Process and Operational Audit Report
BP Texas City
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Executive Summary

Context

Over the last year several major accidents/incidents have occurred at Texas City Refinery culminating in the recent tragic events on the ISOM Unit. As a result of this, BP Products North America Inc. commissioned a Process and Operational Review to provide enhanced assurance of safe operation at the Texas City Refinery.

Scope

An independently led team of BP and external experts was assembled to review Texas City refinery processes and operations against the elements included in the protocol:

I. Process and Operations
II. Incident Management, Control of Work, Risk Assessment, Compliance Assessment
III. People and Contractor Management (including Training and Assessment and Performance Management and Workplace Conditions)
IV. Maintenance, Reliability and Integrity

The team divided into four groups to cover the topics listed above. The report follows this outline.

In addition, a High Reliability Organization (HRO) protocol, designed by the Refining Strategic Performance Unit (SPU) as an evaluation tool for all Refining sites, was used in this review.

The team conducted interviews, inspections, documentation reviews and observations at the Units identified in the protocol.

Opinion and key findings

In the opinion of the audit team, the Texas City refinery generally has well-designed and documented Operations and Maintenance processes and procedures, with the exception of control of work. It has a workforce capable of delivering good performance, subject to the provisions of good leadership and management. Significant changes to the behaviors and performance of the senior and extended leadership teams will be necessary to ensure that delivery achieves reality. A number of improvement programs are in place, such as the Inspection Renewal Process and BPSH 1000 Day Goals and KPI program.

We have identified a number of issues that are preventing the successful execution of some key work processes.

Leadership

- Failure to hold people at all levels at the refinery accountable for executing defined processes and procedures resulting in a tolerance for non-compliance with those processes and procedures.
- A silo-based culture exists, where Units and Workgroups function as separate entities rather than in a collaborative manner, which creates significant inconsistencies across the refinery.
- The refinery appears isolated from some Group and SPU initiatives and exhibits a preference for local programs.
- The refinery organization works against senior leadership developing good leadership behaviors due to the extended span of control that exists beneath the senior leaders.

Risk Awareness

- Repeated failure to complete recommended actions from audits, peer reviews and past incident investigations.
- Complacency towards serious process safety risk, driven by a lack of awareness of potential consequences.
- The lack of awareness of risk is also reflected in day-to-day operational activity.
- Refinery leadership to the lowest level of BP supervision has to be held accountable and responsible for facilitating the identification of hazards and the risks associated with those hazards.

Control of Work

- The existing Control of Work process does not provide adequate assurance that risks are being effectively managed.
- There is not full compliance with the existing Control of Work process.
- Refinery leadership to the lowest level of BP supervision has to be held accountable and responsible for facilitating the identification of hazards and the risks associated with those hazards.

Workplace Conditions

- Areas of the refinery did not appear to be well maintained.
- There are pockets of excellent housekeeping, however in general housekeeping is poor.
- The work environment in some controls rooms is inadequate to allow full focus on Unit control.

Contractor Management

- The Diversity and Inclusion (D&I) values are not reflected in BP working relationships with Contractors.

Key Recommendations

Leadership

- The Business Unit Leader (BUL) should issue a clear statement of expectations of compliance with rules and procedures. The BUL should also establish clear common goals for the refinery, emphasizing teamwork and a one-site mentality.
- Leadership Team must hold superintendents and supervisory employees accountable for implementation of rules and procedures within their areas of responsibility.
- Make HRO a universal and unifying culture for Texas City.
- The Leadership Team should verify that Health, Safety, Security and Environment (HSSE), Operations, and Maintenance activities are being satisfactorily conducted. They should schedule time out in the plant on a regular basis with Operators, Crafts and Contractors. This should include detailed random checks using the HRO protocol and Advanced Safety Auditing (ASA).

Risk Awareness.

- The Leadership Team should establish a process to re-assess outstanding recommendations, assign accountability and monitor completion of actions from audits, peer reviews and past incident investigations.
- Establish a risk-awareness training program for all levels.
- Refinery leadership to the lowest level of BP supervision has to be held accountable and responsible for facilitating the identification of hazards and the risks associated with those hazards.
- Review the responsibilities for refinery leadership to ensure that they include facilitating hazard identification and implementation and monitoring of any mitigation put in place to control hazards. Refinery leadership should also be clearly responsible for any lessons learned on completion of work.

Control of Work

- A team of subject matter experts should be assembled to conduct a fundamental review of Control of Work processes and practices. Terms of reference should include a requirement to make detailed recommendations based on good practices from other Refineries.
- A Single Point of Accountability (SPA) should be appointed by the BUL immediately to review all project and maintenance work currently in progress or

planned to start in the near future with the objective of stopping all non-essential work until an improved Control of Work process is in place.
- All work that is deemed essential to the safe operation and maintenance of the refinery must be executed in full compliance with the provisions of the existing Control of Work process.

Workplace Conditions:

- Use the examples of good housekeeping that now exist in the refinery as a performance benchmark to set expectations for the entire refinery.
- Reinforce by strong leadership and engagement of the workforce to build a pride of ownership in all Units.
- Develop a robust plan for the completion of the Inspection Renewal Process (IRP) across all areas of the refinery.
- Provide the appropriate level of resource in support of the plan to ensure IRP completion as planned. Consider redirecting appropriately qualified and experienced personnel from less critical functions to support this process.
- Develop, communicate and enforce clearly defined policies to eliminate all non-essential control room activities.

Contractor Management

- The BUL should provide a clear statement that contractors are, and will remain, an integral and important part of the refinery workforce and that any behaviors not in alignment with BP's D&I policy will not be tolerated.
- Seek expert help to address the behavioral issues on respect and inclusion.

Detailed Issues and Recommendations

I. Process & Operations

Issue: Management Visibility
Visibility of Leadership Team is inconsistent and tends to focus primarily on areas of responsibility. The team is not connecting to the workforce in a meaningful way below the Supervisor level.

Recommendation:
Leadership team members should schedule time out in the plant (control rooms, craft shops etc) with Operators, Crafts and Contractors to cover a number of aspects:

- Verification that Health, Safety, Security and Environment (HSSE), Operations, and Maintenance activities are being satisfactorily conducted, including detailed random checks using the High Reliability Organization (HRO) protocol and Advanced Safety Auditing (ASA)

- Obtain an understanding of what is going on, i.e., listen to the 'voice' of the refinery.
- Convey to staff and contractors what is important and test how effectively they are communicating to the workforce.
- Demonstrate to all personnel, including contractors, BP values regarding occupational safety, personal safety, and treating all individuals with dignity.
- Provide context for staff on business and HSSE performance and explain background and rationale behind the Business Unit (BU) strategy and its implementation.

Issue: High Reliability Organization

Extremely low level of awareness or understanding in the Operations Department of HRO at all levels below the Leadership Team.

Despite the lack of HRO awareness we noted a consistent and strong message that all Operations staff feel empowered to use their judgment to stop a job or suspend/shut-down operations if the situation demands it.

Recommendation:

Make HRO a universal and unifying culture for Texas City Refinery.

- Make the HRO story a primary message for the Leadership Team to share with the workforce as part of refinery visits.
- Engage and support Superintendents in developing among the workforce a deep understanding of HRO.
- Leadership Team should model HRO behaviors in their interaction with the workforce.
- Learn from the good practices of other Refining sites concerning the communication about HRO (e.g., Carson, Whiting, Grangemouth).

Issue: Compliance with Rules and Procedures

Quality of procedures and associated training across the refinery appears good. Inconsistent compliance with rules and procedures across the refinery has reduced the effective management of risks that the procedures are designed to address. Less than 100% compliance with Personal Protective Equipment (PPE) rules was evident.

Examples of good practices in Management of Change (MOC) action closure and the Weekly Safety Checklist were noted.

Recommendation:

- Business Unit Leader (BUL) should issue a clear statement of expectations of compliance with rules and procedures.

- Leadership Team must hold superintendents and supervisory employees accountable for implementation of rules and procedures within their areas of responsibility.
- Leadership Team must communicate that there will be real consequences for non-compliance, and such consequences must be implemented.
- Superintendents and Supervisors must relentlessly hold employees/contractors accountable for compliance with rules and procedures.
- Create an expectation that unsatisfactory procedures should be revised and not ignored or tolerated.
- Where the workforce is delivering work in accordance with the appropriate standards and practices, these actions should be celebrated and encouraged by management.

Issue: Control of Work

Based on the Units visited, we observed a need to improve Control of Work procedure as well as rigor of implementation.

The existing Control of Work process does not provide adequate assurance that the risks are being effectively managed. Decisions are left at lowest refinery levels.

There is not full compliance with the existing Control of Work process.

There is lack of risk awareness in day-to-day activities.

Recommendation:

- A team of subject matter experts should be assembled to conduct a fundamental review of Control of Work processes and practices. Terms of reference should include a requirement to make detailed recommendations based on good practices from other Refineries.
- A Single Point of Accountability (SPA) should be appointed by the BUL to review all project and maintenance work currently in progress or planned to start in the near future with the objective of stopping all non-essential work until an improved Control of Work process is in place.
- Immediate efforts must be made to comply with the existing Control of Work system and in particular:
    - Operators must be aware of every job going on in their Unit.
    - Operators and Operations Supervisors must participate in the risk assessment part of the Authorization to Work (ATW) process.
    - Maintenance and Construction crafts must return field ATW forms to the control room at the end of each work shift.
    - Ensure that the refinery Compliance group regularly performs spot verification of compliance with Control of Work process and shares findings with the BUL.

Issue: Shift Turnovers

Some Shift Turnovers lack structure and discipline to make them fully effective in communicating to incoming staff what is happening on the unit.

Operators see the Process Reporting Information Data Entry (PRIDE) system as an effective positive control tool.

Recommendation:

All shift turnovers need to be face-to-face at the place of work directly between the outgoing/incoming Operators each of whom needs to be ready/geared (e.g., in appropriate PPE) to go out into the unit until turnover is complete in case an emergency occurs. First priority after Turnover should be conducting a quality check of the unit and board.

Occasional audits of the hand-over-process should be a responsibility of the plant superintendents. These audits must be documented.

Issue: Rotation of Management

Current length of Management/Superintendent rotations is often insufficient to allow managers to develop a deep understanding of unit operations and develop effective working relationships with Operations staff.

Recommendation:

Development and succession plans should reflect the need for increased tenure in these critical positions.

Issue: Progression to Board Operator/Shift Supervisor positions

Reward structure and responsibilities associated with these key roles has created a situation that does not encourage Operators to apply for these positions.

Recommendation:

- Support the recommendation currently in front of US BULs to address the Supervisor grade levels and remuneration.
- US BULs should look for options to also address the Board Operator remuneration.

Issue: Operating Envelope

Operating Envelopes (OE) define the range of operating parameters for safe and reliable operation of each process unit. The quality of OE data integrity (e.g. erroneous out of compliance data points) is undermining the effective use of OE.

Recommendation:

- Address the issue of OE data accuracy and reinforce the use of OE by Operating staff by making the implementation of the OE an explicit performance measure in the performance contracts of the Operations Superintendents.
- Establish a weekly meeting on each unit which should involve Shift Supervisors, Board and Outside Operators and Operations Engineers to review OE and Critical Alarms.

Issue: Plant Housekeeping

- Housekeeping standards are highly variable across the refinery, both outside on units and in Control Rooms.

Recommendation:

- Use the examples of good housekeeping that now exist in the refinery as a performance benchmark to set expectations for the entire refinery.
- Build a pride of ownership in all Units through strong leadership and engagement of the workforce.

Issue: Control Rooms

Some control rooms do not provide a work environment where the board operators can fully focus on unit control, for example:

- The TV Network serves a useful purpose for dissemination of refinery information but broadcasting of news channels and other program content has no clear work-related purpose.
- Extensive use of the control rooms for activities such as food preparation, eating, meetings, inductions, and unit sign-ins provide significant distractions.

Recommendation:

- Use of TVs should be limited to dissemination of Company information only. Broadcasting of news channels and other program material should be stopped.
- Develop, communicate and enforce clearly defined policies to eliminate all non-essential control room activities.
- Provide adequate alternative arrangements where by duty personnel can be provided meal facilities and breaks away from the workplace.

Issue: Contractor Relationships

- Governance and supervision over contractor activities is ineffective.

- Numerous indications of a deep-seated lack of respect for contractors were seen throughout the refinery.

Recommendation:

- Establish clear BP accountability for BP job representatives with regard to contractors operating on the units.
- Use "Responsible, Accountable, Consult, and Inform" (RACI) tool to help define/clarify the roles and responsibility for Operations, Maintenance and Construction to ensure:
    - Operations supervision and Operators understand that they are accountable for knowing all activities going on within their area, that process hazards are adequately identified and managed, and that account is taken of the effect that maintenance/construction activities may have on unit operations.
    - All Maintenance and Construction supervision (both BP and contractors) understand that they are accountable for understanding and managing the risks of the work and doing the job safely.
- Ensure that Control of Work procedures reflect the above accountabilities and ensure that performance management includes verification that the accountabilities are being fulfilled.
- Seek expert help to address the behavioral issues on respect and inclusion.

II. Incident Investigation & Analysis; Control of Work; Risk Assessment; Compliance Assessment

Incident Investigation & Analysis

Strengths:

Learning and Sharing Lessons

The refinery has access to and utilizes several mechanisms for sharing lessons from incidents that occur at the refinery (e.g., the Shift Directors' Website, Tr@ction, HSSE Safety and Toolbox Talks, et al). The After Action Review (AAR) process and Shift Directors meeting provide for effective and rapid feedback on incidents across the supervisor community. There are regular meetings of the HSSE and Process Safety Committee at which incidents are reviewed.

Lessons from other sites and outside BP are captured by the Process Safety Department, via attendance at Refining Process Safety Community of Practice and via the refinery Quarterly Safety Bulletins, and are shared via these same mechanisms.

Incident Investigation Procedures and Practice

There are good documented procedures for Incident Reporting and Investigation, which are, on the basis of the documentation reviewed, followed. The incident investigation

procedure is complemented by a robust Root Cause Failure Analysis (RCFA) process (e.g., use of the BP Comprehensive List of Causes) and a number of trained incident investigators for each of the incident levels. Incident investigation reports are comprehensive and generally well written.

Issues and Recommendations:

Issue: Action Tracking Systems

Perceived problems with the Tr@ction system have led to the use of duplicate systems for tracking Process Safety Incidents. This tends to lead to confusion as to where to find incident information. Also, linkage between the AARs and the Tr@ction System is not consistently present.

Recommendation:

Consolidation of all incident reporting into a single tracking system would eliminate confusion.

Issue: Action Tracking "Quality Assurance"

The training of Tr@ction authorizers does not extend to understanding the criticality of action items. Tr@ction authorizers may not have sufficient technical knowledge to authorize particular actions and closures. This is one of the drivers to retain the separate parallel tracking system discussed above to help ensure Process Safety Management (PSM) compliance.

Recommendation:

The refinery should establish a minimum level of technical competence for Tr@ction authorizers and modify the system procedures accordingly.

Issue: Categorization of Incidents

The incident tracking system allows for classification of incidents under a broad list of categories. There is apparently not clear guidance as to the correct category to be used in all cases. Inconsistent classification of incident categories reduces the opportunity to identify trends.

Recommendation:

Improved guidance and training on incident classification for Tr@ction approvers is required to help ensure a more consistent approach.

Issue: Incident Analysis

There is very limited analysis of data to identify accident trends. Periodic analysis of incidents and root causes is key to identifying both trends and potential underlying systemic issues.

Recommendation:

Analyses should be done at the unit, area, and refinery levels, and the results brought to the attention of the Leadership Team to enable appropriate, proactive actions.

Issue: Effective Communication of Lessons Learned

Information on incidents is widely available and broadly communicated via e-mail and electronic websites. The lessons learned from these incidents, however, are not being distilled and actively communicated across the whole workforce.

Recommendation:

Key learnings from specific major incidents (both internal and external) and recurring themes from the incident trend analysis should be actively communicated to the workforce in face-to-face sessions.

Issue: Improved Recognition of Incidents Having Process Safety Implications

There is widespread recognition of incidents having potential environmental consequences. Conversely, some incidents with significant potential process safety implications are not as readily recognized.

Recommendation:

While environmental stewardship is critical, there also needs to be an increased awareness of events having process safety implications. Operational incidents that have the potential for significant process safety impact, need to be reported into Tr@ction as process safety Near Misses.

Where these Near Misses are identified, consideration needs to be given to the use of appropriate procedural and engineering controls to prevent, control and mitigate major accidents (e.g., application of inherently safer design concepts, engineered relief containment systems, emergency shutdown valves and controls, enhanced flammable and toxic gas detection, etc.).

Issue: Action Item Follow-Up

There is currently a backlog of unclosed action items in the tracking databases related to various aspects of process safety management, including those stemming from incident investigations. Some of the latter extend back over a period of more than twelve months. There is a tendency to subjectively rank items as "high priority," potentially masking their true relative importance.

Recommendation:

There needs to be improved prioritization of action items resulting from incident investigations, on the basis of risk, and enhanced leadership focus on getting these action items completed promptly.

Control of Work

Issue: ATW and Permit Completion

By procedure, a majority of the ATW form is completed by personnel not specifically familiar with the unit hazards. Mechanical and/or Job Representatives pre-complete the ATW prior to the operations personnel fully completing and reviewing the document. In the audit team's review of multiple ATWs, many revealed inadequate completion and limited usefulness. The thoroughness and effectiveness of training for this area is viewed by the audit team as having been diminished by the move from classroom-based training to computer-based training.

Recommendation:

The refinery should consider returning to classroom-based training for permit issuers and acceptors, including an effective verification of understanding step as part of the training.

Issue: Work Coordination

A potential issue with the current ATW and Permit procedure is that work activities that may adversely impact one another (e.g., flammable liquid task and adjacent hot work task) are not systematically coordinated. Additionally, contractors obtain the ATW and Permits from the BP Job Representative, which introduces a third party hand-over issue.

Recommendation:

A SPA at each unit should review Active ATWs on a daily basis to help avoid incompatible work activities. This position must be consistent from unit to unit.

Issue: ATW Status Tracking

A review of 'In Progress' ATWs uncovered several that were not filed in accordance with the ATW procedure, which made it difficult to track work status. By procedure, the ATW may be issued for several consecutive days with the original returning to the control room following the work shift.

Recommendation:

Require adherence to existing ATW procedures.

Issue: Process Overview

The detail of the process overview provided as part of the unit safety orientation varies significantly from unit to unit. The best involved a detailed sit-down presentation led by the Process Technician, which identified the hazards in the unit, the location of safety systems and evacuation muster points, and review of the unit safety verification checklist. The least effective orientation consisted of being presented with a set of documents to be read individually, without any formal discussion of safety systems and issues.

Recommendation:

A consistent, effective format for conducting unit safety orientations should be developed and implemented. For example, FCC No. 2 uses a locally produced video that very effectively presents the relevant information.

Issue: Lock out/Tag out

Discussions with unit employees indicated a lack of sufficient understanding of the overall lock out/tag out procedure.

Recommendation:

While there may be a need to clarify language in portions of the procedure, the primary need is for more effective initial and/or refresher training on key work permit procedures (see also item under **ATW and Permit Completion**, above).

Issue: Adjacent Area Notification

There is not a formal method to provide notification of adjacent unit start-ups and shut-downs for BP and contractor personnel. Within operations, adjacent units are generally informed through shift supervisor meetings and/or direct communication between control rooms of the potential unit impacts. There are some efforts to clear non-essential personnel from the respective unit when start-up and shut-down procedures begin.

Recommendation:

A formal policy is needed to require notification of operations, maintenance and contractor personnel working in adjacent units of impending start-ups, shut-downs and serious process upsets. A telephone call to each adjacent control room is one effective way to notify adjacent units and personnel of a start-up or shut-down.

Issue: Applicable Procedures

Although not directly related to control of work procedures, there is a general confusion over which procedure is applicable. In reviewing procedural access on the BP Intranet, the actual procedure origin (e.g., BP Refinery, BP Chemical, BP Texas City, BP South Houston, Amoco heritage documents, etc.) with differences in each, introduces confusion as to what is actually required.

Recommendation:

A single set of procedures to cover the Texas City refinery would significantly reduce the potential for confusion.

Risk Assessment - Process Hazards Analysis (PHA)

Strengths:

PHA Practices
The refinery practices for conducting Benchmark and Revalidation PHAs are comprehensive and produce documentation in compliance with the requirements of the OSHA Process Safety Management Regulation (29 CFR 1910.119). In addition, the PHA procedures and practices show indication of continuous improvement of the PHA processes over time.

PHA Leaders
The refinery has a stable corps of experienced PHA facilitators, who have years of direct operating experience and who are knowledgeable in the application of the PHA methodologies of choice for the refinery. They resource all major PHAs done at the refinery, bringing an enhanced level of experience and consistency of application to the hazards analysis process.

Revalidation PHAs
Cyclical, or Revalidation, PHAs are consistently completed on schedule. They uniformly include a good review of the Action Items from the previous PHA and incidents and MOC activities in the unit since the prior PHA.

Process Descriptions
All of the PHAs reviewed contained comprehensive descriptions of the process equipment and operations.

MOC PHAs
The PHAs done in support of Management of Change activities make very effective use of the"What If/Checklist" methodology. Initial brainstorming sessions (What If) are supplemented by the application of one or more specialized checklists, containing questions specific to the relevant aspects of the change being made.

Layers of Protection Analysis
The refinery has recently begun to use Layers of Protection Analysis (LOPA) as an additional tool for evaluating the effectiveness of safeguards. It is being applied as part of new HAZOP studies for each process area, as they come due for their next cyclical PHA. The use of this tool represents a significant enhancement over pure qualitative assessments.

Issue: Application of the HAZOP Methodology

The Hazard and Operability Methodology (HAZOP) is the refinery's preferred hazards evaluation tool for all Benchmark PHAs and for those cyclical PHAs not meeting the criteria for use of the refinery's "Simple Revalidation" checklist technique. Refinery practice for doing HAZOPs is a variation on the traditional method. The PHA Leader divides the process into nodes. A node is typically a single line, vessel, or some combination of these. In the Texas City Refinery's methodology, a node may include several lines or several lines and a vessel, or even several lines and several vessels. Each node is then classified into one of 6 categories of equipment found in the refinery (i.e., column, tank/vessel, line, heat exchanger, pump or heater). A set of pre-established deviations for each equipment category, selected from a list of 16, is then applied as described above.

Recommendation:

Based upon the PHAs reviewed, application of the method in this manner raises several concerns, as described below:

- Node size: The size of some of the nodes, in terms of the number of lines or vessels, sometimes makes it difficult to discern where in the node a particular deviation is a matter of concern. No explanation of the rationale behind consolidation of multiple lines or vessels into a single node is provided. While some combination of lines and vessels may be appropriate, smaller node sizes, more in alignment with the "classic" application of HAZOP, would help to eliminate this sometimes confusing aspect of the PHAs.
- Node intention statements: None of the unit HAZOPs reviewed included design intention statements for each node. More recent HAZOPs, being done for units not included in this assessment, have started to include these statements. This is a much-needed upgrade that should greatly benefit all HAZOPs done in the future.
- Documentation of safeguards: Safeguards are typically documented using acronyms or other abbreviated designations. A glossary or key to define the terms used would

greatly improve the understandability of the documentation from the perspective of new personnel or others not familiar with the facility.

Issue: Hazardous Event Identification

The unit-level PHA documentation reviewed did not contain any type of summary of the major hazards and/or potential hazardous events associated with the unit. Within the HAZOP worksheets, events are described generically, typically either as explosion, explosive mixture, fire or pool fire. This level of description does not provide differentiation that may be significant in understanding the true nature and potential consequences of the event and in facilitating a complete analysis of the adequacy of the safeguards. For example, an unconfined vapor cloud explosion, a confined vapor cloud explosion, a vessel burst explosion due to internal over-pressurization, and a Boiling Liquid Expanding Vapor Explosion (or BLEVE) are all "explosions." There is, however, typically a great deal of difference, in terms of both significant causal factors and potential consequences, between these different types of explosions. The same can be said for flash fires, fireballs, jet fires and pool fires.

Recommendation:

The existing procedure should be upgraded through:

- use of more precise hazardous event descriptions within the hazard evaluation (i.e., HAZOP or What If/Checklist) and
- a summary list of the major hazards and hazardous events, including a generic summary of potential causes, consequences and safeguards (e.g., like those included in the Safety Cases done for facilities in Europe).

Issue: Characterization of Event Severity Levels

The more recent PHAs have begun to use the Safety, Environmental and Asset-Operability Severity Descriptions as a means of characterizing the potential severity of hypothetical events. Of the PHAs reviewed as part of this assessment, the majority of fire, explosion and toxic release events were classified as S-2 or S-3 level events (i.e., potential for single on-site DAWFC and potential for single on-site permanent injury/multiple DAWFC injuries, respectively). Some events, involving leak/rupture scenarios for the reactors, debutanizer and depropanizer towers, reboilers and connecting lines were typically classified as S-4 (potential for single on-site fatality), but no events were classified as having an S-5 level (potential multiple on-site fatalities). Given the nature and quantity of materials contained in the process, and their conditions of use, there are some scenarios that have S-5 potential under certain circumstances.

Recommendation:

PHA teams should think about the full range of potential operational states within the unit under study and the potential impact on populations beyond the unit. These can

dramatically impact the consequences of the event, and should be reflected in the assessed potential severity level.

Issue: Consequence Analysis

With the exception of some recent explosion over-pressure modeling, PHA teams are not getting any quantitative consequence analysis of potential events as an input to the PHA process.

Recommendation:

While there is no regulatory requirement to do quantitative modeling, source term and downwind dispersion modeling of a range of potential release events (involving both toxic and flammable materials) might help PHA teams to characterize the severity level of different events and to understand the relative differences in event magnitude.

Issue: Maintenance Participation on PHA Teams

While the refinery has recently begun to include maintenance personnel (i.e., pipefitters, millwrights, I&E technicians) on PHA teams, the most recent unit-level HAZOPs for the units reviewed in this assessment did not include any maintenance personnel.

Recommendation:

While not required by the OSHA PSM regulation, continued inclusion of maintenance personnel is a vehicle to help insure that the team gets a proper perspective on the reliability of equipment and critical safeguards (e.g., those used to provide alarms or interlocks on critical process parameters and pressure relief devices).

Issue: Action Items from PHAs

Overall, action item completion status as of the most-recent unit HAZOP was very good for the five PHAs reviewed. However, there were, for two of the PHAs, a limited number of items still outstanding (and some overdue) after five years.

Recommendation:

Each PHA action item should be assigned to a SPA, and given a realistic target date and then be closed by the target date. Extension of target dates should only be allowed where legitimate extenuating circumstances dictate. Increased emphasis by the refinery on prompt and timely closure of action items resulting from PHAs is needed.

Issue: Learning From "Weak Signals"

Part of the PHA process involves a review of all of the incidents occurring in the unit under study since the previous PHA. There is some indication that not all failures of

protective systems in the field, both under test or on demand, are being identified and investigated as "near miss" process safety events. Discrepancies in event category selection can also help to mask potential learning opportunities when incidents are being collected for analysis in preparation for cyclic PHAs.

Recommendation:

A review of the Maintenance Work Orders for the unit since the last PHA would provide a check step to potentially identify additional events having significant learning opportunities that may have been missed otherwise. (See also the item **Improved Recognition of Incidents Having Process Safety Implications**, under Incident Investigation, above.)

Issue: Refinery PHA Procedure

As stated above, the refinery practices for conducting PHAs are comprehensive. They are documented, however, in a draft procedure (SH-PSM-3.0) that has yet to be issued.

Recommendation:

Prompt formal issuance of this document would help ensure continued application of PHA procedures in a consistent manner.

Issue: Facility Siting Analysis

All of the unit PHAs reviewed as part of this assessment contained a statement indicating that facility siting considerations had been addressed by the team, in compliance with the requirements of the OSHA PSM regulation. The wording typically used, however, does not provide documentation of the depth of the analysis. Neither do the HAZOP worksheets.

Recommendation:

Use of a specific facility siting checklist, analogous to the human factors checklist already in use, would be both a good upgrade and would provide a useful input to the five-year cyclic revalidation of the refinery-wide facility siting study.

Issue: Risk Assessments of Turnarounds and Pre Start Up Safety Reviews

Turnaround (TAR) planning does not specifically address major accident scenarios. It focuses on controls within a single unit. Also, Pre Start Up Safety Reviews (PSSRs) do not consistently address the potential for a major accident.

Recommendation:

A protocol should be developed for use in TAR planning and all Pre Start Up Safety Reviews, which specifically seeks to minimize risk and addresses relevant safeguards for all populations who could be affected in a major accident scenario. A specific safety report for each unit that documents the major hazards, consequences, probabilities, and key controls and safeguards would be a useful reference document for this purpose and it could also be used in training sessions for operations.

Compliance Assessment

Strengths:

PSM Compliance Review
The refinery has an appropriate procedure for conducting compliance reviews in accordance with the requirements of 29 CFR 1910.119 (OSHA Process Safety Management) and 40 CFR Part 68 (EPA Risk Management Plan). Reviews are conducted by teams consisting of company personnel from other global sites, per the required schedule. They are documented in comprehensive reports, which include a list of prioritized action items.

"Getting HSE Right" (gHSEr)
The refinery completed a self-assessment based upon the "gHSEr" protocol in 2004. The assessment was competently done and identified many of the key issues being seen in the current assessment.

"Big Four" Audits
The refinery has recently established an HSSE Verification Team to provide verification that good HSSE policies are in place and that personnel know and follow these policies. This team conducts unannounced audits in the units at the refinery. To date, these audits have focused primarily on compliance with the Authorization To Work and Work Permit procedures. These are referred to at the refinery as "Big Four" Audits.

Issue: Response To Audit Findings

The audit processes are identifying key areas for improvement.

Recommendation:

There needs to be improved prioritization of action items resulting from audits and enhanced leadership focus on getting these action items completed promptly.

Management of Change

Strengths:

Management of Change Procedure
The refinery procedure covering MOC is well written and comprehensive.

PHAs In Support of MOCs
The refinery has a group of PHA facilitators who are trained to lead small-scope PHAs in support of MOC activities. As noted above, the PHAs done make very effective use of the"What If/Checklist" methodology. Initial brainstorming sessions (What If) are supplemented by the application of one or more specialized checklists, containing questions specific to the relevant aspects of the change being made.

Monitoring of Maintenance Work Orders
In preparation for conducting cyclical revalidation of unit-level HAZOP studies, a review of Maintenance Work Orders for the unit, done since the last PHA, is conducted to help ensure that the MOC system is not being circumvented.

Maintenance Understanding of MOC
An effective process exists within the maintenance planning system and job preparation to flag the requirement for approvals for jobs covered by MOC. These are included in the maintenance work packs, in the maintenance work shop.

III. People & Contractor Management

People

Issue: Safety Culture

The safety culture is more like a "silo culture", where units and work groups function as separate entities, rather than a "collaborative culture", characterized by collective effort.

Some "pockets of excellence" were observed, such as the plant-wide shift directors' meetings.

Recommendation:

- Perform a formal organizational systems analysis, conducted by external experts, to more clearly understand the exact nature of the "silo culture" as it currently functions
- Focus on minimizing barriers to collaborative effort identified by the systems analysis, and on becoming seamless in terms of practices and procedures, diversity and inclusion, and safety ownership

- Include metric-based and behavioral-based expectations in the existing accountability system to require the establishment of collaborative effort across all units, plants and employee groups
- Provide Leadership Team, superintendents and supervisors with a robust consequence management system that focuses attention on recognizing individual and group behaviors that contribute to the shift to the "collaborative culture"
- Provide training, coaching, specialist support and competency-based feedback to enable Leadership Team, superintendents and supervisors to provide adequate safety-culture leadership

Issue: Personnel Management of Change

PSM-10 section 14.8 requires that under certain circumstances a Personnel Change MOC be completed. There is evidence that the MOC is completed for senior supervisory positions. The checklist is completed and any "no" responses are followed by an explanation and relevant action items. However, it does not appear that "no" responses negatively impact upon the planned personnel change.

Recommendations:

- Confirm whether action items arising from the Personnel Change MOC are entered into and followed by the Tr@ction system.
- Consider whether "no" responses on the checklist can reverse the personnel change decision.
- Team was unable to determine if the Personnel Change MOC is utilized below the middle management level. Recommendation is to use the Personnel Change MOC at all grade levels.

Training and Assessment

The importance of training and performance competency has been institutionalized through the creation of the Learning and Development (L&D) Organization and through the extended training function embedded within the units.

Issue: L&D Leadership & Accountability

The L & D Organization lacks adequate leadership and accountability.

Recommendations:

- Accelerate efforts to fill the vacancies within the L & D Organization. Bring in external training and development talent to fill the manager position.
- Create a Texas City Refinery Training Steering Team that, at a minimum, includes all unit trainers

- Implement Trainer accountability plans to clarify expectations and provide a formal mechanism for recognizing proactive, positive, contributions to Texas City Refinery's safety culture

Issue: Trainer Utilization

Unit trainers are expected to spend 85%-90% of their time on unit training needs. The recent utilization assessment shows that unit trainers are under utilized with utilization ranging from 30% to 80%.

Recommendation:

- Hold superintendents accountable for ensuring that unit trainers are spending 85-90% of their time on unit training needs
- Conduct an internal peer review of the unit trainer function to determine if there are systematic gaps between what trainers are expected to do and actual performance
- Resolve any expectation-performance gaps identified by the peer review by clarifying trainer role and communicate that role clarification throughout all units

Issue: Operator and Maintenance Tech Competency Assurance Audit Follow Up

The Operator and Maintenance Tech Competency Assurance Audit results indicate deficiencies in the training support systems and processes, and that deficiencies remain from audit to audit with little to no improvement.

Recommendations:

- Each deficiency identified in training support systems and processes should be assigned to a SPA, and given a realistic target date for closure and then be closed by the target date.

Issue: Gun Drills

Interviewees identified competency in responding effectively to upsets as a critical requirement for all unit employees. However, the utilization of gun drills is inconsistent. The range of utilization goes from once or twice a month to not having a gun drill in the past two years.

Recommendations:

- Determine the optimal frequency of gun drills by unit, require the drills to be performed in alignment with that frequency, and hold supervisors responsible for conducting quality gun drills.

- The unit trainer within the Ultracracker (ULC) has access to simulator capability for gun drills. Suggest exploring options for providing similar simulator access to other units.

Issue: Supervisor Competency

There is no system for ensuring that "step up" supervisors and supervisors have the necessary skill sets to be effective safety leaders.

Recommendation:

- Develop a process that sets forth safety roles and responsibilities, establishes competencies, and includes training, competency demonstration, evaluation and refinement

Issue: Respect Between Management and Employees

Although there were examples of appropriate behavior between management level and hourly employees, the team noted examples of lack of respect between these levels.

Recommendation:

- The BUL should provide a clear statement that managers and employees are expected to work as a team, and that any behaviors not in alignment with BP's D&I policy will not be tolerated.

Performance Management

Issue: Performance Accountability System

The performance accountability system is characterized by an array of antecedents and consequences designed to prompt and maintain desired behaviors. The accountability system lacks standardization and execution is inconsistent across units. Employees, at all levels, are not being held accountable for aligning their behaviors with the safety performance expectations.

Recommendations:

- Implement a safety balanced-scorecard system that is owned by unit teams, and that includes input and output measures
- Implement a safety absolutes program that includes articulation of behavioral expectations for supervisors and hourly employees. This program must include management and supervisory support, a balanced consequence management system, and workgroup or team specific reinforcement plans

- Create an integrated consequence management system that incorporates positive reinforcement, Positive Discipline, and Just Culture.
- Train managers and supervisors in safety leadership skills and in effective consequence management
- Consistently apply consequences that are appropriate for the behavior

Issue: Risk and Hazard Recognition

Risk complacency and tolerance for risk can be further minimized by implementing a robust hazard recognition process.

Recommendations:

- Provide hazard and risk awareness training for the workforce
- Require supervisors and hourly employees to front-end load safety into tasks by performing Pre-Task Assessments prior to starting work, and to conduct continuous assessment throughout the task to address changing conditions
- Improve the quality of ATW execution and work planning discussions
- Promote near-miss reporting as a hazard recognition and reporting tool
- Use the Workforce Safety Observation Process to strengthen hazard awareness
- Enhance management and supervisory involvement in hazard recognition through the ASA process

Issue: "Duty of Care" Philosophy

BP's "Duty of Care" philosophy establishes the expectation that all employees will intervene on behalf of their co-workers. The Workforce Safety Observation Process provides the mechanism through which hourly employees can systematically intervene. There is low participation in the process, with the exception of during turnarounds. Peer intervention without use of the Workforce Safety Observation Process is weak.

Recommendations:

- Establish specific, behavior-based expectations around BP's Duty of Care philosophy and hold the workforce accountable for acting upon those expectations
- Commission an inclusive team (i.e., management, employees, contractors) to perform an evaluation of the Workforce Safety Observation Process to identify barriers to effectiveness and to redesign the process as needed
    - Launch the refined process and promote participation
    - Provide training on the key components: feedback, observation, recognition
    - Use observation data to develop opportunities for positive reinforcement, to highlight trends and the need for directed interventions, and to pinpoint barriers to safe choices

Issue: Contractor Safety Management

The contractor management program is rooted in the written contractor management procedures and in the Texas City Contractor Safety Council. The procedures are systematically applied to the management of contractor employees during turnarounds, routine maintenance and special projects. Contractor performance is managed through a "no tolerance" approach to deviations from appropriate safety performance.

Recommendations:

- Improve the business partner relationship through diversity and inclusion
- Every employee's performance contract must include actions designed to strengthen this relationship
- Assess the adequacy of the contractor safety orientation program and various contractor safety training programs

IV. Maintenance Reliability and Integrity

Issue: Maintenance Management Information

Data exists for virtually all aspects of equipment and maintenance process performance. The equipment databases are in several separate locations. Each of these systems is basically robust; however, their separation affords the potential for error in migration of requirements from one system to another.

An overview of plant maintenance / reliability / integrity performance is produced in different forms from the same basic data across the plant.

Recommendation

- Provide a refinery wide standard suite of performance measures using existing data sources. Consider the web-based system recently developed for East plant as a good option.

Issue: Maintenance Work Process

A comprehensive maintenance work process has been developed and documented by the Maintenance Branch. The process is very dependent upon the interactions between the plant Maintenance Coordinators and the Maintenance Supervisors. Ownership of the process is much stronger within the Maintenance Branch than across the units where it is variable.

The intent of the process is to increase work efficiency through work preparation and continuity delivered through good planning. Schedule compliance is a Key Performance Indicator of the effectiveness of the process and is currently variable across the units.

Roles and responsibilities are well described in the Responsibility Accountability Consult Inform (RACI) documents. The use of Ranking Index for Maintenance Expenditures (RIME) system is embedded in the process; however, in some areas RIME did not feature in the actual scheduling & prioritization.

Recommendations:

- Change the current organization to increase the functional focus on Maintenance and the Maintenance process by having all Maintenance personnel report into the Maintenance function while remaining physically based in three or more plant areas.

Issue: Availability Strategy and Strategic Plan

A clear, comprehensive and well-advertised Availability Strategy exists. Buy-in to the strategy and the tactical actions required to achieve it is variable across the plants and branches of the refinery.

The refinery strategic plans are indicating that maintenance cost will approach Solomon 1st / 2nd quartile within two or three years. Given the increased focus on Inspection and Integrity and the efforts in that regard it is considered likely that additional funding required to follow through on these programs will at least keep total maintenance costs above this level in the medium term.

Although safety is mentioned explicitly in the Availability Strategy in association with contractors, risk, new equipment, MOC, there is no component that is explicitly devoted to safety/integrity in terms of unnecessary risk of harm to people.
What is not necessarily explicit in the strategy is that production must be delivered in accordance with the company value of no harm to people.

Recommendation

- Develop and include a component of the Availability Strategy that is explicitly for Safety and Integrity.
- Review the potential cost impact of the increased focus and effort on inspection and translate that to a realistic maintenance cost prediction in strategic plans.

Issue: Reliability Centered Maintenance

Reliability Centered Maintenance (RCM) has been chosen as a method to review, in a structured way, the process units and areas of the refinery. This effort has been allocated sufficient resources and appropriate organizational structure within the Maintenance Branch to support implementation.

A prioritization process has been developed to aid the selection of the units / areas for execution of the process.

Plant Superintendents are not strongly linked into the current work. Given the potential benefits of the system it is surprising that there is not a more closely defined plan for application of the system with an associated performance-managed approach by the eventual beneficiaries of the system.

Recommendations

- Make the implementation of the RCM process an explicit performance measure in the Performance Contracts of the Superintendents.
- Provide appropriate resources in support of implementation within each unit or site.

Issue: Root-Cause Failure Analysis

The Root-cause Failure Analysis (RCFA) process is regarded as having been used productively and was more widely recognized than the RCM process.

Development of a small center of expertise for the application of the RCFA process is seen as a sensible development supported by the training carried out more generally for potential participants in the process. It is acknowledged that the development of the service is still at a relatively early stage; it would be advantageous to accelerate the application of the process.

Recommendation

- Capitalize on the apparent success of the process by making it more widely applied, perhaps by reducing the current threshold of $300,000 loss potential.

Issue: Coaching of Plant Superintendents

The spread of responsibility of the Manufacturing Delivery Leaders (MDLs) appears to offer little or no latitude to the MDLs to offer coaching and developmental support to the key role of Superintendent.

Recommendation

- Staffing at the line management level above Superintendent should be sufficient to provide adequate interaction between line management and Superintendents so that Superintendents are supported in their development to meet their accountabilities.

Issue: Inspection Processes

The recent substantial changes with respect to Inspection at Texas City Refinery, which include additional BP Inspection personnel and an additional level of Inspection supervision are entirely appropriate and appear to be beginning to deliver better focus to inspection efforts.

Recommendation

- Develop a robust plan for the completion of the Inspection Renewal Process (IRP) across all areas of the refinery.
- Provide the appropriate level of resource in support of the plan to ensure completion as planned. Consider redirecting appropriately qualified and experienced personnel from less critical functions to support this process.

Issue: Inspection Procedures & Involvement

A revised process to address Defect Resolution for Fixed Equipment contains all the essential requirements for effective control of these issues, including appropriate timely assessment time frames; however, it has not been issued as a formal Texas City Refinery Process Safety Management (PSM) Policy.

The process for the installation of temporary clamps and repairs, while involving the Inspector does not fundamentally require approval of the Inspector.

Previous Risk Based Inspection (RBI) processes applied to the refinery units have some outstanding actions that require completion and close to validate the RBI.

Recommendations

- Issue the Defect Resolution procedure as a Texas City Refinery PSM policy.
- Modify the clamp and temporary repair process to require approval of an inspection group leader.
- Each RBI action item should be assigned to a SPA, and given a realistic target date, with a resource plan, and then be closed by the target date. Extension of target dates should only be allowed where legitimate extenuating circumstances dictate. Increased emphasis by the refinery on prompt and timely closure of action items resulting from RBI is needed.

Issue: PCMS Inspection System & Data

The system is basically a robust method to collect and maintain inspection data on equipment items and record historical data on measured condition at specific times.

There were anomalies in some detailed data within the system when investigated on a sample basis.

The methodologies of calculation of discard (end of useful life) are documented, but the PCMS internal calculation methods were not immediately known to inspection people.

Recommendations

- Review all PCMS data as part of the IRP and rectify any deficiencies in system allocation and circuitization.
- Train and educate Inspection Leads on the workings of PCMS calculation process to allow Quality Assurance of output.

Issues: Instrument Protective System Categories

An explicit policy with respect to conducting complete unit Safety Integrity Level (SIL) reviews on a routine basis does not exist; Instrument Protective devices are only reviewed as part of revalidation Hazard & Operability (HAZOP) programs or associated with modifications. The "grandfathered" status of Instrument Protective Systems is also not entirely clear; however, there is a belief that these issues will be addressed in BP Engineering Technical Practices on the subject about to be issued.

A relatively small number of automated unit or partial unit trip systems exist on the plants.

The Loveland system does not currently have a means of identifying critical devices with respect to functional purpose, such as, Safety, Environment, or Equipment Protective, all items are categorized as either OSHA or not categorized.

Recommendations

- Address the need for a completely clear policy stating timeframes within which SIL analysis will be completed on all operating plants. This action should include a quantified assessment of the need for automated systems.
- Investigate a refinement in the Loveland system to increase specificity of "critical" (OSHA) items to at least Equipment, Safety or Environmental in nature.

Issue: Instrument System Endorsement Process

All equipment that is currently categorized as OSHA by Texas City is scheduled for testing on an annual basis. TAR items (those requiring a unit shutdown to test) are identified and are endorsed until the next TAR. There was evidence that technicians may take opportunities at non-cycle ending shutdowns to pick up TAR tests but the process or requirement for this is unclear.

No process was identified that reviewed the "As Found" conditions with respect to tests which failed "As Found", these items are corrected by resetting and placed back in service with the same time endorsement that occurred prior to being tested.

Data security is maintained by log on and password system, however, there is some scope for improvements in password control.

Recommendation:

- Where tests can only be conducted at TARs, appropriate analysis of the system must be completed to ensure the test frequency is adequate.
- Require that a Tr@ction Process safety Near Miss report is created when a critical alarm or trip is tested and found in a failed state, this report should be approved by the I&E Reliability Engineer and appropriate actions to address root cause and future endorsement for the test completed.
- Develop and implement a more robust password system for Loveland users.

Issue: Instrument System Testing

The Loveland system has the capability to accept data automatically from a pre-programmed test recorder device that interfaces to the test equipment used. This "2020" system was provided to all plant areas when the Loveland system was established some years ago. Use of the 2020 tools is variable across different plant areas, some almost exclusively using and some not. The use of manual means of recording test data limits data assurance. Technicians have broad access to revise test procedures and process within the database.

Recommendations:

- The use of the 2020 data logger system is best practice and should be encouraged in all areas of the plant.
- Implement a process for Supervisory sign off for changes to test procedures made by technicians.

Issue: Relief Valve Maintenance Process

The processes and personnel associated with the management of Relief Valves for the refinery are adequate and meet the requirements of the relevant codes and standards. The lack of a structured process for resolution of issues with the small number of valves that do not pass tests is a gap.

Enhancements to these systems are under development, when implemented these will move the refinery's efforts in this area to a best practice.

Recommendations:

- The PCMS version 6.5 is a best practice system and should be implemented in a timely manner, currently expected end 1H 2005. It should receive the required support from IT and management to achieve this.
- Finalize and issue the Endorsement Review protocol that is currently under development.
- A process to require a Tr@ction Process safety Near Miss report for each instance where an RV fails a test. The report should address the root cause and endorsement using the Endorsement Review Protocol.