Layer of Protection Analysis of Clean Fuels Complex of Refinery

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Abstract

Light Cycle Oil (LCO) Hydro Cracker (HC) is a critical unit of Clean Fuels Complex (CFP) in the refinery which enables to upgrade low-value products into high-value products and convert high-sulfur material to low-sulfur material. The process of hydrocracking in this unit poses one of the highest hazards of runaway reaction in the whole refinery complex other than the toxicity hazard of Hydrogen Sulphide.

This paper describes a Layer of Protection Analysis (LOPA) study recently conducted for LCO HC and associated facilities in CFP at refinery to identify the risk arising due to any malfunction affecting operating personnel and to carry out a more detailed analysis of existing safeguards after a baseline Process Hazard Analysis (PHA).

The study follows a classical approach to risk assessment. Scenarios were screened from Hazard Evaluation exercise from baseline PHA. From baseline PHA, loss of containment scenarios were identified for safeguard validation based on consequence category. The LOPA study was conducted minimum for scenarios with Risk category I and II after validation of existing safeguards. Single cause–consequence pairs were developed with clearly identified and documented causes/threats as the initiating events and the failure of Independent Protection Layers (IPLs) that lead to an undesired consequence. All existing safeguards were evaluated for validity for identified scenarios and IPLs were determined based on validity rules of Effectiveness, Auditability and Independence. Further, initiating event frequency and probability of failure on demand of each IPL was determined from global database. The frequency for a release scenario with a specific consequence end-point was obtained and evaluated against organisation’s tolerable risk criteria.

One of the major recommendations from the study described in detail in the paper is development of Early Event Detection scenarios considering different hazards. The study also resulted in the development of in-house competency in Layer of Protection Analysis and ability to translate such study findings into suitable risk reduction measures. Also, study supported revisiting the What-if analysis and validating safeguards to ensure effective risk assessment.