

# Practice Sharing

## FCC Preparing for PHAs and Consequence Safeguard Table

### Purpose and Use:

The purpose of this document is to describe the preparation steps that facilitate a thorough Process Hazards Analysis (PHA) of a Fluidized Catalytic Cracking (FCC) unit, meeting or exceeding regulatory requirements. The practice can be used by PHA coordinators and leaders early in the planning phase of PHA preparation.

### DISCLAIMER:

Practice Sharing Documents are meant to share information on process safety practices in order to help improve process safety performance and awareness throughout industry. The goal is to capture and share knowledge that could be used by other companies or sites when developing new process safety practices or improving existing ones. The Practice being shared has been used by an industry member, but this does not mean it should be used or that it will produce similar results at any other site. Rather, it is an option to consider when implementing or adjusting programs and practices at a site.

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### Scope:

This document covers preparation activities for a PHA of an FCC unit. Its guidance can be generally applied to other process unit PHAs.

### Description and Implementation:

#### Documentation:

It is important to have a full and accurate set of unit documentation in advance of the PHA study. Some of this information may be difficult to collect, so allocate time to it during the planning phase of the PHA. It is also important to verify that documents are current and have not been superseded by subsequent changes. Some of the important document sets are:

- Current unit Piping and Instrumentation Diagrams (P&IDs)
- Previous unit PHA report. (Native file, if available), and “noded” (color coded) P&IDs.
- Company PHA/Layers of Protection Analysis (LOPA) standards with Consequence Ranking Matrix
- FCC unit standards/guidance documents
- Equipment data
- Instrumentation data
- Alarm settings and Protective System documentation
- Unit Process data
- Reports of previous incidents on the unit and FCC units, in general
- Facility siting data/analysis

See OSHA 1910.119(d) for a complete list of Process Safety Information that should be available to the PHA team.

#### Site Personnel:

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Interview local site personnel that may have knowledge of the unit. Most refineries have people that have extensive unit history but are currently in other roles. Information such as unit operations, design and previous incidents are important to consider in PHA studies. Make requests for input in person and hold a face-to-face meeting. It is not likely people currently in other roles can devote the required time to prepare a full written response to information requests, therefore take extensive notes during the face-to-face meeting, and to respect their time do not ask questions that simply duplicate information from available source documents. Sources of information may be identified and can be requested. Make sure to keep a detailed list and follow up on each item until it is received. Recommended areas of discussion are:

- Comments on Transient operations (startup, shutdown, unit upsets)
- Chronic unit problems
- One-time unit problems

### Preparation Activities:

Preparation activities save time and ensure a thorough, detailed study can be performed. Organize all of the document sets so they can be easily referenced. Determine the type of PHA to be performed, e.g., a redo or a revalidation, to help guide preparation requirements.

“Nodes” preparation requires unit specific knowledge and advance planning. A PFD can be used to organize the primary areas before the P&IDs are color coded or highlighted. Previously highlighted P&IDs may be used as a reference if revalidating a PHA, however be aware of P&ID updates since the last PHA was performed. The process function of each node should be reviewed with the PHA team “in session,” whether it is a redo or a revalidated PHA.

### Industry Experience:

It is common for all of the unit knowledge held by the PHA team to consist of local refinery experience. Refineries or operating companies with multiple FCC units have access to more experience, but in all cases, there is still important knowledge that is not known by anyone on the PHA team. Therefore, gathering information from outside the team’s sphere of experience is necessary. Some example sources of information include:

- Industry Safety Groups like the FCC Safety Regional Roadshows
- Investigations or summaries of industry incidents from groups like API or the US Chemical Safety Board (CSB)
- Conference presentations and technical trade articles from groups like AFPM, Petroleum Technology Quarterly (PTQ), Hydrocarbon Processing, or the Oil and Gas Journal.
- Operating company industrial safety committees
- The Event Sharing database, Hazard Identification documents, Practice Sharing documents, and Industry Alerts on the AFPM Safety Portal

A site may not recognize that their way of doing things is unique and may assume that their discussion topics are standard everywhere. The PHA team should not assume that all initiating causes, conclusions, and safeguards from prior PHAs are preferred, or even the only answer to PHA questions. Teams should challenge the prior PHA’s results and utilize all of the information available.

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FCC Safety Scenario Table:

Any two FCC units, even within the same company, may have significantly different consequences from an event scenario and may, therefore, have different safeguards. Differences in local legislation, refinery culture, recent experience, PHA team membership, and several other factors can contribute to this variation. Most companies that operate more than one refinery would like standardization in their PHAs and safeguards for similar units. This helps to ensure that safeguards are adequate, and limits resources spent on non-ideal solutions. Standardization can be achieved by developing safeguard standardization guidelines for FCC units.

An FCC Safety Scenario table is a scenario-based list of categories, and a description of the potential initiating causes, consequences, and safeguards. The list is prepared in advance of the PHA, typically by corporate resources, with input from a broad range of unit support personnel, including unit operations, process engineering, control engineering, and safety department. The list is a collection of potential cause-consequence pairs organized by category/hazard or section of the process. Additional information can also be included.

Below is a list of items to consider:

- Category/hazard or section of the process
- Cause(s)
- Considerations for PHA discussions (such as specific transient conditions)
- Other primary control or containment measures
- Potential non-Independent Protection Layer (IPL) safeguards
- IPL safeguards applied to similar units
- Alternate critical safeguards or IPLs
- Consequence rankings/severities

Consequence(s) considerations include:

- Does the scenario impact personnel? (on unit or offsite)
- Does the scenario result in a fatality without safeguards? (Yes or No)
  - Is the fatality inside the fence line or outside the fence line? (safety vs. community impact)
- Does the ranking trigger a further review, like LOPA or Quantitative Risk Analysis (QRA) based on company requirements?
- Provide references or links to internal incidents or recordable injuries/events.

You should include all known major unit hazards. While major hazards are the primary concern of these guidelines, lower ranked scenarios are also sometimes included to avoid omitting scenarios or over/under-cautious application of safeguards. One possible source for major unit hazards for FCC units is the Practice Share Document, *FCC PHA Scenario Reference List* in the Knowledge Sharing tab on the AFPM Safety Portal at <https://safetyportal.afpm.org/File/1748/1>.

Ensure the categories are not so general that very broad causes can be listed, resulting in overly generalized consequences without specifics. Consider differentiating process and mechanical reliability such as “hot spots”

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related issues. Process safeguards for general mechanical consequences are not possible without a process cause and usually list a specific monitoring or inspection program as a safeguard.

Consider all FCC unit hazards, including those that could occur during transient operations, and including scenarios that may not have occurred at the local site. A partial list of industry FCC scenarios is referenced in the *FCC PHA Scenario Reference List* Practice Share document in the Knowledge Sharing tab on the AFPM Safety Portal at <https://safetyportal.afpm.org/File/1748/1>. Once the draft table is created, it should be circulated among other personnel with FCC unit experience for additional comment and input. The table can be split into sections (Reactor/Riser, Boilers, Flue Gas handling, etc.) to aid readability and navigation, especially since the team will likely be dealing with a single section at a time.

Transient operations inherently involve human interaction with the process. Many activities that occur during transients will therefore be procedure-based. Procedures for FCC startup, shutdown, and standby should be referenced during transient hazard analysis. Refer to the AFPM Hazard Identification Document on FCC Standby Operation for information on three modes of standby operation and administrative controls employed during each.

The guideline document should be treated as that, “A guideline.” No two FCCs have the exact same configuration. They likely use different technologies and components. Size and operating conditions may also vary. Even if two units were initially constructed identically, they were likely modified over time through repairs and improvements and may currently be quite different from one another. PHA teams should be free to deviate from the guideline document as long as the differences are documented. Deviating from the consequence ranking should be approved by a higher/broader authority.

The PHA team should mark or highlight each appropriate item in the scenario table that could credibly occur and strike out those that are not credible based on the unit’s configuration, equipment, or operating conditions. Once the PHA team has agreed on the applicability of the guideline, they should use the valid, cause-consequence pairs as the basis for those scenarios in the PHA.

### Implementation Actions:

Implementation actions for FCC PHA Preparation provide assurance that refinery personnel are properly prepared for a detailed PHA study that includes a broad list of potential scenarios. Compliance can be ensured by management’s required approval of the documents, or the actions can be embedded into the PHA process. Some examples are:

- Checklist for PHA preparation (with supervisor signoff)
- Documentation checklist
- Formalizing “FCC Safety Scenario Table” in refinery safety documentation.

The following listing of checklist items can be used to aid in PHA preparation and completion per the guidance included in this practice share.

#### Before PHA

- Prepare a document that outlines overall PHA expectations. For example, what types of scenarios will be considered for each node and how will a broader industry perspective be included in the review.

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- Ensure major process changes since the last PHA have been documented in P&IDs.
- Create a document checklist of items to be field verified 30 days before a scheduled PHA. Assign this checklist to the PHA team several months in advance of the scheduled PHA.
- Prepare Node Drawings in advance of scheduled PHA
- Create Safety Scenario Table template by agreeing on the various information that will be included.
- Schedule several meetings with various unit support team members and list all applicable scenarios to be considered in the scenario table. Fill out supporting information on the table.
- Obtain and review current version of procedures to be referenced during transient hazard analysis.
- Create a list of Site Personnel to be interviewed in advance of schedule PHA and interview in advance as outlined above
- Create a list of possible questions or what if scenarios.

### During PHA

- Have a running list during the PHA that captures any procedure errors, outdated information, or opportunities to improve.
- Ensure that a Human Factors checklist is included in the PHA review, and that the checklist includes appropriate questions on alarms.

### After PHA

- Create a condensed version of findings and have a broader review with operations.

### References:

Occupational Safety and Health Administration (OSHA) 1910.119(d) – *Process Safety Information* available at <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.119>

Occupational Safety and Health Administration (OSHA) 1910.119(e) – *Process Hazards Analysis* available at <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.119>

AFPM Hazard Identification document, *Flammable Mixture Accumulation in FCC Units*, on the Safety Portal available at <https://safetyportal.afpm.org/File/1652/1>

AFPM Practice Sharing document, *FCC PHA Scenario Reference List*, on the Safety Portal available at <https://safetyportal.afpm.org/File/1748/1>

AFPM Safety Portal Hazard Identification Document, *FCC Standby Operation* available at “To Be Posted.”

Revision	Date	Summary of Changes
Initial Draft	April 2024	Initial Version
Revision	August 2024	HIPS Review
Revision	October 2024	PSW Review
Legal Review	December 2024	AFPM Legal Review
Final	January 2025	Published

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