**HazOp Analysis: going beyond traditional goals**

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**Highlights**

* Arthur D. Little supported a major refinery in the EPC[[1]](#footnote-1) phase HazOp[[2]](#footnote-2) of a plant
* The review integrated several aspects (asset integrity operations, operating manual, safety report development, etc.) not typically included in such an assessment
* The integrated approach supported the client in managing the multiple activities required for the construction and startup phase, making up for some EPC delays.

**1. Introduction**

In 2018, risk management consulting firm Arthur D. Little was tasked to carry out a HazOp assessment on the EPC design of a plant in a major Italian refinery. The plant, built according to an innovative hydrocracking process, underwent major modifications: there was considerable interest at site, Business Unit and HQ levels to ensure a thorough HAZOP review.

In accordance with the client, Arthur D. Little’s framework included additional discussions and analysis, allowing an early start on future activities such as asset integrity checks, alarm management, layers of protection improvement.

**2. Methods**

The HAZOP was carried out according to international standards ([1] and [2]). The analysis was «full recording», noting all discussions even when no credible scenarios would emerge. Both consequences on occupational and process safety, asset integrity and on operability have been taken into consideration. Therefore, a comprehensive assessment was carried out not only on Top-Events, but also on other scenarios typically not assessed during a HazOp due to time and resources constraints.

A comprehensive set of recommendations was issued regarding design and instrumentation modification to be implemented prior to start-up. Furthermore, suggested improvement actions gave relevant contribution on the following aspects:

* Asset integrity. Whenever a scenario was at risk of going beyond design conditions, the equipment and lines were included as “Safety Critical Elements” and/or “Operational Critical Elements” (SCE/OCE) to be subject to dedicated monitoring. Arthur D. Little also recommended additional verifications on the asset integrity whenever such alarms were activated (e.g. registration and analysis of integrity operating windows)
* Transient states. Startup/shutdown procedures, as well as safety operations such as slow and fast depressurization, were included in the study. These operations typically involve less than 10% of the operating time, but account for more than 50% of incidents ([3]). Through the assessment of these procedures, some deficiencies were noticed and countermeasures were considered and included in the operating manuals
* Operating manuals. They had been issued in preliminary versions: the inclusion in the HAZOP highlighted the need of further integrations
* Training. A specific list of recommendations was drafted to ensure that future training programs included special operations following the activation of alarms or emergency procedures.
* Safety Report. The HazOp assessment was included in the Safety Report, as defined by European legislation Seveso-III-Directive [4]. From it, quantitative risk assessments were carried out on the key scenarios, using the Fault Tree Analysis methodology.

**3. Results and discussion**

The HAZOP team divided the recommendations in 10 categories and additional 35 sub-categories and conducted the complete follow-up activities.

The assessment was also fundamental to strengthen the interaction between the process design team (a mixed team with internal and external resources) and the production internal team.

**4. Conclusions**

Throughout this project, the fruitful collaboration between Arthur D. Little and client representatives allowed the HazOp assessment to go beyond its original goals. It can be used as a tool to highlight the “typical” deviations and also to assess and integrate in safety management several other aspects that are not typically considered in the traditional approach.

This way, the client got a head start on follow-up activities, allowing to recover the delay in the EPC process and to start construction activities as planned.

**References**

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1. Engineering, Procurement & Construction [↑](#footnote-ref-1)
2. Hazard & Operability [↑](#footnote-ref-2)