

CONDEA VISTA COMPANY CORPORATE SAFETY & HEALTH STANDARDS

Subject: Process Hazard Analysis
Issue Date: May 19, 1997
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Approved By: Harry D. Garrison
Manager Safety, Health & Environment

1. SCOPE

This standard applies to all existing CONDEA Vista processes covered by the PSM regulation [Reference: CONDEA Vista Corporate Standard PSM-001]. It includes provisions that address some anticipated requirements of the EPA Risk Management Programs for Accidental Release Prevention [40 CFR Part 68].

The procedure does not include all potential requirements that may be included in State or EPA regulations. Nor does it include requirements for hazard reviews that may be required or implied by other paragraphs of the OSHA PSM Standard such as Management of Change or Pre-Startup Safety Reviews.

2. PURPOSE

This standard defines the minimum requirements for complying with the Process Hazard Analysis requirements, paragraph (e), of the OSHA Process Safety Management of Highly Hazardous Chemicals (PSM) regulation, 29 CFR 1910.119.

3. DEFINITIONS

- 3.1 Catastrophic Release or Incident - means a major uncontrolled emission, fire, or explosion, involving one or more highly hazardous chemicals (HHC), that presents a serious danger to employees in the workplace.
- 3.2 Covered Process - This is the group(s) of equipment and systems to which all PSM elements except for the Mechanical Integrity element (which is a subset of the Covered Process) apply. It is possible to have one or more covered process equipment groups.

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- 3.3 Process - refers to any activity involving a highly hazardous chemical (HHC) including any use, storage, manufacturing, handling, or the on-site movement of chemicals, or combination of these activities. For purposes of this definition, any group of vessels which are interconnected and separate vessels which are located such that a highly hazardous chemical could be involved in a potential release shall be considered a single process.
- 3.4 Process Hazards - for purposes of clarification for this standard only, the term "process hazards" means findings resulting from a Process Hazard Analysis that have safety (on-site or offsite), environmental, or community consequences having a scenario ranking requiring mitigation as determined by this standard.
- 3.5 Flammable Gas - means (a) a gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of thirteen (13) percent by volume or less; or (b) a gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than twelve (12) percent by volume, regardless of the lower limit. (29 CFR 1910.1200, Hazard Communication)
- 3.6 Flammable Liquid - means any liquid having a flashpoint below 100°F, except any mixture having components with flashpoints of 100°F or higher, the total of which make up 99 percent or more of the total volume of the mixture. (29 CFR 1910.1200, Hazard Communication) Refer to 1910.1200 for definitions of flashpoint.
- 3.7 HAZOP - A Hazards and Operability (HAZOP) study is a systematic method to identify hazards and operability problems. A HAZOP study involves a systematic, methodical examination of design documents that describe a process. The study is performed by a multi-discipline team. Deviations from the design value of key parameters are studied using guide words to control the examination evaluation. This presumes that the design values of flows, temperatures, and other process variables are inherently safe and operable.
- 3.8 Highly Hazardous Chemical (HHC) - A Highly Hazardous Chemical (HHC) means a substance possessing toxic, reactive, flammable, or explosive properties and specified in Appendix A of the OSHA PSM Standard or a flammable liquid or gas on site in one location, in a quantity of 10,000

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pounds or more. See 1910.119 (a)(1)(A), (a)(1)(B) and (a)(2) of the OSHA PSM standard for exceptions.

3.9 PHA - Process Hazard Analysis (PHA) is a thorough, orderly, systematic approach for identifying, evaluating and controlling the hazards of processes involving highly hazardous chemicals.

3.10 Threshold Quantity (TQ) - Quantity at or above which the OSHA PSM Standard applies. The threshold quantities listed in Appendix A of the standard apply only to pure (or "commercial grade") chemicals unless otherwise specified.

4. PROCESS HAZARD ANALYSIS (PHA) METHODOLOGY

Each covered facility shall conduct Process Hazard Analyses (PHA's) on each of its existing covered processes. PHA methods used will depend on the nature and complexity of the process under consideration.

4.1 Each covered facility shall perform an initial process hazard analysis (hazard evaluation) on each of its existing covered processes as soon as possible but not later than the following schedule:

4.1.1 No less than 50 percent of the initial PHA's will be completed by May 26, 1995.

4.1.2 No less than 75 percent of the initial PHA's will be completed by May 26, 1996.

4.1.3 No less than 100 percent of the initial PHA's will be completed by May 26, 1997.

A PHA on a process or part of a process should not be delayed even if it is of a lower priority than one where records and documentation are still being generated.

4.2 The initial process hazards analyses will be conducted using the Hazard and Operability Study (HAZOP) methodology and reviews of human factors, facility siting and other hazards common or specific to the location.

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Except as limited by Section 9 (PHA Revalidation), subsequent process hazard analyses may utilize any of the hazard evaluation techniques accepted by OSHA.

- 4.3 Each facility shall determine and document the priority order for conducting the initial process hazard analyses based on a rationale which includes as a minimum such considerations as:
- a. The extent of the process hazards,
 - b. The number of potentially affected employees,
 - c. The age of the process, and
 - d. The operating history of the process.
- 4.4 The documentation shall include a priority order listing of each covered process and a narrative explanation of the rationale for the priority order. A matrix similar to the one presented in Appendix A may be useful in documentation of the rationale.
- 4.5 If the facility contains large processes with different risk factors within the process, the large processes can be broken down into sub-processes for the priority determination.
- 4.6 In addition to the considerations listed above in Section 4.3, it may be appropriate for the facility to consider other items when setting the priority for completing PHA's. Some examples are:
- a. Previous safety studies.
 - b. Potential for off-site impacts.
 - c. Volume of highly hazardous chemicals on site.
 - d. Operating conditions of process containing HHC's.

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4.7 Process Hazard Analysis Requirements

Except as provided in and 4.8 of this standard, all Process Hazard Analyses of existing covered processes in CONDEA Vista require:

4.7.1 Specifically including and addressing each of the following elements:

- a. The hazards of the process.
- b. Previous incidents which had a likely potential for catastrophic consequences in the workplace.
- c. Engineering and administrative controls applicable to the hazards and their interrelationships such as appropriate application of detection methodologies (acceptable examples include process monitoring and control instrumentation with alarms and hydrocarbon or inorganic vapor detection systems) to provide early warning of releases. Other controls include inventory reduction, substitution of less hazardous materials, protective systems (deluges, monitors, foams, etc.), increased separation distances, modification of process temperatures or pressures, redundancy in instrumentation, etc.
- d. Consequences of failure of engineering and administrative controls.
- e. Facility siting. An example includes taking into consideration safe distances for locating control rooms based on evaluations of the individual characteristics of equipment involved such as types of construction of the room, types and quantities of materials, types of reactions and processes, operating pressures and temperatures, presence of ignition sources, fire protection facilities, capabilities to respond to explosions, drainage facilities, location of fresh air intakes, etc. Other relevant siting factors such as equipment spacing, equipment spacing from potential ignition sources, and the potential of an incident spreading from one unit to another should also be considered.

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- f. Human factors (the interaction between the process and the employees on the scenarios being evaluated). Examples may include review of operator-process and operator-equipment interfaces, the number and frequency of tasks operators must perform, the evaluation of extended or unusual work schedules, the clarity and simplicity of control displays, operator feedback and communications, clarity of signs and codes, etc.
 - g. A qualitative evaluation of a range of the possible safety and health effects of failure of controls on employees in the workplace.
- 4.7.2 The PHA must be conducted by a team of at least two individuals. The team members must have the following expertise:
- a. Engineering - An engineer must have a minimum of four (4) years of engineering experience.
 - b. Process Operations - The individual filling this requirement shall have at least four (4) years of plant experience.
 - c. Knowledge specific to the process being evaluated. It is recommended that the individual with this expertise be from the unit Operations group. The individual should have at least four (4) years of experience with the unit's operation.
 - d. The team leader must have formal class room training in the PHA methodology being used. On-the-job training or participation in PHA's is not considered formal training.
 - e. The scope and type of process being studied will determine the make-up and number of the remainder of the team. Typically, representatives from the Mechanical Maintenance group will participate in evaluating processes involving mechanical equipment or piping and those from the Instrument Maintenance group will help evaluate processes involving instrumentation or electrical equipment. Safety Department representation is also typical. Members may

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be full-time or may participate only on a part-time, as-needed basis as determined by the full-time members of the team.

4.8 PHA's Conducted Prior to Issuance of the Final Corporate Standard

If PHA's completed after May 26, 1987 and prior to the issuance of this FINAL corporate standard do not meet the requirements of this standard, facilities must evaluate the PHA's and take appropriate actions to ensure the safety of the facility and compliance with the OSHA PSM standard. Such evaluations shall be conducted by a team satisfying the requirements of 4.7.2 of this standard. The results of the evaluation(s) shall be documented, addressed as required by Section 7 of this standard (if applicable), communicated as required by Section 8 and retained with the original PHA.

4.9 Process Hazard Analysis Pre-work Requirements

The following information must be available to the PHA team when they conduct the PHA:

- 4.9.1 The information requirements contained in 1910.199 (d) - Process Safety Information.
- 4.9.2 A chemical interaction matrix.
- 4.9.3 Documentation of any previous incidents that had a likely potential for catastrophic consequences in the work place being evaluated.
- 4.9.4 Documentation of relevant safety audits or studies in the facility's files that addressed the potential for catastrophic consequences in the work place.
- 4.9.5 Facility siting information. At a minimum, this will include calculations for occupied plant buildings using the Dow Fire and Explosion Index.
- 4.9.6 Shutdown, startup, and emergency operating procedures.
- 4.9.7 Plant Safety & Health Manual.

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4.10 Process Hazard Analysis Team Orientation

The orientation of the PHA team is a critical step in obtaining a good quality PHA. This is used to set the tone for the PHA and to meet some of the OSHA requirements that are not a direct result of some PHA methods. Attendance records must be kept.

All full-time (or core) team members must attend an orientation that includes the following elements:

- 4.10.1 A review of the purpose and scope of the PHA.
- 4.10.2 A review of why the PHA method chosen is appropriate for the PHA. Currently, only the HAZOP method is approved for CONDEA Vista's initial PHA's. Unlike most of the other methods, the HAZOP method was developed specifically for chemical plants and processes. In particular, it is an appropriate method for complex processes and when operating conditions are important.
- 4.10.3 A review of the PHA methodology that the team will use.
- 4.10.4 A review of all pre-work information. This is not intended to be an detailed review. The intent is to make the team members aware of the resources available to the team.
- 4.10.5 A review of the process description.
- 4.10.6 Process or Unit tour (if necessary to ensure all team members are physically oriented and familiarized with the process or unit being evaluated).
- 4.10.7 A review of the process chemistry description, chemical interaction matrix, and the hazards of the process. The review of the hazards of the process consists of identifying the process chemicals or streams and reviewing the chemical hazards, physical hazards, and corrosion potential for each. This review may result in recommendations to reduce the hazards of the

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process. These should be listed but no scenario ranking should be assigned.

- 4.10.8 A review of previous incidents that had a likely potential for catastrophic consequences in the work place.
- 4.10.9 A review of human factors. If a separate human factors study has not been conducted, the human factors list in Appendix B will be used as a checklist of items that the team should discuss. This review may result in recommendations to reduce the risks associated with the operation of the process. These should be listed but no scenario ranking should be assigned.
- 4.10.10 A facility siting review. The primary intent is to determine if there are process hazards (as defined by this standard) associated with the facility location/layout that should be examined in detail. If a separate facility siting study has not been conducted, an evaluation of occupied plant buildings utilizing the Dow Fire and Explosion Index as required by 4.9.5 and the facility siting checklist contained in Appendix C will be used to conduct the facility siting study. This review may result in recommendations to reduce the risks associated with the operation of the process. These should be listed but no scenario ranking should be assigned.
- 4.10.11 A review of the site-specific hazards. This review may result in recommendations to reduce the risks associated with the operation of the process. These should be listed but no scenario ranking should be assigned. This review may also highlight specific areas of focus for the PHA.

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5. HAZOP METHODOLOGY FOR PROCESS OR UNIT PHA's.

5.1 Scenario Ranking

The team will use the Consequence Rating Table, Likelihood of Occurrence Rating Table, and the Scenario Ranking Matrix included in Appendix D to rate each scenario. Each scenario can receive three (3) separate ratings - Safety (on-site), Economic, and Environmental/Community (including off-site safety). Each scenario must receive a safety and environmental/community rating.

The information in Appendix D can not be modified without the approval of the corporate Manager of Safety, Health and Environment.

5.2 Team Responsibility

The team's responsibility is to define deviations from normal operating conditions that may represent an unacceptable risk level and to identify the problems. The team does not have the responsibility to engineer the solutions; however, it may recommend actions or solutions for consideration in remedying the hazard/risk identified for correction.

5.3 Process Parameters

Common process parameters are listed below. The team should review the list and select those appropriate for the process being evaluated. Other deviations may be added by the team if necessary.

Flow	Pressure	Temperature
Level	Time	Composition
Reaction	pH	Speed
Frequency	Viscosity	Voltage
Information	Mixing	Addition
Separation	Startup	Shutdown
Corrosion	Fouling	Atmospheric Temperature
Tube Leak	Tube Rupture	Leak
Utilities	Electricity	Steam
	Fuel Gas	Instrument Air
	Nitrogen	Cooling Water

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5.4 Guide Words and Phrases

- 5.4.1 Common guide words and phrases for process design and operations are given below:

<u>Guide Word/Phrase</u>	<u>Meaning</u>
No	Negative of the design intent
Less or Lower	Quantitative decrease
More or Higher	Quantitative increase
Part Of	Qualitative decrease
As Well As	Qualitative Increase
Reverse	Logical opposite of intent
Other Than or Sooner/Later	Complete Substitution

- 5.4.2 Common guide words and phrases for procedures are given below:

<u>Guide Word/Phrase</u>	<u>Meaning</u>
Missing	A step is missing from the written procedure at, or just before, the step being examined.
Skip/Part of	The operator skips this step (or some part of it) and performs the rest of the procedure correctly.
More	The operator does too much of the specified action or does it too quickly.
Less	The operator does too little of the specified action or does it too slowly.
Out of Sequence / As well as	The operator performs the steps in a different order than specified by the procedure, possibly as a short cut.

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Other Than/Reverse

The operator performs some action other than the one specified in the procedure, usually because of confusion or haste.

5.5 Study Nodes - P&I Diagrams

Each P&I Diagram is divided into study nodes. The study nodes should be as large as possible without the team having to apply the guide words to the parameters for parts of the study node.

Most utility connections are handled as one part of the study node if the utility is selected as a process parameter. The exception is process-generated fuel gas which may involve multiple nodes.

These nodes are reviewed as part of the HAZOP.

5.6 Study Nodes - Operating Procedures

Emergency, startup (initial introduction of HHC into the unit), and shutdown operating procedures are divided into nodes which are normally defined as the group of sequential steps with one intent. These nodes are reviewed as part of the HAZOP.

Other operating procedures are covered as part of the P&I Diagram node. These operating procedures are reviewed when the team believes that it is appropriate.

5.7 Team Process

The team will use the following process:

5.7.1 The team selects a study node and reviews the design intent of the study node. If the design intent is not documented, the team can develop it.

5.7.2 The team applies the first guide word to the first process parameter to form a deviation. Guide words and process

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parameters that have no meaning (such as reverse temperature) are ignored.

- 5.7.3 The team defines the consequences associated with the deviation assuming that all equipment and procedural protection systems fail.
- 5.7.4 The team lists all possible causes of the deviation.
- 5.7.5 The team identifies all safeguards that prevent the deviation.
- 5.7.6 The team uses the tables found in the Appendix D to define the consequence rating, likelihood of occurrence rating, process hazards scenario ranking.
 - a. Economic scenario rankings can also be generated using the same process.
 - b. If information necessary to define scenario ranking is missing, then the scenario can not be ranked. The team will define an action step to obtain the missing information. If the information can not be found during the HAZOP, then the team will recommend an action step to obtain the information and for the scenario to be ranked at that time.
 - c. The team should not over-state or under-state the risk of the scenario. Making scenarios greater than reality as a method to get faster action or being conservative and playing it "safe" is unacceptable. Down playing the scenario because the solution may be perceived to be politically unacceptable is equally unacceptable.
 - d. To highlight the risk reduction afforded by existing safeguards and/or to evaluate the impact of any additional safeguards, teams may choose to first identify the scenario ranking without (or "before") considering the effects of safeguards and then arrive at a final (or "after") ranking considering all existing safeguards. If teams choose to do this, the final (or "after") ranking will be the ranking reported for mitigation as appropriate.

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- e. In each scenario where various combinations of consequences and probability are possible, only the consequence and corresponding probability yielding the maximum scenario ranking will be reported for mitigation.

5.7.7 If there are scenarios that result in catastrophic consequences even though some of the safeguards work properly, these scenarios should be risk ranked.

5.7.8 If the team has a recommendation to mitigate the risks, the team should recommend that the person or team responsible for mitigation evaluate that option. Since the team does not take the time to evaluate all options, the team should phrase recommendations as "consider" or "evaluate" rather than "do" or "install".

5.7.9 Repeat the process for each deviation until all deviations have been applied to the node. Then repeat the process for each node.

5.8 Scenarios with a Ranking of 1 or 2.

Any scenarios with a ranking of 1 or 2 shall be reported to the managers having engineering and operations responsibility for the process being evaluated as soon as possible but not greater than 24 hours of the determination.

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6. PROCESS HAZARD ANALYSIS REPORT

The report shall contain sufficient detail such that a second PHA team can understand the findings and conclusions of the first team. At a minimum the report shall contain the following items:

- 6.1 A table of contents.
- 6.2 Start and end date of the PHA team work covered by the report.
- 6.3 Issue date.
- 6.4 The distribution of the report. Please note that either a paper copy or electronic copy must be available to employees affected by the findings and conclusions of the PHA.
- 6.5 The signatures of the team members and/or the team leader.
- 6.6 PHA methodology used. This shall include a rationale for the selection of the PHA method.
- 6.7 Description of the process evaluated.
- 6.8 The scope of the PHA. This will include a listing of the P&I Diagram(s) and operating procedures that were reviewed. The listing shall include the diagram or procedure number and issue date.
- 6.9 A listing of the team members and their qualifications. The documentation shall specify those individuals meeting the expertise requirements of Section 4.7.3 of this standard.
- 6.10 Attendance records.
- 6.11 Team orientation. This documentation should identify the steps covered in the PHA orientation and copies of any completed checklists.
- 6.12 Listing of updates and revalidations to the PHA report.
- 6.13 Copies of the P&I Diagrams with the study nodes marked and identified.
- 6.14 Work sheets from the team meetings.

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- 6.15 A listing or index of resources utilized that were not included in the process safety information such as a list of previous incidents considered, technical experts who may have been consulted, research and engineering reports, etc.
- 6.16 A listing of actions steps requiring further evaluation including identifying nodes which require further evaluation due to missing process safety information.
- 6.17 Separate listings of the team's process hazards (as defined by this standard) findings and recommendations. This should include any recommendations or findings resulting from the review of human factors, facility siting, previous incidents, or hazards of the process. If economic or operability findings or recommendations are made, then these should be listed separately from the process hazards findings.

7. SYSTEM FOR ADDRESSING PHA TEAM'S FINDINGS

Utilizing the clarifications provided in Appendix E, each covered facility shall develop written procedures for the facility's management to address the PHA Team's process hazards (as defined by this standard) findings and recommendations. These procedures shall include the following elements:

7.1 Mitigation Requirements

7.1.1 1 Ranked Scenarios

A written schedule for responding to a scenario ranked 1 must be completed within five (5) working days of the managers having engineering and operations responsibility for the process being evaluated being made aware of the finding. If the unit is shut down at the time, the schedule must be completed prior to the unit resuming operations. The written schedule must include a plan for sufficient mitigation to drop the scenario ranking to at least a 3 level. The schedule shall include major milestones and responsibilities. This schedule will be updated monthly.

Within ten (10) working days of the managers having engineering and operations responsibility for the process being evaluated being

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made aware of a 1 ranked scenario, the ranking level must be reduced to a 2 level or that portion of the process must be shut down.

Items can not be deleted from the schedule until all appropriate paperwork has been placed in the PHA file. A copy of each schedule shall be placed in the PHA file.

7.1.2 2 Ranked Scenarios

A written schedule for scenarios ranked 2 must be completed within ten (10) working days of the managers having engineering and operations responsibility for the process being evaluated being made aware of the team's findings. The written schedule must include a plan for sufficient mitigation to drop the scenario ranking to at least a 3 level. The schedule shall include major milestones and responsibilities. This schedule will be updated monthly.

A 2 ranked scenario shall be mitigated sufficiently to obtain a 3 ranking within sixty (60) working days of the managers having engineering and operations responsibility for the process being evaluated being made aware of the item. Exceptions must be approved by the facility S.H.E. Manager and the managers having engineering and operations responsibility for the process being evaluated.

Items can not be deleted from the schedule until all appropriate paperwork has been placed in the PHA file. A copy of each schedule shall be placed in the PHA file.

7.1.3 3 Ranked Scenarios

A written schedule for all 3 ranked scenarios must be completed within two (2) months of the issuance of the PHA report. Scenarios initially ranked 1 and 2 that have been mitigated to a 3 level should be incorporated into this schedule. The schedule shall include major milestones and responsibilities. This schedule shall be updated each quarter.

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Scenarios ranked 3 should normally be mitigated to at least a 4 ranking within twelve (12) months unless significant engineering design work or a turnaround is required to make revisions.

Items can not be deleted from the schedule until all appropriate paperwork has been placed in the PHA file. A copy of each schedule shall be placed in the PHA file.

7.1.4 4 Ranked Scenarios

Within two (2) months of the issuance of the PHA report, all 4 ranked scenarios must be evaluated to determine whether mitigation is required, and a written schedule for all 4 ranked items requiring mitigation must be completed. Scenarios initially ranked 1 and 2 that have been mitigated to a 4 level should be incorporated into this schedule. The schedule shall include major milestones and responsibilities. This schedule shall be updated each quarter.

Mitigation action steps shall be completed within two years of issuance of the report. Extensions to the next scheduled shutdown are permissible if a shutdown is required to implement.

Items can not be deleted from the schedule until all appropriate paperwork has been put in the PHA file. A copy of each schedule shall be placed in the PHA file.

7.1.5 5 Ranked Scenarios

Scenarios ranked 5 do not require mitigation.

7.2 Documentation of Resolution of Team Findings

The PHA file will include documentation of the resolution of each team's findings or recommendations. At minimum, there will be a typed page (or electronic equivalent) summarizing the corrective action taken in sufficient detail that the next PHA team can understand the corrective action that was taken and how the corrective action impacted the scenario ranking. This document can refer to other attached papers such as a Process Design. However, the design alone is not acceptable documentation.

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7.3 Tracking System

Each facility must have a documented system to track the status of each team's findings.

8. PROCESS HAZARD ANALYSIS COMMUNICATIONS

8.1 Determination of Affected Employees

An affected employee is any operator, maintenance employee, contractor, or other employee whose:

8.1.1 Normal work assignment can significantly affect the likelihood of occurrence or consequences of the 1, 2, and 3 ranked scenarios;

or

8.1.2 Normal work assignment in occupied buildings takes them within a Dow Fire and Explosion Index radius for more than 2 hours per week.

Note: The immediate Supervisor of those individuals defined by items 8.1.1 and 8.1.2 above are also affected employees.

8.2 Pre-Process Hazard Analysis Communications

Prior to each process or unit PHA, affected employees and their representatives shall be provided notice of the scheduled PHA. The notice shall indicate the unit or process being analyzed, the team leader and other team members who will be conducting the PHA, the scheduled meeting place/dates/times, etc. The notice shall also solicit input from affected employees who have concerns or knowledge of issues that the team should consider in its analysis.

8.3 Post-Process Hazard Analysis Communications

8.3.1 Process or Unit PHA findings and mitigation plans shall be reviewed with affected employees within one month of the

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issuance of the PHA report. Meetings for this purpose are required if scenarios ranked 1 or 2 were identified; otherwise, written communications to affected employees are acceptable.

- 8.3.2 The affected employees shall have access to a copy of the PHA and the latest mitigation plan.
- 8.3.3 Documentation including lists of affected employees, date(s) of reviews, meeting attendance records, etc. shall be prepared and placed in the PHA file.
- 8.3.4 Updates on the status of the mitigation plans for scenarios with rankings of 1, 2 or 3 can be handled through meetings or written communications as deemed appropriate by the facility management. Updates on scenarios ranked 4 or 5 are not required.
- 8.3.5 Where written communications are used or PHA's are provided to employees, management shall take measures if necessary to make sure recipients understand the information being communicated.

9. PROCESS HAZARD ANALYSIS REVALIDATION

- 9.1 At least every five (5) years after the completion of the initial process hazard analysis, the process hazard analysis shall be updated and revalidated by a team meeting the requirements of Section 4.7.2 to assure that the process hazard analysis is consistent with the current process.
- 9.2 Until another methodology is approved, the HAZOP methodology shall be used for the revalidation.
- 9.3 PHA's performed prior to the issuance of this FINAL standard and not meeting the requirements of this standard shall be evaluated on an accelerated timetable and actions shall be taken to remedy deficiencies as prescribed in 4.8.

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10. RECORDS RETENTION

Process Hazard Analyses (report and other documentation generated by the team) and updates or revalidations for each covered process and documentation of the resolution of process hazards identified by each shall be retained for the life of the process.

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Appendix A PHA ORDER ANALYSIS MATRIX

Each facility shall determine and document the priority order for conducting the initial process hazard analyses based on a rationale which includes as a minimum such considerations as:

- A - the extent of the process hazards,
- B - the number of potentially affected employees,
- C - the age of the process, and
- D - the operating history of the process.
- E - other as determined by facility

A matrix similar to the one presented below may be useful in documentation of the rationale. The documentation of this chart alone does not satisfy the narrative documentation required by Section 4.4 of this standard.

By force ranking the criteria above (and others the facility feel are appropriate) for each of the Processes (or Sub-Processes) for the Unit or Facility and comparing the composite scores, a PHA order may be established. Criteria are ranked from Highest Risk (1) to Lowest Risk (# of Processes being ranked).

E X A M P L E

Unit/Facility	Criteria	Rank	Total	Order	Comments/Remarks
Process A	A	1	8	1	
	B	2			
	C	2			
	D	1			
	E	2			
Process B	A	3	10	2	
	B	3			
	C	1			
	D	2			
	E	1			
Process C	A	2	12	3	
	B	1			
	C	3			
	D	3			
	E	3			

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Appendix B HUMAN FACTORS CHECKLIST

EQUIPMENT	+	-	OBSERVED PRACTICE
Labeling	equipment clearly labeled, uniform coding	mislabeled or not Labeled	
Access	immediately at hand	hard to reach or access	
Operability	power-assisted operation	difficult t to operate/change position	
Layout	well-planned, logical arrangement	confusing/inconsistent arrangement	
Uniqueness	only component of its kin in area	several components look similar	

CONTROLS	+	-	OBSERVED PRACTICE
Labeling	controls clearly labeled; uniform coding	mislabeled or not labeled	
Mode	fully automatic; well-tuned	manual operation; many manual steps	
Involvement	operator continually involved	operator detached from process	
Displays	clear, simple, representational	unclear, complex, non-representational	
	immediate, unambiguous	none or potentially misleading	

DEVIATIONS	+	-	OBSERVED PRACTICE
Alarms	first-out; safety-critical alarms	many simultaneous or false alarms	
Coverage	dual operator coverage at all times	operator not always present	
Time	no time pressure for response	inadequate time to respond	
Preparedness	periodic simulation exercises	no drills or simulation of scenarios	
Last-Resort	shutdown not discouraged; fast access	shutdown discouraged or unsafe	

TRANSIENT	+	-	OBSERVED PRACTICE
Procedures	complete, accurate, current, verified	incomplete/too general/out of date	
Identifying	ID, location of devices/actions given	ambiguous device/action identification	
Format	graphical identification aids	confusing/inconsistent; difficult to read	
Aids	checklist or supervisory check	task sequence done by memory	

"+" = FACTORS BEYOND STANDARD PRACTICE; MAY REDUCE HUMAN ERROR OR INADEQUATE RESPONSE LIKELIHOOD.

"-" = FACTORS THAT MAY TEND TO INCREASE THE LIKELIHOOD OF HUMAN ERROR OR INADEQUATE RESPONSE

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Appendix B (continued) HUMAN FACTORS CHECKLIST

SCHEDULING	+	-	OBSERVED PRACTICE
Overtime		extreme enough to affect performance	
Consistency	permanent shift assignments	inconsistent shift rotations/schedules	
# of Tasks	tasks, work force, and skills matched	tasks required exceed time available	
Task Frequency	routine task	very infrequent; no expertise base	
Intensity	regular task at normal pace	differing tasks in rapid succession	

COMMUNICATE	+	-	OBSERVED PRACTICE
Shift Changes	status communicated verbally, plus turnover sheet used	inadequate communication of plant status between shifts	
Field/Control	constant communication with field	no communication with field operator	
Supervision	frequent supervisory communication	little or no supervisory checks	
Emergency	rapid, unambiguous plant alarm system	no distinction between area, type	

ENVIRONMENT	+	-	OBSERVED PRACTICE
Noise Level	office environment noise level	area where hearing protection required	
Climate	indoors, climate controlled	temperature/humidity/precipitation/wind extremes	
Visibility	visibility enhancement of some kind	often foggy or other visibility limitation	
Lighting		inadequate lighting for task	

"+" = FACTORS BEYOND STANDARD PRACTICE; MAY REDUCE HUMAN ERROR OR INADEQUATE RESPONSE LIKELIHOOD.

"-" = FACTORS THAT MAY TEND TO INCREASE THE LIKELIHOOD OF HUMAN ERROR OR INADEQUATE RESPONSE

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Appendix C (Pages 25 - 32) FACILITY SITING CHECKLISTS AND MITIGATION GUIDANCE

Instructions:

The team will review each item on the checklist. After evaluation, each item is marked to indicate that the item has been reviewed. Comments and findings are attached on a separate sheet. No scenario rankings are given to the findings.

REVIEWED YES NO		DISCUSSION TOPIC
		1. Location of on-site populations relative to the unit.
		2. Location of off-site populations relative to the unit. Location of environmentally sensitive areas.
		3. Location of critical and safety systems.
		4. Dominant Wind Direction.
		5. Climate and water extremes; earthquake; flooding; hurricanes; tornadoes; windstorms.
		6. Site topography
		7. External hazards and threats (fire, explosion, toxic release from nearby process or facilities; aircraft, subsidence, sabotage).
		8. On-site traffic flow patterns and clearances.
		9. Security and reliability of all critical feeds, utilities, and safety systems.
		10. Evacuation routes, emergency exits, safe rally spots.
		11. Passive mitigation systems such as dikes, berms, (control spills and fires) and blast walls (protect against explosions).
		12. Crane lifts over operating equipment and piping.
		13. Barricades between traffic and equipment and piping.
		14. Adequate lighting for normal operation, routine maintenance, power failure procedures, evacuation.
		15. Communication systems.
		16. House keeping - walkways, aisles, operating areas, evacuation routes.

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REVIEWED YES NO		DISCUSSION TOPIC
		17. Location of railroads to process equipment (derailment, access).
		18. Open ditches, sumps, low points (collect toxic and flammable vapors).
		19. Entry into confined spaces during emergencies- Trapped Gases, Hazards, Permit.
		Buildings
		20. Location of occupied building near process units. (Please note that the Dow Chemical Fire and Explosion Index will be used as a screening tool to determine if the building is located sufficiently remote from the process. If the building is not located sufficiently remote from the process, the team should suggest that a more detailed study be conducted.)
		Control Rooms
		21. Minimum occupancy; only essential functions during emergencies.
		22. Control Room Construction.
		23. Fresh air intake locations/isolation; Temporary safe havens; Access during an emergency.
		24. Control room location relative to unit, columns, and pipe bridges.
		25. Supply of breathing air in control room. Sufficient for emergency shutdown.
		26. Instrument labels up-to-date.
		Process Facilities
		27. Area electrical classification.
		28. Accessibility for mechanical integrity inspection and testing.
		29. Protection of piping and vessels from vehicles and forklifts.
		30. Protection of small bore lines, fittings, from external impact, personnel.
		31. Routing of process piping, critical controls cable trays, critical utilities.
		32. Vent, drain, and relief valve discharge locations.
		33. Remote shutoff valves for feed lines to the unit, accessible, functional in emergency.
		Loading, unloading, and storage facilities

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REVIEWED YES NO		DISCUSSION TOPIC
		34. Incompatible materials segregated; storage, dikes, sumps, drains, and waste.
		35. Siting, labeling of unloading spots for incompatible materials.
		36. Spacing consideration for flammable, combustible, and unstable liquid storage (note use the checklist - "Hazardous Analysis Review for Spacing Considerations for flammable, combustible, and Unstable Liquid Storage")
		39. Storage of flammable solids such as wood, paper, rags.
		Fire Protection
		40. Access for fire fighting and other emergency services - trains, vehicle parking, construction.
		41. Ignition sources, continuous, intermittent, uncontrolled, hot surfaces.
		42. Access to hydrants, monitors, and deluge valves.
		43. Grading drains flammables away from storage.
		44. Equipment spaced to minimize potential fire explosion damage.
		45. Coverage of fire monitors/sprinkler systems.
		46. Fire proofing of structures.
		Accident Mitigation
		47. Detection of leaks and ruptures.
		48. Emergency shutdown switch locations.
		49. Accessibility of isolation valves, size.
		50. Potential for fire/explosion in units affecting other equipment.
		51. Critical control, mitigation, communication after initial explosion or release.
		Personnel Protection
		52. Passageways, pedestrian traffic patterns vs. hazardous locations.
		53. SCBA/respirators locations; accessibility on all shifts.
		54. Sufficient escape routes from operating areas, shops, labs, offices.

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HAZARDOUS ANALYSIS REVIEW FOR SPACING APPLICATIONS FOR FLAMMABLE, COMBUSTIBLE AND UNSTABLE LIQUID STORAGE

Instructions: This checklist represents item #36 on the CONDEA Vista Company Facility Siting Checklist. The hazard review team will review each item and mark to indicate a review was completed. Comments and findings are shown in a separate report. No scenario rankings are given to these findings.

REVIEWED YES NO		DISCUSSION TOPIC
		1. Tanks accessible for fire fighting purposes.
		2. Minimum distance between tank and property line or building as defined in paragraph 2-3 of NFPA 30, attached.
		3. Outside base tank dike at ground level at least ten (10) feet from property line.
		4. Minimum distance between any two storage tanks one third (1/3) of adjacent tank diameters, but at least three (3) feet. If unstable, flammable, or combustible liquids are stored, distance shall be minimum of one half (1/2) the sum of the diameters.
		5. Inside base of tank dike at ground level at least five (5) feet from storage tank.
		6. Minimum distance between liquefied petroleum gas (LPG) container and storage tank twenty (20) feet. If storage tank operates above 2.5 psig, or is equipped with emergency venting that will permit pressures to exceed 2.5 psig, then Item 4. above applies.
		7. Storage tanks not permitted inside buildings.
		8. When a storage tank is located in an area subject to flooding, the following shall be observed.
		a. The provisions of Item 8. shall apply only if the maximum flood stage exceeds the elevation of the dike wall.
		b. Provisions to prevent tank, either full or empty, from floating during rise in water level to established maximum flood stage.
		c. Independent water supply facilities available for loading partially empty tanks with water. If filling with water is impractical or hazardous due to tank contents, tank shall be protected by other means against movement or collapse.

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REVIEWED YES NO		DISCUSSION TOPIC
		d. Top of vertical tank extends above maximum flood stage by at least thirty (30) percent of its allowable storage capacity.
		e. In addition to Items a., b., c., and d. above, if tank is located such that seventy (70) to one hundred (100) percent of its allowable liquid storage capacity will be submerged at the established maximum flood stage, then the following also applies.
		i. Is tank raised, or height increased, until it extends above the level obtainable at maximum flood stage a distance equivalent to at least thirty (30) percent of its allowable liquid storage capacity. Submerged part of tank shall not exceed two and one-half (2 ½) times its diameter.
		ii. As an alternate to Item i. above, adequate noncombustible structural guides, designed to permit tank to float vertically without loss of product may be provided.
		f. Horizontal tanks located such that more than seventy (70) percent of storage capacity will be submerged at the established flood stage attached to foundation of concrete, or of steel and concrete, of sufficient weight to provide adequate load for the tank when filled with flammable or combustible liquid and submerged by flood waters to the established flood stage.
		g. For tanks in Item f. above, are tank vents or other openings that are not liquid tight extended above the level obtainable by flood waters at maximum flood stage water level.
		h. Spherical or spheroid tanks protected by applicable methods specified for either vertical or horizontal tanks as described above.
Definitions: <u>Combustible Liquid.</u> A liquid having a flash point at or above 100°F (37.8°C). <u>Flammable Liquid.</u> A liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psia at 100°F (37.8°C). <u>Unstable Liquid.</u> A liquid that, in the pure state or as commercially produced or transported, will vigorously polymerize, decompose, undergo condensation reaction, or become self-reactive under conditions of shock, pressure or temperature. Reference Materials: NFPA (National Fire Protective Association) 30, Flammable and Combustible Liquids Code OSHA 1910.106		

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List of Short-term Mitigation Steps for Consideration for Normally Occupied Buildings Inside the Dow F&EI Radius

This list is intended to serve as a guide for measures to be considered as short-term mitigation steps for facility siting issues identified. It is not an all inclusive list.

MITIGATION STEP	APPLICATION
1. Provide a system on the buildings' fresh air intake to detect and alarm when hydrocarbons, smoke, or toxic chemicals are present above acceptable levels.	Fire Explosion Toxic
2. Provide the means to quickly shutdown the building's ventilation system to prevent entry of contaminated air. Locate this control inside the building at a readily accessible location and clearly mark its function.	Fire Explosion Toxic
3. All sewers, except sanitary sewers, leaving a building shall be sealed by installing a break tank or equivalent in the sewer system. The break tank shall be located outside the building, and must be between the building and any other inlet into the sewer line. There shall be no additional inlets into the sewer between the building and the break tank. Additional inlets into the break tank or into the sewer after the break tank are acceptable. Venting of the break tank shall be routed away from the building to an appropriate place.	Fire Explosion
4. The exterior surface of the building, at risk including its roof, shall be constructed of fire resistant materials, or a fire suppression system shall be provided to protect these exterior surfaces.	Fire
5. All office equipment, supplies, and other materials located within the building which could fall over or become mobile should be removed, relocated, or secured. This applies to all areas except for designated store rooms. Samples, office, janitorial supplies, and other liquids should be evaluated for potential hazards from spills.	Explosion
6. Interior fixtures, such as ceiling lighting fixtures, wall mounted video monitors, other wall mounted equipment, etc., shall be attached to a building structural member.	Explosion
7. Exterior windows shall not be permitted unless required for safety or regulatory compliance. If required, windows shall meet these criteria: a. Strength equivalent or better than the building wall, and safe construction that fails in a manner that minimizes risk to building occupants. Examples are 3/8" minimum thickness polycarbonate, toughened glass, laminated glass with internal catch bars. b. Window area is minimized.	Explosion

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MITIGATION STEP	APPLICATION
8. Provide clearly marked utility (gas, electric, steam, etc.) shut-offs inside the building.	Fire Explosion
9. Occupant assignments should be reviewed to determine if individuals can be relocated to buildings that do not fall within the radius defined by the Dow Fire and Explosion Index, unless the building is blast resistant design (BRD). Develop a policy to minimize the use of conference areas in non-BRD buildings located within the radius of concern defined by the Dow Fire and Explosion Index. Non-BRD buildings within the radius of concern defined by the Dow Fire and Explosion Index shall not be used as shelter-in-place facilities for non-operating personnel when there is a potential for fire or explosion impacting such buildings.	Explosion
10. The building should be equipped with sufficient exits to allow personnel to exit in a direction away from potential fire and explosion sources. Doors shall open to the outside and be capable of resisting at a minimum the same external pressure as the building. The door frame shall support the door on all four sides. The door shall be weather stripped, and have a door closer of sufficient strength such that the door will remain closed and sealed against any positive pressure system that may be present in the building.	Fire Explosion
11. Other openings in a building shall be sealed to prevent flammable or toxic gases and smoke from entering the building. An opening is defined as penetration of the walls, roof, or floor by a system component. Any system component penetrating the wall, roof, or floor, shall be capable of resisting the same external pressure as the building until the system component is inside the building. Examples of system components that require openings include, but are not limited to, the following: 1) Pipes 2) Conduits 3) Cable trays	Explosion Toxic
12. Each building shall have an emergency response plan for fire, explosion, and toxic release situations. The normal occupants shall be trained in the plan. A brief summary of actions to take in the event of an emergency (evacuation, shelter-in-place, etc.) shall be posted in common areas, such as hallways, and conference or training rooms, so visitors can quickly see what they need to do in the event of an emergency.	Fire Explosion Toxic
13. Occupied temporary buildings will not be located within the radius calculated by the Dow Fire and Explosion Index.	Fire Explosion

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DEFINITION: Normally occupied building

- The primary function is to house people on a routine basis.
- Examples of normally occupied buildings include:
 1. Control rooms that are staffed during emergencies
 2. Offices
 3. Laboratories
 4. Maintenance shops
 5. Buildings designated as gathering points for emergencies
- Examples of buildings that are not normally occupied buildings include:
 1. Motor control centers
 2. Electrical substations
 3. Temporary operator shelters
 4. Compressor sheds, etc.

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Appendix D

**NO INFORMATION IN THIS APPENDIX MAY BE MODIFIED
WITHOUT THE APPROVAL OF THE
CORPORATE MANAGER SAFETY, HEALTH & ENVIRONMENT.**

If information necessary to define scenario ranking is missing,
the scenario can not be ranked.

The team should not over-state or under-state the likelihood of occurrence or consequence of the scenario.

Making scenarios greater than reality as a method to get faster action or being conservative and playing it "safe" is unacceptable.

Down playing the scenario because the solution may be perceived to be politically unacceptable is equally unacceptable.

Note: The Environmental and Community column of the Consequence Rating Table was changed on May 19, 1997. PHAs done after May 19, 1997 should use the table as revised. PHAs done prior to May 19, 1997 do not need to be re-rated until the PHA is revalidated.

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Appendix D (continued)

NO INFORMATION IN THIS APPENDIX MAY BE MODIFIED WITHOUT THE APPROVAL OF THE CORPORATE MANAGER OF SAFETY, HEALTH & ENVIRONMENT.

CONSEQUENCE RATING

CONSEQUENCE LEVEL	EXPECTED RESULT OR IMPACT		
	SAFETY (ON-SITE)	ECONOMIC	ENVIRONMENTAL AND COMMUNITY (OFF-SITE SAFETY)
I MAJOR	- LOSS OF LIFE - PERMANENT TOTAL DISABILITY OR PARTIAL DISABILITY. - HOSPITALIZATION OF 5 OR MORE PEOPLE.	- EQUIPMENT DAMAGE IN EXCESS OF \$1,00,000 - RAW MATERIAL OR PRODUCT LOSSES IN EXCESS OF \$1,000,000	- HOSPITALIZATION OF ONE COMMUNITY MEMBER - DAMAGE TO AN ENVIRONMENTALLY SENSITIVE AREA - SIGNIFICANT PROPERTY DAMAGE. - COMMUNITY EVACUATION - SHELTER IN PLACE THE COMMUNITY AND/OR AN OFF-SITE INDUSTRIAL FACILITY.
II HIGH	- MEDICAL TREATMENT FOR FIVE OR MORE PEOPLE. - HOSPITALIZATION OF TWO OR MORE PEOPLE.	- EQUIPMENT DAMAGE IN EXCESS OF \$100,000. - RAW MATERIAL OR PRODUCT LOSSES IN EXCESS OF \$500,000	- MINOR DAMAGE TO OFF-SITE STRUCTURES. - INJURY TO ONE OR MORE COMMUNITY MEMBERS. - OFF-SITE ENVIRONMENTAL DAMAGE.
III MEDIUM	- MINOR INJURY OR HEALTH EFFECTS. - MEDICAL TREATMENT OF ONE PERSON. - MULTIPLE EXPOSURES ABOVE OSHA LIMITS.	- EQUIPMENT DAMAGE IN EXCESS OF \$10,000. - RAW MATERIAL OR PRODUCT LOSSES IN EXCESS OF \$100,000	REGULATORY REPORTABLE EVENT.
IV LOW TO NONE	- FIRST AID TREATMENT ONLY - SINGLE EXPOSURE ABOVE THE OSHA LIMITS - NO IMPACT	- EQUIPMENT DAMAGE LESS THAN 10,000. - RAW MATERIAL OR PRODUCT LOSSES LESS THAN \$100,00.	NO IMPACT

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Appendix D (continued)

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LIKELIHOOD OF OCCURRENCE RATINGS

RATING	DESCRIPTION	LIKELIHOOD OF OCCURRENCE
A	FREQUENT	EXPECTED TO OCCUR ONE OR MORE TIMES WITHIN THE NEXT YEAR
B	PROBABLE	EXPECTED TO OCCUR ONCE WITHIN THE NEXT TEN (10) YEARS
C	POSSIBLE	EXPECTED TO OCCUR ONCE WITHIN THE NEXT 100 YEARS
D	REMOTE	EXPECTED TO OCCUR LESS FREQUENTLY THAN ONCE EVERY 100 YEARS OR IS PHYSICALLY IMPOSSIBLE

SCENARIO RANKING MATRIX

	A	B	C	D
I	1	2	3	4
II	2	2	3	4
III	3	3	4	5
IV	5	5	5	5

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RESPONSE/MITIGATION REQUIREMENTS FOR SAFETY & ENVIRONMENTAL RANKED ITEMS (See Section 7.1 of this Standard for expanded detail)

SCENARIO RANK	WRITTEN SCHEDULE	MITIGATION REQUIREMENT
1	COMPLETE WITHIN 5 DAYS OF NOTIFICATION OF THE MANAGERS HAVING ENGINEERING AND OPERATIONS RESPONSIBILITY FOR THE UNIT BEING EVALUATED (SEE NOTE BELOW)	MITIGATE TO SCENARIO RANK 2 OR LOWER WITHIN 10 DAYS OF NOTIFICATION OF THE MANAGERS HAVING ENGINEERING AND OPERATIONS RESPONSIBILITY FOR THE UNIT BEING EVALUATED (SEE NOTE BELOW) OR SHUT DOWN UNIT
2	COMPLETE WITHIN 10 DAYS NOTIFICATION OF THE MANAGERS HAVING ENGINEERING AND OPERATIONS RESPONSIBILITY FOR THE UNIT BEING EVALUATED (SEE NOTE BELOW)	MITIGATE TO SCENARIO RANK 3 OR LOWER WITHIN 60 DAYS OF NOTIFICATION OF THE MANAGERS HAVING ENGINEERING AND OPERATIONS RESPONSIBILITY FOR THE UNIT BEING EVALUATED (SEE NOTE BELOW)
3	COMPLETE WITHIN 2 MONTHS OF ISSUANCE OF PHA REPORT	MITIGATE TO RISK RANK 4 OR LOWER WITHIN 12 MONTHS OF ISSUANCE OF PHA REPORT
4	COMPLETE WITHIN 2 MONTHS OF ISSUANCE OF PHA REPORT	MITIGATE (IF REQUIRED) WITHIN 2 YEARS OF ISSUANCE OF PHA REPORT
5	NOT REQUIRED	NO MITIGATION REQUIRED

NOTE: SCENARIOS RANKED "1" OR "2" REQUIRE NOTIFICATION OF THE MANAGERS HAVING ENGINEERING AND OPERATIONS RESPONSIBILITY FOR THE UNIT BEING EVALUATED WITHIN 24 HOURS OF DETERMINATION.

IF MITIGATION REQUIRES MORE TIME THAN DEFINED ABOVE, A MOCA EXTENSION IS REQUIRED.

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Appendix E

OSHA GUIDELINES ON ADDRESSING PHA TEAM FINDINGS AND RECOMMENDATIONS

Paragraph (e) of the OSHA PSM standard requires that a team with expertise in engineering and process operations conduct a process hazard analysis, containing specific findings and recommendations for each covered process. The employer is then required to promptly "address" and resolve[] the team's findings, document the actions taken, and communicate these actions to the affected employees. 29 CFR 1910.119(e)(5).

OSHA considers an employer to have "resolved" the team's findings and recommendations when the employer either has adopted the recommendations, or has justifiably declined to do so. Where a recommendation is rejected, the employer must communicate this to the team, and expeditiously resolve any subsequent recommendations of the team.

An employer can justifiably decline to adopt a recommendation where the employer can document, in writing and based upon adequate evidence, that one or more of the following conditions is true:

1. The analysis upon which the recommendation is based contains material factual errors;
2. The recommendation is not necessary to protect the health and safety of the employer's own employees, or the employees of contractors;
3. An alternative measure would provide a sufficient level of protection; **or**
4. The recommendation is infeasible.