TK-190 Overfill Incident
Root Cause Analysis Report
And
Post Accident Review

June 22, 2010

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A guard was installed on the Control Module UPS DC input breaker to protect it from accidentally being tripped. This guard is UL required because the UPS feeds emergency lighting circuits. The particular configuration of the guard prevented visual confirmation that the breaker had opened and made it difficult to troubleshoot.

When power was restored to the Station Control Panel, part of the initialization sequence was to reset all the PLC internal registers to zero. When this happened, all the outputs were reset, which in this case indicated a fire in the PDC Module and opened the PDC transformer breakers again.

The tank farm audible and visual alarm activates whenever any of the relief valves move open 5% or more. The alarm is powered from the non-critical bus and gets the control signal from SIPPS. The loss of power to the Control Module caused the SIPPS panel to be de-energized resulting in the tank farm evacuation alarm not functioning.

After the first fire system test, battery limit valves BL-1 and BL-2 could have been either in the normally operated open position or remained in a closed position isolating the station. Had the valves remained in a closed position, the subsequent power outage would have caused minimal crude flow and TK-190 would not have overfilled. The relief valves provide protection from over pressurizing the pipeline. Isolating the pipeline from the relief system is permissible but must be properly executed and managed.

In preparation for the shutdown, the fill level of TK-190 had been reduced from 18' to 13.8'. Prior to 1994 the minimum fill level for TK-190 was approximately 5.5'. Currently, the tank has a minimum operating fill level of 13.3' to ensure flooding of the relief valves and elimination of vapor pocket formation. It is unclear if TK-190 capacity at the existing minimum fill level is adequate under the current operating philosophy.

Maintenance issues were noted during the investigation including UPS batteries with some dead cells and temperature concerns in the PDC Module. Work orders were generated prior to the May 25, 2010, shutdown to address this work but had not been completed. This work was not considered critical by the Investigation Team and not integral to the incident.

Root Cause #1 Recommendations:

1. Establish technical teams to conduct reviews of the technical and design issues identified above and to validate the overall Strategic Reconfiguration (SR) Design Basis. Examples of areas that should be considered for review include:

    - Control Logic
    - Use and capacity of the breakout tanks
    - Process configuration and relief systems
    - Electrical configuration and circuits on the critical bus or non-critical bus
    - How power is fed to the control systems in the Control Module (SIPPS, SCADA, NIPS, and SCP).

2. Conduct a review of the philosophy and operating practice regarding the configuration of the mainline valves (RGVs and BLs) during shutdowns

3. Review Electrical and Automation (E&A) changes made at PS03 and PS04 and ensure all applicable to PS09 have been completed. Expedite the implementation of optimization projects at PS09, specifically the security and controls upgrade projects.

Root Cause #2 - Previous Incident MAPs & Lessons Learned LTA

Over the last several years, there have been a number of incidents with resulting Management Action Plans (MAPs) intended to implement recommendations identified during the investigations. Lessons Learned are routinely conducted throughout the organization for a wide variety of activities such as major maintenance completion, pipeline shutdowns, oil spill drills, and incident response. Despite the efforts made to address previous incidents and to learn from previous work activities, there continues to be a

pattern of significant incidents occurring. As an organization, we are not optimizing our opportunities to learn. Personnel are working hard to complete all requirements and remain in compliance, but the completion of actions intended to prevent incidents and the opportunities to learn from work activities have not been effective in influencing the culture or behaviors. Although actions are implemented to address deficiencies and foster continuous improvement, the fragmented approach does not always result in the comprehensive results intended.

Reports and recommendations from previous incidents have not been communicated well throughout the organization. There may be some expectation for the communications to be included in the MAPs but most actions are specific with little disseminating of information for possible application to other parts of the organization. Review of the Incident Investigation Process and sub tier procedures reveals no direction regarding MAP development, implementation, or validation of resolution action effectiveness. There is usually no continuity between the Incident Investigation Team and the MAP Development Team. The richness of discussion and complete appreciation for the report recommendations may not always be transferred into the MAPs. The Operations Incident Review Board has not been meeting as routinely as intended and has not effectively communicated incident learning's throughout the organization.

The organization does not always conduct Lessons Learned with the rigor necessary or fully use the previous lessons learned for the next major maintenance activity or pipeline shutdown. An example of procedural deficiencies regarding Lessons Learned is OMPV-0001, *Management of TAPS Shutdown Based Maintenance*. This procedure includes a requirement for conducting post shutdown Lessons Learned but no direction or requirements for how this information is specifically considered during planning for the next shutdown. Management has not fully succeeded in fostering a culture of learning by taking actions such as establishing a centralized repository for lessons learned, establishing expectations for utilization, or developing methods for broader analysis and communication.

Root Cause #2 Recommendations:

1. Include TK-190 Investigation Team representation during the MAP development and implementation to ensure continuity during the transfer of recommendations into completed action items. Ensure Incident Investigation Team representation during MAP development and implementation for future incident investigations.

2. Enhance AMS-024, *Incident Reporting, Investigation and Analysis Process*, and LPS-001, *Loss Prevention System*, to provide direction and detail on MAP purpose, accountabilities, Investigation Team/MAP continuity, development, communication, tracking, and validation. Also, provide guidance to the Operations Incident Review Board to incorporate knowledge sharing and a learning culture.

3. Improve methods to provide easy and reasonable access to incident investigation reports, Lessons Learned, risk assessments, and hazard analysis (e.g. SOC, PHAs) type documents. Establish expectations for personnel to utilize the tools to foster a culture of knowledge sharing and learning throughout the organization.

Contributing Causes

Contributing Cause #1 - Situational Awareness LTA

Employees knowledgeable of operational processes (OCC & Field) did not react in a manner that supported the safety and integrity of TAPS. The investigation team strongly considered "Situational Awareness LTA" as a primary root cause. However, after much deliberation, the team concluded that this was a significant Contributing Cause of this event and actually fit beneath the umbrella of Root Cause #2, Previous Incident MAPs & Lessons Learned LTA. Specifically, situational awareness was identified in the previous PS09 Piping Overpressure Event report and the fact that it was identified as an issue during this incident investigation provides direct linkage to Root Cause #2.

Situational awareness is paramount to responding to abnormal conditions. Interviews suggest many of those directly involved in this event, both at OCC and PS09, reflected that they should have realized the relief valves had opened and crude was flowing to TK-190 when power was lost. OCC and operational procedures and training do not historically focus on static-state shutdown conditions. Procedures are not consistently written in a manner that provides the user with instruction or guidance on how to address an abnormal condition should the system not react in the expected manner. PS09 field personnel failed to monitor for gas detection before entering the Manifold Building during the initial incident response. Existing hazard recognition training programs focus on personnel safety (e.g., line of fire).

During the PS09 power outage, OCC and field personnel immediately began troubleshooting the power and communications failures. No one stepped back to take a more holistic view of the pipeline or potential ramifications to the pump station due to loss of power. The OCC Controllers had some degree of attention on the relief system because the relief valve set point was changed twice, but they did not recognize available information to help them further assess the situation (e.g., OCC data indicating significant upstream flow). OCC personnel monitor and react to volumes of data, alarms, and screens. As such, we must ensure they remain focused (situational awareness) and equipped (visibility to critical decision making data) to appropriately respond to abnormal conditions. This lack of action and preparedness prevailed in spite of a communication in 2009 which noted the fire system testing "will not shut down the station unless the relief system UPS is not up to snuff".

Individuals on-site at PS09 during the shutdown, including the O&M Supervisor, had operational backgrounds but their focus was on maintenance activities and not operational processes. These individuals did not achieve situational awareness nor did they react in a manner to safely address the abnormal condition. Individuals in operating roles must have operational process knowledge and focus to be successful. Currently, there are expectations for maintenance and response personnel to fill some of the roles historically performed by operations personnel. In the case of the TK-190 overfill incident, one individual filled three roles as the Pump Station Caretaker, Maintenance Technician, and project F645 SPOC.

While OCC did not have visibility of PS09, monitoring upstream pressure at PS08 could have provided insight to the Controllers that pipeline pressure was dropping, indicating flow. OCC is responsible to operate a complex system in terms of station configurations, human machine interfaces (HMI), and complexity of automated systems. Each of the four active pump stations currently has a different configuration. PS09 is fully automated and unstaffed, PS03 and PS04 are also fully automated and transitioning to unstaffed, and PS01 has not started the automation process and remains in the legacy configuration. OCC responses to alarms received vary station to station due to their particular configuration. For automated stations, the interconnection and failure modes are complex and can be difficult to troubleshoot. Automation Engineers are routinely consulted to assist OCC and field personnel with troubleshooting activities.

Contributing Cause #1 Recommendations:

1. Enhance the organization's Process Safety competencies with emphasis on heightened awareness, understanding, and communication of Process Safety. Within this context consider:
   - Provide Process Safety Management (PSM) training for all managers involved with operations, maintenance, and projects. The training should familiarize personnel in leadership positions with the differences methods for managing process safety versus personnel safety
   - Develop operating procedures to ensure pipeline shutdown states (e.g. slowdown, static) are considered and appropriately addressed
   - Incorporate SOC and risk assessment results with appropriate contingency actions for potential abnormal conditions in operating procedures (e.g., at specific hold points or significant steps within the procedure)
   - Assess the opportunity to apply the Safe Performance Self Assessment (SPSA) concepts within an operating procedure (e.g., if this next step does not respond as intended what will I do and what should I be concerned about)
   - Incorporate elements of Situational Awareness in the work permitting process.

2 Review Situational Awareness training programs and incorporate improvements into existing training considering:
   - Retaining a resource with expertise in the area of Situational Awareness
   - Defining Situational Awareness and its importance in operating TAPS safely
   - Scenario based simulations (OCC) and exercises (field) which test situational awareness and related decision making to abnormal conditions
   - Specific situational awareness exercises within spill drills
   - Process knowledge skills based training for accountable managers, supervisors, and technicians
   - Assessment of knowledge for accountable managers, supervisors, and technicians
   - A structured feedback or Situational Awareness Mentoring Program where more experienced technicians/controllers mentor new personnel focusing on potential abnormal conditions and how to respond appropriately.

3. Assess industry best practices and improve management processes for OCC alarms and HMI screens.

4. Enhance the investigation and lessons learned processes by incorporating a focus for identifying situational awareness deficiencies for improvement opportunities.

Contributing Cause #2 – Safe Operating Committees LTA

The *Corporate Safety Program,* SA-38, and other Department Operating Procedures (DOPs) outline specific requirements for performing Safe Operating Committee (SOC) review of procedures. As a result of the recent PS09 Piping Overpressure Event in July 2009, some of these procedures were improved and others developed. These procedures were reviewed during the investigation and noted as not fully addressing all the issues previously identified. As an example, SA-38 specifically requires DOP's be developed and to identify who can be an SOC Chairperson. OCC procedure OMD-0101, *Oil Movements Department Safe Operating Committee Review Requirements*, was published in 2008 but this requirement has not been addressed.

Specific to this event, SOCs were not conducted by field personnel for the three fire system testing procedures (TWSP-40007697-01, 02, 03) to fully assess potential impacts by their execution. An SOC was conducted for the OCC May 25, 2010, shutdown procedure (TP-OCC-1007) by OCC but it did not include all affected parties as required (e.g., no PS09 participation). There was an opportunity to block in or isolate the station and still accommodate the fire system testing and pressure protection of the pipeline. The SOC process employed did not recognize or encourage discussion involving alternate methods to isolate the station.

No requisite training on the SOC requirement was provided to personnel. There appears to be a high degree of variability in implementing the SOC process as it is inherently influenced by the Chairperson and participants. SA-38 provides structure but there is no standard methodology for conducting SOCs. SOCs may not be viewed as a critical barrier in our overall safety system and their value may not be fully understood. For example, a Lead Maintenance Technician was specifically questioned about SOCs for the PS09 shutdown work and he answered affirmatively that they had been completed. However, the SOCs for the fire system testing TWSPs had not been completed prior to the shutdown.

Contributing Cause #2 Recommendations:

1. Revise relevant SOC programs, processes, and procedures (e.g. SA-38 and DOPs) to:
   - Ensure sufficient clarity is provided for when an SOC shall be performed and address any remaining gaps previously identified in the PS09 Overpressure Investigation Report (e.g., OMD-0101 OCC Chairperson clarity)
   - Incorporate risk assessment methodologies into the SOC processes and procedures to provide a standardized approach and aid in the performance of SOC's

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(http://www.finebergresearch.com/pdf/Investigation%20Report%20100622.pdf)

Click here for complete copy of this report (originally posted on this web site August 25, 2010 with “The Story of a Troubled Tank”).