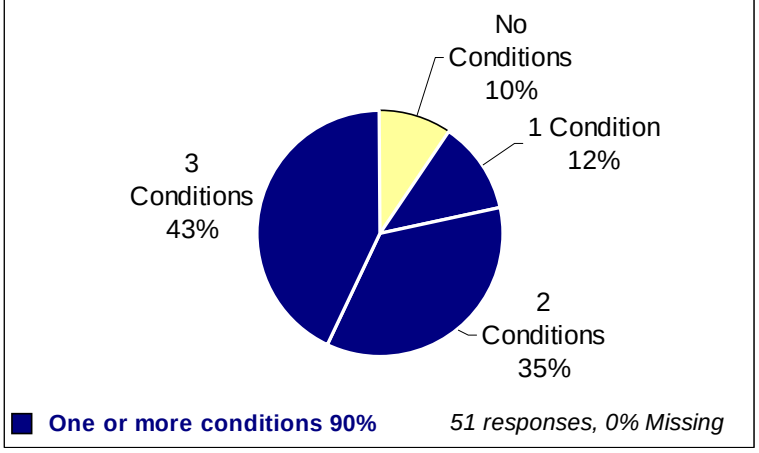
12% - had one

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 one or more incidents or near misses involving at least one *highly hazardous condition*

39% - reported no incidents or near misses for these conditions

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

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

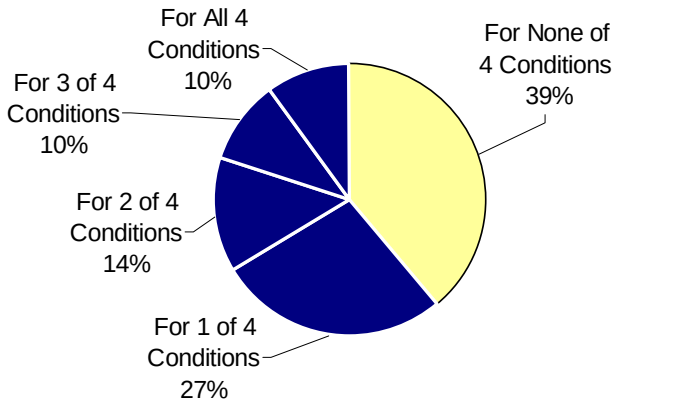
10% - involving three *highly hazardous conditions*

14% - involving two *highly hazardous conditions*

27% - involving one *highly hazardous condition*

(See Figure 5.)

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



For one or more conditions 61% *51 responses, 2% missing*

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.

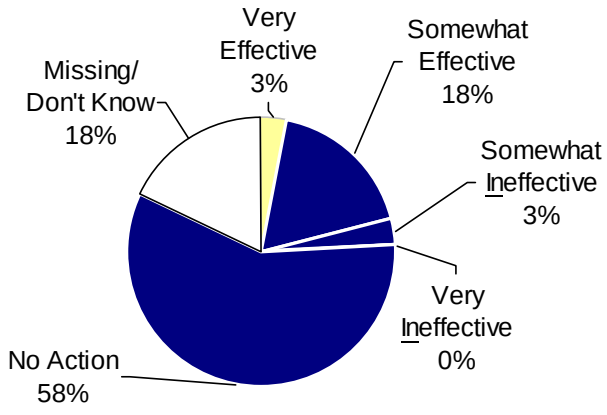
To present a more complete picture of company action and inaction concerning the four *highly hazardous conditions,* researchers combined data from two different groups of questions. These included the data regarding company actions to address the *highly hazard*

[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

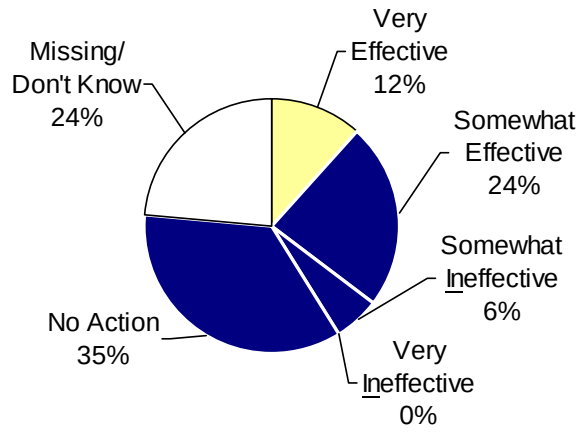


***No*, or less than *very effective* action 79%**

33 responses - limited to sites reporting atmoshpheric vents

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

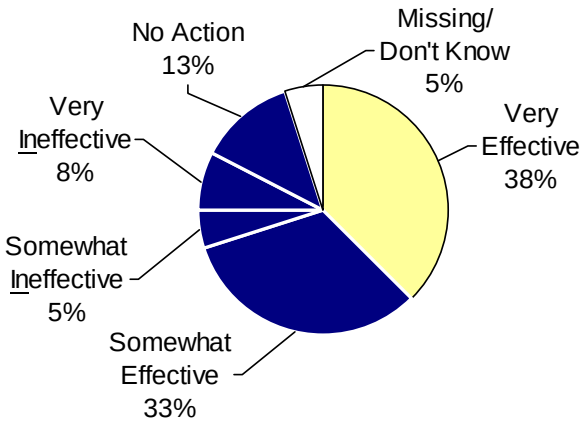
Figure 7. Managing Instrumentation and Alarms: Action and Effectiveness



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

51 responses

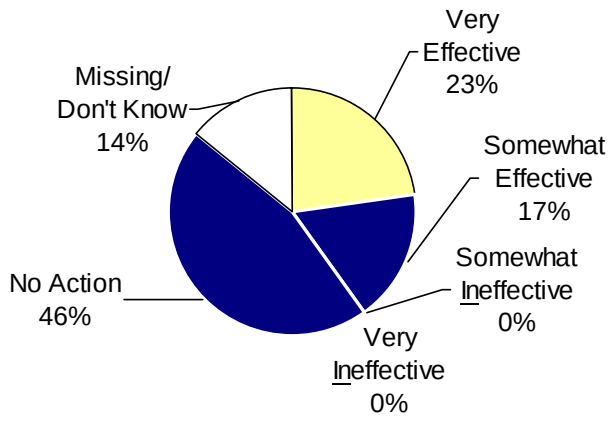
Figure 8. Removing Trailers and Other Unprotected Buildings: Action and Effectiveness



***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



***No*, or less than *very effective* action 63%**

35 responses - limited to sites reporting non-essential personnel in hazard. areas

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

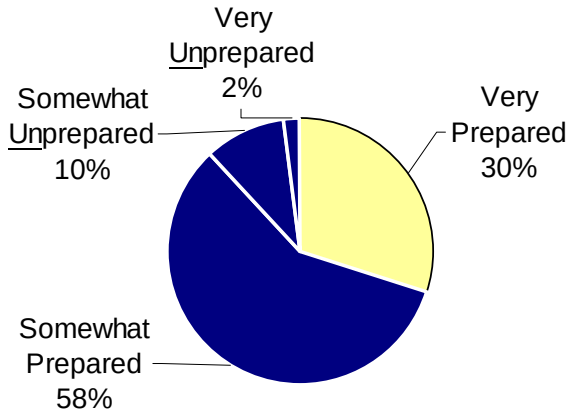
62% - on trailers or other unprotected buildings

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 less than *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 less than *very prepared*. (See Figure 10.)

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



Less than *very prepared* 70% *48 Responses, 6% missing*

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*

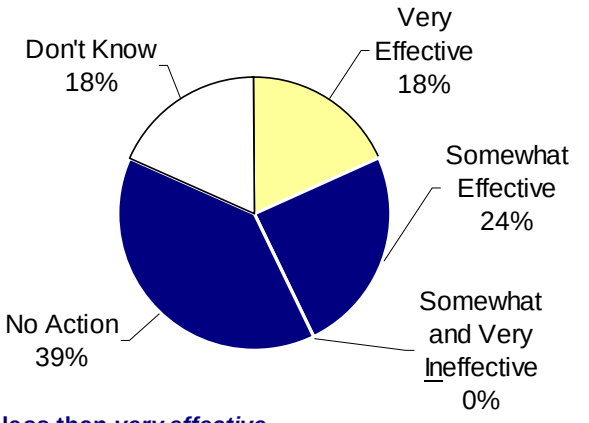
55% - action taken was *somewhat effective*

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.)

Figure 11. Company Acted to Improve Emergency Preparedness & Response



***No*, or less than *very effective* action 63%**

49 responses, 4% missing

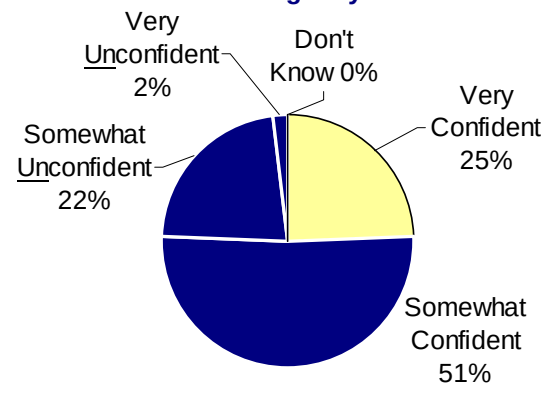
Emergency Response Training Recipients*:* The survey asked respondents about which groups of workers had received emergency response training in the last 12 months. Respondents reported the following:

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)

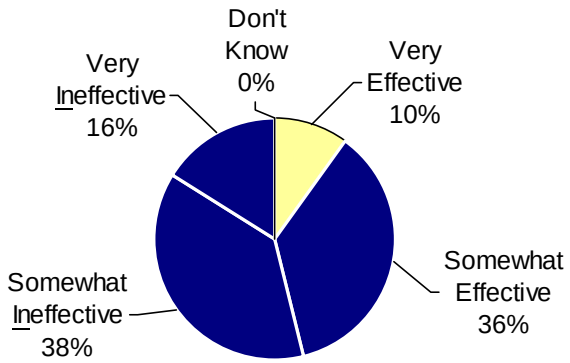
78% - Emergency shutdown and isolation systems

- Alarm and notification systems
- Process hazard analysis (PHA)

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

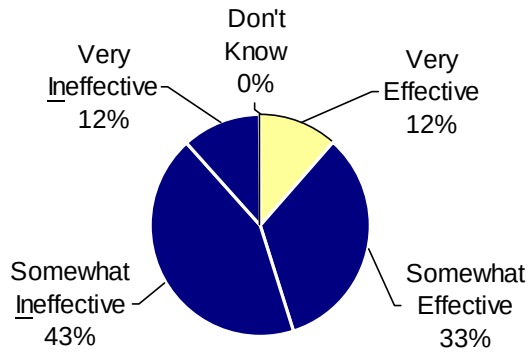
(See figures 15 to 23 below.)

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



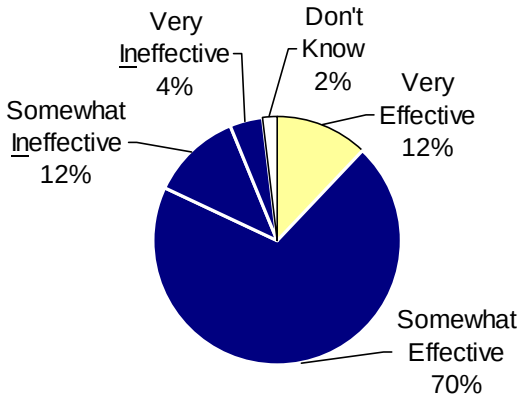
Less than *Very Effective* 90% *50 responses, 2% missing*

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



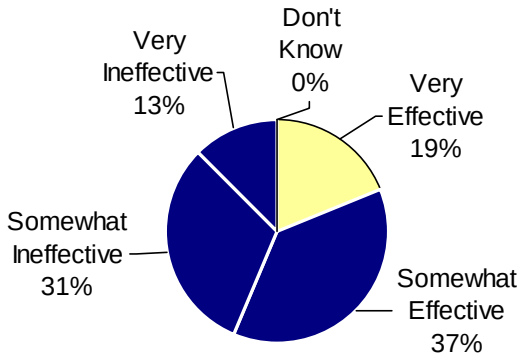
Less than *Very Effective* 88% *51 responses, 0% missing*

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



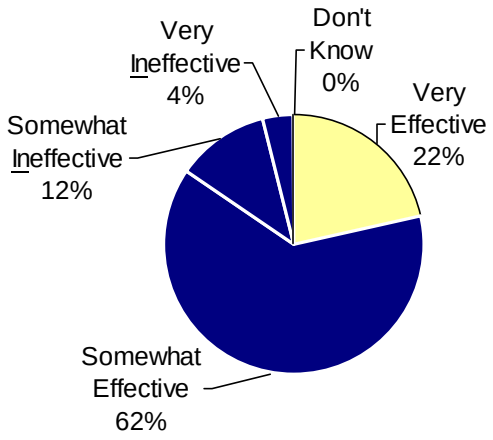
Less than *Very Effective* 86% *51 responses, 0% missing*

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



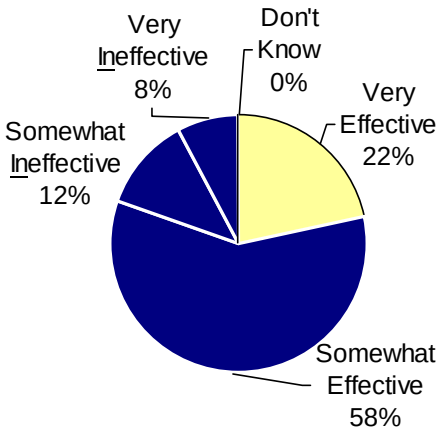
Less than *Very Effective* 81% *49 responses, 4% missing*

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



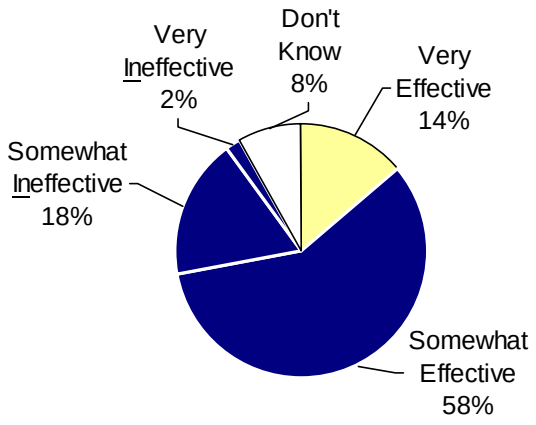
Less than *Very Effective* 78% *51 responses, 0%*

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



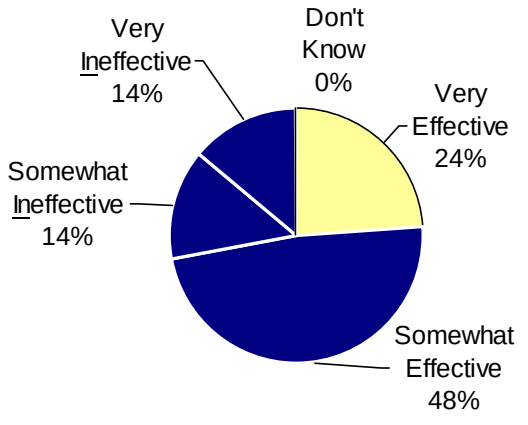
Less than *Very Effective* 78% *51 responses, 0% missing*

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



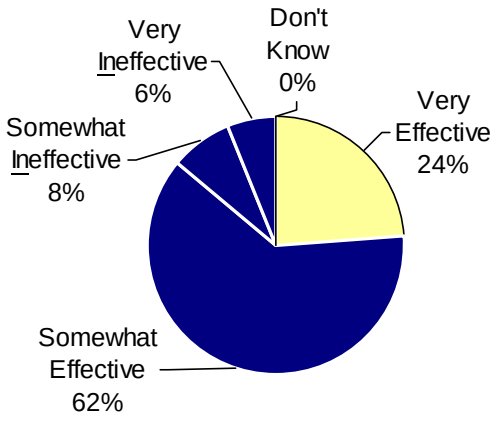
Less than *Very Effective* 78% *51 responses, 0% missing*

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



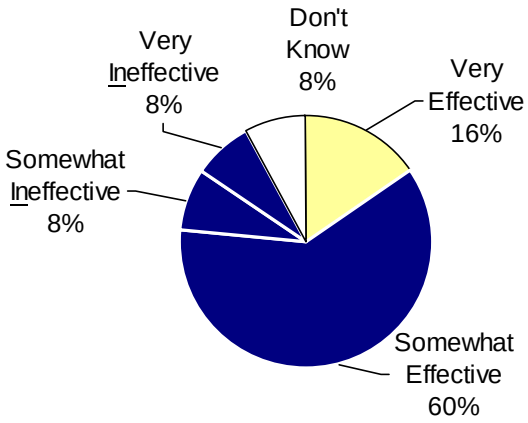
Less than *Very Effective* 76% *50 reaponses, 2% missing*

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



Less than *Very Effective* 76% *49 responses, 4% missing*

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

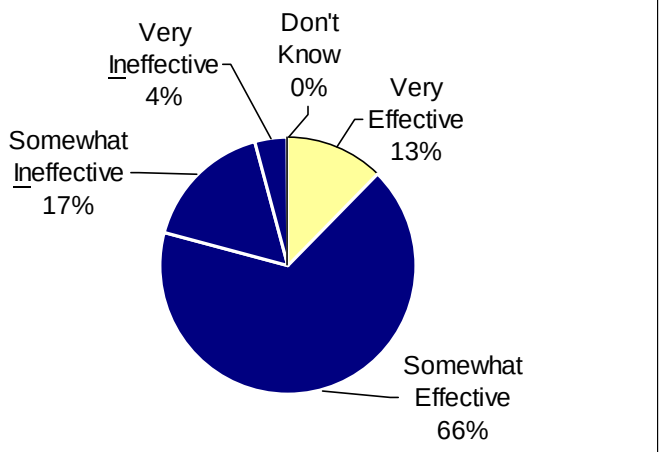


Less than *Very Effective* 76% *51 responses, 0%*

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



Less than *Very Effective* 87%

48 responses, 6% missing

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 all 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 not 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 shut-downs.
   - 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

Table of Contents

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 ineffective**	**Very ineffective**	**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:

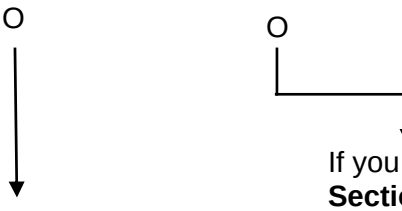
- those buildings where people work, meet or congregate, and
- siting of buildings in high hazard or vulnerability zones where occupants could be exposed to fires, explosions or releases of toxic or hazardous materials.

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 ineffective	Very ineffective	Don't know
O	O	O	O	O

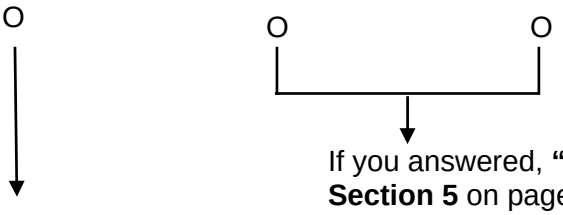
Section 4: Non-Essential Personnel in Potentially Hazardous Areas During Process Start-Up or Shutdown

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

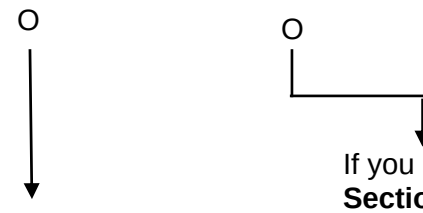


If you answered, **"No"** or **"Don't Know**,**"** please **skip to Section 5** on page 10.

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 ineffective	Very ineffective	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	**No**
O	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 <u>only one</u> 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**" **for all four issues,** please **skip to question 16** below on this page. **Otherwise, continue with part b** of this question.

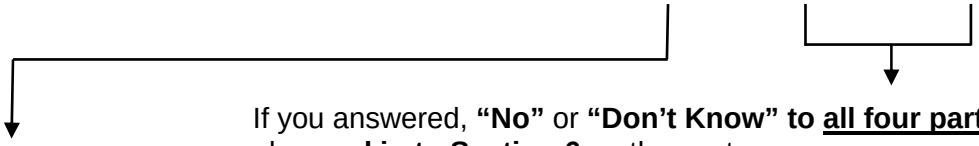
b. Please use the box below to **describe the training** the company conducted about preventing a catastrophic event involving the issues covered in this survey. Include **who was trained** and on **what subjects**. If you need more space, use the back of this page and write "15. b." next to your response.

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 ineffective	Very ineffective	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 unconfident**	**Very unconfident**
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 unprepared**	**Very unprepared**
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.

European Communities. 1998. Guidelines on a Major Accident Prevention Policy and Safety Management System, as required by Council Directive 96/82/EC (Seveso II) in Mitchison N, Porter S (Eds), Luxembourg: Office for Official Publications of the European Communities, 1998.

American Industrial Hygiene Association (AIHA). 2005. Occupational Health and Safety Management Systems. ANSI/AIHA Z10-2005. Fairfax, VA: AIHA. (ANSI/AIHA—American National Standards Institute/American Industrial Hygiene Association.)

ILO-OSH. 2001. Guidelines on Occupational Health and Safety Management Systems. Geneva, Switzerland: ILO, 2001. <http://www.ilo.org/public/english/support/publ/xtextoh.htm>.

[14] Rosenthal I, Kleindorfer PR, Elliot M. 2006. Predicting and Confirming the Effectiveness of Systems for Managing Low-Probability Chemical Process Risks. American Institute of Chemical Engineers Process Safety Progress (Vol.25, No.2)

[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.

[16] Organisation for Economic Co-operation and Development. 2005. Report of the OECD Workshop on Lessons Learned from Chemical Accidents and Incidents (21-23 September 2004, Karlskoga, Sweden), OECD Environment, Health and Safety Publications Series on Chemical Accidents NO. 14. Environmental Directorate OECD. Paris, France.

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[18] Argyris, C, Schön, DA. 1996. Organizational Learning II. New York: Addison-Wesley Publishing Co.

[19] Marais K, Dulac N, Leveson N. 2004. Beyond Normal Accidents and High Reliability Organizations: The Need for an Alternative Approach to Safety in Complex Systems. Paper presented at the Engineering Systems Division Symposium, MIT. Cambridge, MA. March 29-31.

[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.

[36] McQuiston TH. 2000. Empowerment evaluation of worker safety and health education programs. American Journal of Industrial Medicine 38:584–597.

[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.