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Successful Implementation of Hazards and Effects Management System in Capital Project

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Abstract

Tiger AO4 Project delivers a competitive Linear Alpha Olefins (LAO) project at Geismar in 2018, recovering 100 kta of "stranded" LAO capacity in the Geismar Chemical Plan and contributes an additional 716 MMlbs/year of LAO to the Shell LAO Capacity. This paper elaborates the successful implementation of Hazards and Effects Management Process (HEMP) in Tiger AO4 project through design, procurement, construction, commissioning, startup, and operation. During the design process, the key processes include hazard identification, risk assessment, risk management to ALARP (as low as reasonably possible). It also covers the technical integrity verification process during the procurement, construction, commissioning, and startup., this paper explains the processes of incorporating HSSE critical activities (*e.g.* inspection, maintenance, surveillance, operator response, operating procedure steps, *etc.*) with current Geismar management system. At last, this paper also describes the development and operationalization of the Safety Case.

INTRODUCTION

Project Tiger AO4 will add a new Linear Alpha Olefins (LAO) at the Geismar Chemical Plant using Shell Technology. When completed, it will make the Shell Geismar site the largest alpha olefins producer in the world. Alpha olefins are used to produce household detergents, plastics, synthetic lubricants, and drilling fluids, among other useful products. The AO4 Unit will use ethylene as feed stock and produce full range of Linear Alpha Olefins.

The paper documents the effective application of the Hazards and Effects Management Process (HEMP) during the design, fabrication, and construction of the facilities under the scope of the AO4 Project (referred to as Project hereafter).

HEMP OVERVIEW

The Hazards & Effects Management Process (HEMP) is the process by which the Project identifies and assesses hazards, implements measures to manage them, and demonstrates that their risks are reduced to a level that is As Low As Reasonably Practicable (ALARP). This paper gives an overview of how the Hazards and Effects Management Process (HEMP) has been implemented on the Project to identify, assess and manage risks to ALARP.

The HEMP included the following:

- A robust Hazard Identification Process to identify the full range of hazards applicable to the operation of the facilities designed and constructed by the Project
- Appropriate risk assessment tools to assess the risks associated with the identified hazards
- Implementation of effective and valid controls to reduce the risk to ALARP.
- Defining operation and maintenance activities for effective management of Major HSSE Hazards to ALARP risk levels.

See Figure 1 for an overview of the HEMP process.

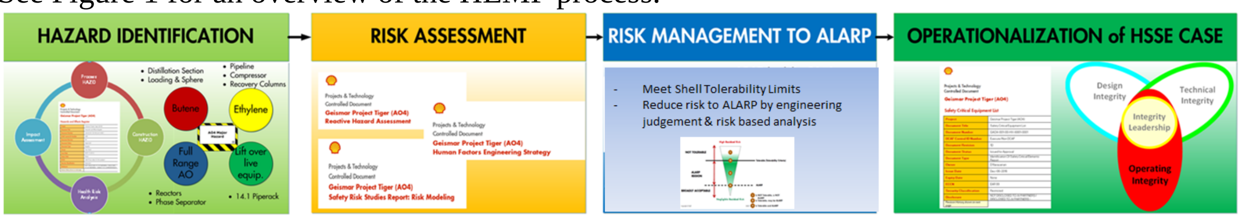

Figure 1. HEMP Overview

HEMP in Project

Hazard Identification and Risk Assessment

Hazard identification and risk assessment were done through a series of studies such as the HAZID (Hazards Identification), HAZOP (Hazards and Operability study), RHA (reactive hazards analysis), Consequence Modelling, layout assessment, health risk assessment and HFE (Human Factor Engineering) Screening. Also, Health, Security, Environmental Hazards and social aspects were identified through an Impact Assessment. The risk ranking is based on the established Shell Risk Assessment Matrix (RAM), which accounts for the likelihood and severity of consequences associated with the hazards.

A Hazards and Effects Register was developed which is a compilation of all AO4 process and construction hazards, along with the source of the hazard, credible worst-case consequence, risk ranking and methodology for demonstrating ALARP.

Risk Management and ALARP Determination

AO4 Project selected the risk management methodology based on the severity and likelihood of the hazards. The risks were managed to tolerability criteria defined by the Project HSSE Premise. The tolerability criteria were in line with current industry practices. In addition, the Project drove the risks to ALARP, which was not a specific numerical quantity but was defined as the level of risk reduction beyond which the cost of further risk reduction is grossly disproportionate to its benefit.

Figure 2 provides an overview of the Risk Management Methodology.

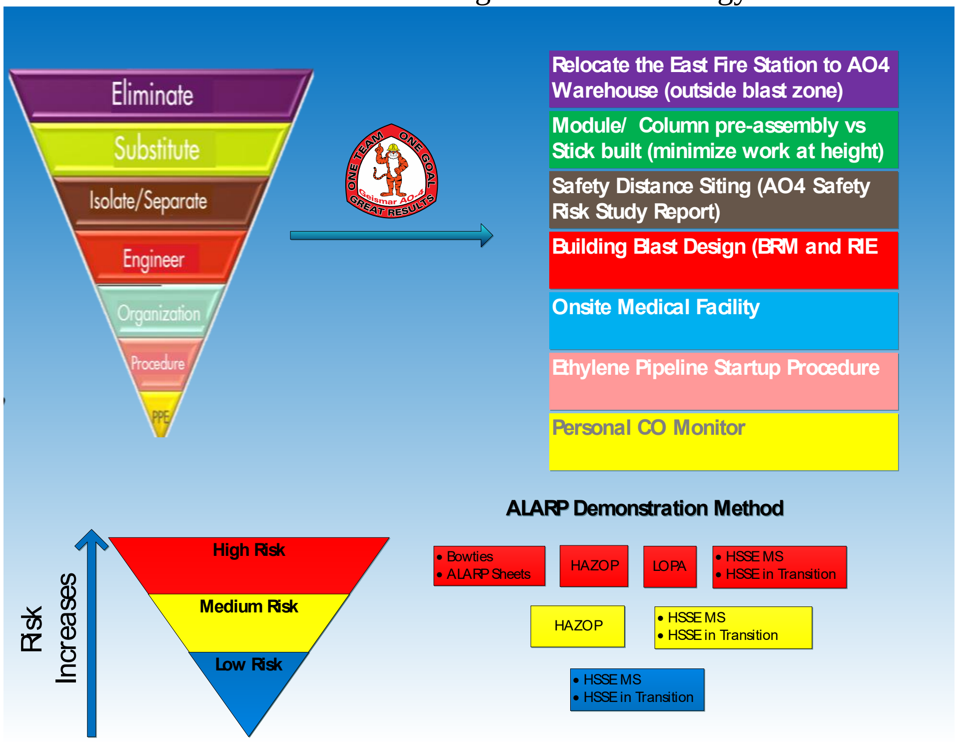

Figure 2. Risk Management to ALARP

- Low Risk Hazards: The Project managed hazards having low risks through the effective implementation of the Shell Project HSSE Management System
- Medium Risk Hazards: The Project managed hazards having medium risks through compliance to International codes and standards (i.e. ISO, API, ASME, IEC, etc.); and Shell DEPs (Design Engineering Practices). In addition, the Project identified and documented control and recovery measures for all scenarios associated with medium risks through the HAZOP study.
- High Risk Hazards: For each of the high-risk hazards identified in the Hazards and Effects Register, the Project demonstrated that the risk is tolerable through the LOPA exercise. The LOPA exercises focused on verifying whether previously identified Control and Recovery Measures (during the HAZOP) were sufficient to meet the Tolerability and ALARP criteria set for the project. Additional barriers were provided if the previously identified barriers did not meet the tolerability or ALARP criteria. Demonstration of ALARP involved an assessment of residual risk compared to project premises to determine whether sufficient controls are in place to manage the residual risk to an acceptable level and whether additional risk reduction options are reasonably practicable. Residual Risk is considered ALARP if further action is grossly disproportionate to the reduction in risk achieved. Hazard control sheets and bowties were developed to

summarize the risks associated with these major process hazards and provide an indication of how these risks have been managed to ALARP.

Implementation of HEMP in Design Phase

Results of various risk management studies were incorporated into the design of the AO4 unit. Here are a few examples:

- The results of consequence modelling were used in the development of the unit layout.
- The HFE requirements were included into the design and verified through 3D model reviews
- Design requirements were developed for barriers identified through HAZOP and LOPA studies to ensure their validity.

The control and recover measures for high risk hazards identified through LOPA, Safety Risk Studies and Application of Design Standards were considered safety critical barriers. The barriers were categorized into safety critical equipment, safety critical activities and other design features. For each of these categories, design performance standards were developed by the responsible disciplines to define the design performance criteria, and the assurance activities.

Implementation of HEMP in Construction Phase

Focused risk assessments were conducted to evaluate the risks and develop risk mitigation measures for the construction hazards identified in the project Hazards and Effects Register. These risk mitigation measures were incorporated into construction plans.

The integrity of safety critical equipment identified in the design phase was managed through various quality inspection test plans developed by the responsible disciplines to meet the performance criteria. Implementation of these inspection test plans were assured by field engineers.

Implementation of HEMP in Commissioning/Start-up (CSU) Phase

HEMP during commissioning and start-up focused on the simultaneous operation (SIMOPs) between construction and CSU activities. Focused risk assessments were conducted to evaluate the risks associated with the SIMOPs. The risk mitigation measures identified in these studies, such as demarcation, energy isolation, communication, were developed into SIMOPs checklists. Implementation of these SIMOPs checklists were assured by field engineers.

The integrity of safety critical equipment identified in the design phase was managed through commissioning procedures developed by the responsible disciplines to meet the performance criteria.

Operationalization of HEMP

The various AO4 Project HEMP deliverables were operationalized and integrated into the existing Geismar HEMP studies, such as the existing Geismar Hazards and Effects Register, facility siting study, consequence model, and HAZOP report. .

In addition, the integrity of safety critical hardware barriers identified in the design phase (HAZOP/LOPA studies) was managed through various Reliability Centered Maintenance

Process. The resulting inspection and maintenance activities and frequencies were incorporated into the existing Geismar management systems.

Operator actions/activities that were used as valid barriers in the HAZOP/LOPA Study for major hazard scenarios were considered as safety critical activity barriers. These activities/actions were incorporated into

- Operating procedures
- Operator response to alarms
- Surveillance/ Operator Rounds
- Emergency Response plans

Figure 3 shows the detailed process of operationalization of the safety critical barriers.

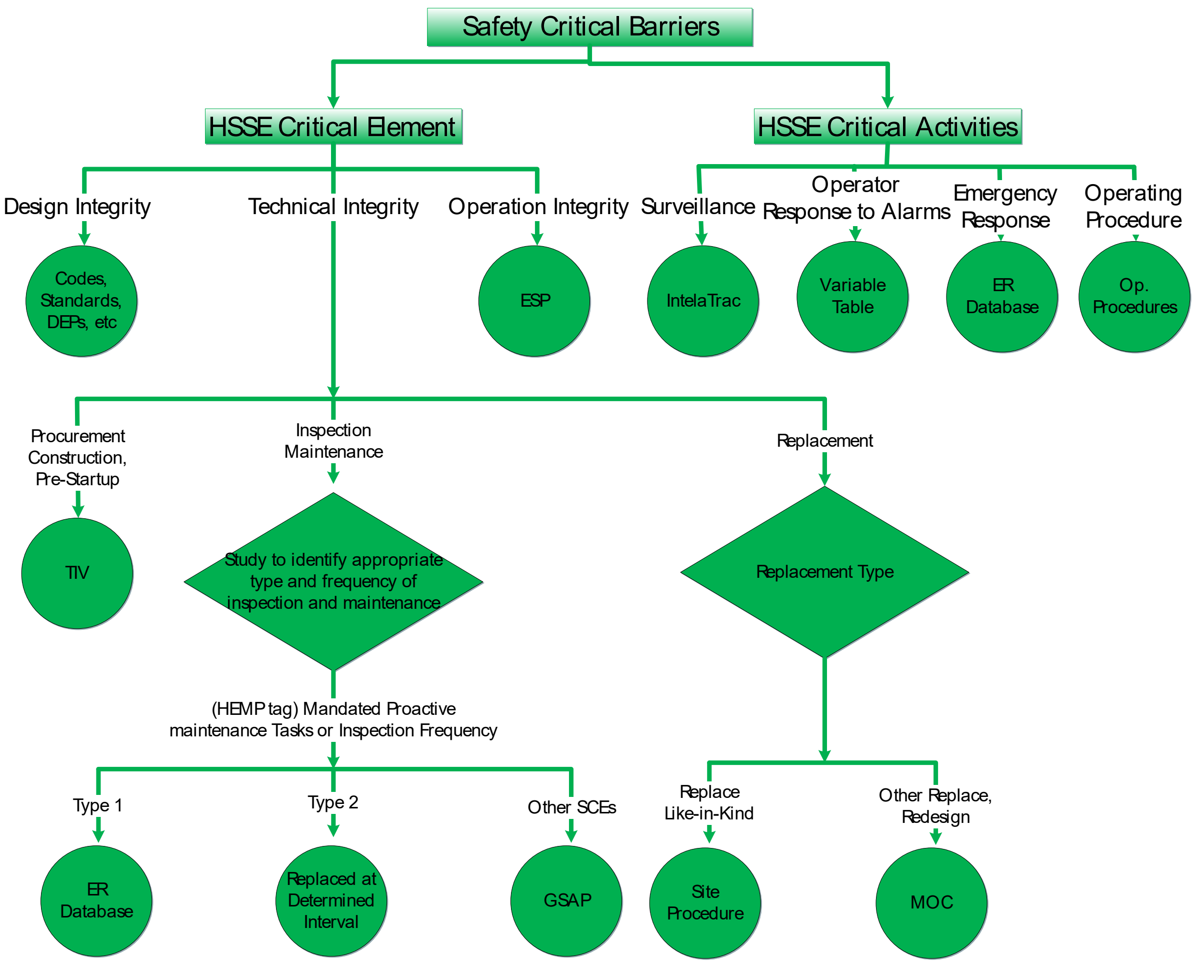

Figure 3. Operationalization of Safety Critical Barriers

Bow-tie diagrams showing threats and barriers associated with the major hazards were developed using the results of the HAZOP/LOPA Studies. These Bow-tie diagrams were used to train operators and to communicate to stakeholders:

- Major hazards and their location in the Unit
- Associated barriers installed

- Operator activities that are required to mitigate risks
- A link to processes that was used to maintain the integrity of the barriers during the operate phase

CONCLUSION

This paper elaborates the successful implementation of Hazards and Effects Management Process (HEMP) in Tiger AO4 project. The project recognizes that HEMP implementation is not effective if it ends with completion of risk management studies. The effectiveness can only be guaranteed if the integrity of the barriers identified through the studies is managed through the life-cycle of the project and the asset. The Project accomplished this by establishing work process to ensure the integrity of the barriers through design, procurement, construction, CSU, and operation. In addition, the Project did not considered HEMP as a standalone or single discipline work process; instead, made it an integral element of multiple discipline work process.