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|  Process Safety Management Program |
| **Title:** Compliance Guidelines for Process Hazard Analysis **Document #:** PSM-SY-UN-015 **Issued:** 08/20/2014 |
| **Responsible Dept.:** EHS **Version:** New**Approved By:** PSM Focus Group **Page:** 1 of 5 |

**1.0 Purpose:** This document summarizes the method The Pennsylvania State University uses to comply with the requirements relating to the Process Hazard Analysis Element of the Process Safety Management (PSM) Program.

**2.0 Scope:** The intent of this element is to define the requirements to conduct a Process Hazard Analysis (PHA) on each process covered by the PSM Program. This critical element identifies the process hazards, evaluates the consequences and defines appropriate control measures to eliminate or minimize the severity of the hazard.

**3.0 Guidelines:** The PHA element is one of the most important components of the Penn State PSM Program. The PHA provides information which will assist the University and its employees in making decisions for improving safety and reducing the consequences of unwanted or unplanned releases of highly hazardous chemicals/biological agents. The PHA is directed toward analyzing potential causes and consequences of fires, explosions, releases of toxic or flammable chemicals/biological agents and major spills of highly hazardous chemicals.

 The PHA focuses on the following factors, which to varying degrees can have an adverse impact on the continued safe operation of a covered process:

1. Process Equipment
2. Instrumentation & Controls
3. Utilities
4. Safety Systems and Interlocks
5. Human Factors
6. Facility Siting
7. External Factors (e.g. extreme weather, transportation incidents, seismic activity, etc.)

There are several methodologies that can be used by Penn State when conducting a PHA. The

methodology selected is based on the capability of the method to thoroughly identify all hazards,

defects, failures, possibilities, etc. for the process being studied. The following methodologies

may be utilized by the University when conducting a PHA:

1. What-If
2. Checklist
3. What-If / Checklist
4. Hazard and Operability Study (HAZOP)
5. Failure Mode and Effect Analysis (FMEA)
6. Fault Tree Analysis
7. An appropriate equivalent methodology

The University will typically utilize the What-If / Checklist methodology since it is flexible and can be customized to fit the various covered process areas determined to be within the scope of the PSM Program . A What-If / Checklist template will be utilized to provide the basis for the range of covered processes anticipated within the University’s PSM Program.

For most covered processes, the PHA should be conducted at the pre-construction or design stage of a new process. Conducting the PHA at this phase provides sufficient time to implement any significant changes that may be necessary to the equipment design or safe guards required. For large complex processes, the PHA process may be divided into logical separate processes for the purpose of conducting the PHA.

The PHA must be performed utilizing a team with a broad understanding of operational and technical backgrounds. This includes expertise in areas such as process technology, process design, operating procedures (including how the work is actually performed), maintenance procedures and environmental, health & safety issues. The team should also include members that have knowledge of the standards, codes, specifications and regulations applicable to the process being studied. Each PHA team will have a designated Leader that will be responsible for selecting the members of the PHA Team, methodology and preparation of the written report. The makeup of the PHA Team shall include:

1. At least one person who has experience and knowledge in the specific PHA methodology planned to be used;
2. At least one person who has experience and knowledge in the operation of the specific process being reviewed
3. At least one person who is familiar with the equipment that is used in the process
4. Other members could include individuals with expertize and/or knowledge in the following disciplines:
	1. Engineering principles
	2. Instrumentation
	3. Equipment design/set-up
	4. Research and Development
	5. Maintenance
	6. Environmental, Health & Safety

Note: it is not necessary to have a different person for each of the areas of expertise referenced above. One person may satisfy two or more of the areas as appropriate.

The PHA Team is responsible for reviewing the process, refining the language/instructions in the process operating procedures and compiling a list of the findings and recommendations that need to be addressed prior to the startup of the process.

For new processes that are under design/construction, the appropriate information required for the PHA is to be compiled by the Design and Construction Services group. For existing processes that have been deemed covered within the University’s PSM Program, the Building Operations Engineer is responsible for compiling the appropriate information. Information to be compiled includes:

1. A summary of the process technology to include:
	1. Chemical/Biological Agent name and inventory amounts (include current Safety Data Sheets)
	2. Any reactions and associated chemical equations describing the reactions (included exothermic or endothermic nature along with rate of energy generation or consumption)
	3. Chemical/Biological Agent name of any generated intermediates or waste streams
	4. Utilities required for the process (e.g. steam, ethylene glycol, natural gas, etc.)
	5. Description of how the utilities support the process
2. Complete and up-to-date process operating procedures
3. Accurate and up-to-date P&ID’s
4. Block Flow Diagram or Simplified Process Flow Diagram
5. Computer Logic Diagrams or Descriptions of Computer Software actions (if applicable)
6. Facility Plot Plans identifying location
7. Information on the equipment to be used in the process, including:
	1. Equipment name and number
	2. Type and volume
	3. Purpose/function in process
	4. Electrical classification
	5. Materials of construction
	6. Pressure rating
	7. Corrosion/Erosion data
8. Any other pertinent documents or information that would be beneficial for the PHA Team during the process review

There are three basic steps to conducting the PHA study that the team will be required to perform during the review. These steps are summarized below:

1. Identify – the hazards associated with each step in the process
2. Evaluate – the consequences of the hazard including the conditions that could lead to the hazard being present
3. Control – the hazard through safeguards (e.g. engineering design, administrative, etc.)

To accomplish the study, the team must assess each piece of process equipment and pipeline associated with a particular step in the process. A PHA Study Worksheet will be used by the team to document the consequence scenarios identified for each step in the process. As the study progresses the team will make sure the following issues are addressed:

1. Safe operating limits for process parameters (e.g. flow rate, temperature, pressure, pH, etc.) have been identified and reviewed
2. Operation of any interlock system is reviewed and thoroughly studied
3. Design basis for the process equipment’s emergency relief devices and vent systems is reviewed and thoroughly studied
4. Any other safety systems (e.g. fire suppression) present in the process are reviewed and thoroughly studied
5. Facility siting concerns are considered
6. Human factor concerns are considered
7. Any process equipment that is designated as being critical to the safe operation of the process is identified and a notation made for the Mechanical Integrity Element (#11)
8. Applicable emergency response procedures are developed
9. Consequences of failure of any engineering or administrative controls that have been incorporated into the process
10. A qualitative evaluation of the range of the possible safety and health effects on employees, students and public should failure of these controls occur

The PHA Worksheet and all supporting documentation used during the PHA study will be retained as part of the Process Safety Master File.

The PHA Team Leader is responsible for preparing the study report and should include the names of the individuals participating in the study, methodology utilized, dates, process description and associated findings and recommendations. The findings and recommendations from a PHA study will be managed according to the Management System to Address Recommendations Element (#04).

The Process Safety Program Manager (PSPM) is responsible to maintain a PHA Master Schedule for the University. The Master Schedule will outline the date of the original PHA and subsequent PHA’s completed as part of an MOC or PHA Review for each covered process.

**4.0 Definitions:** The following definitions provide guidance regarding common issues surrounding the Process Hazard Analysis Element.

*Block Flow Diagram –* diagram used to show the major process equipment and interconnecting process flow lines and show flow rates, stream composition, temperatures, and pressures when necessary for clarity.

*Facility Siting -* the location of process equipment containing a highly hazardous chemical/biological agent and their proximity to other process equipment, storage areas, equipment control rooms, classrooms, research facilities, maintenance shops, public gathering locations, buildings, location of fresh air intakes, etc.

*Piping & Instrumentation Diagram (P&ID) -* is to be generated for each stage of a covered process. It should reflect the as-built equipment setup, instrumentation & controls, safety systems and interlocks included in a covered process. A P&ID is the one document that when properly completed shows the most information pertaining to the technology of the covered process. It is generally considered to be the single most vital document that must be used when performing a Process Hazard Analysis (PHA).

*Process Hazard Analysis (PHA) -* is an analytical tool that is used to identify the inherent causes and subsequent consequences of potential accidents or hazard scenarios that involve fires; explosions; releases of toxic, reactive or flammable chemicals/biological agents; and major spills of hazardous chemicals/biological agents and to recommend corrective measures to prevent such occurrences.

*Process Hazard Analysis Team Leader* – an individual formally trained in leading PHA’s and responsible for preparing the necessary documentation for the review and written report. In addition, in conjunction with the responsible senior leadership will select the PHA Team members.

*Safeguards* – an engineering or administrative control either in the design or operation of the process that may prevent a scenario from occurring, or that mitigates the consequences should it occur. It is an existing measure that detects or warns of a hazard or consequence, prevents a hazard or consequence, or mitigates the effects of a hazard or consequence.

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|  Process Safety Management Program |
| **Title:** Process Hazard Analysis Procedure**Document #:** PSM-SOP-UN-012 **Issued:** 12/09/2014 |
| **Responsible Dept.:** EHS **Version:** New**Approved By:** PSM Focus Group **Page:** 1 of 8 |

**1.0 Purpose:** This document provides guidance to employees of The Pennsylvania State University (Penn State) in the requirements of conducting Process Hazard Analysis studies within the Process Safety Management (PSM) Program.

**2.0 Scope:** A Process Hazard Analysis (PHA) must be conducted on all defined covered process areas within the University. The PHA identifies the associated process hazards, evaluates the consequences and defines appropriate control measures to eliminate or minimize the severity of the hazard.

**3.0 Responsibility:** The following employees have specific responsibilities assigned to them in accordance with the requirements of conducting a Process Hazard Analysis within the PSM Program. Specific Budget Executives and Budget Administrators may assign these responsibilities to a Department or individual other than the one identified in this procedure as appropriate.

 Budget Executives and Budget Administrators:

1. Assume primary responsibility to maintain a safe work environment within their jurisdiction, by monitoring and exercising control over their assigned areas.
2. Assign a representative from their respective academic or administrative unit to ensure compliance with this procedure.
3. Ensure appropriate mechanisms exist to conduct PHA’s within the academic departments or administrative units for which they are responsible.

Director Design & Construction:

1. Ensure employees within their area(s) of responsibility understand and follow the PHA requirements outlined in this procedure.
2. Provide appropriate opportunities for employees to actively participate in PHA’s as the individuals with design experience within the specific covered process being assessed.

Manager Engineering Services:

1. Ensure employees within their area(s) of responsibility understand and follow the PHA requirements outlined in this procedure.
2. Provide appropriate opportunities for employees to actively participate in PHA’s as the individuals with technical / equipment experience within the specific covered process being assessed.

Project Managers:

1. Coordinate collecting appropriate process information required to conduct the PHA.
2. Participate in PHA’s and provide input into covered process area design.
3. Address any assigned action items and/or recommendations generated from the PHA process.

Building Operations / Utility Engineers:

1. Coordinate collecting appropriate process information required to conduct the PHA.
2. Participate in PHA’s and provide technical input into covered process area design and reassessments.
3. Address any assigned action items and/or recommendations generated from the PHA process.

Physical Plant Supervisors:

1. Ensure employees within their area(s) of responsibility are aware and understand their responsibilities outlined within the PHA procedure.
2. Provide appropriate opportunities for employees to actively participate in PHA’s as the individuals with equipment experience within the specific covered process being assessed.
3. Address any assigned action items and/or recommendations generated from the PHA process.
4. Take prompt corrective action when unsafe process safety conditions or practices are observed or reported.

Operations/Facility Manager:

1. Ensure employees within their area(s) of responsibility are aware and understand their responsibilities outlined within the PHA procedure.
2. Provide appropriate opportunities for employees to actively participate in PHA’s as appropriate (e.g. Maintenance, Research and Development, etc.).
3. Address any assigned action items and/or recommendations generated from the PHA process.
4. Take prompt corrective action when unsafe process safety conditions or practices are observed or reported.

Safety Officer:

1. Coordinate implementation of the PHA program within the work unit.
2. Participate in PHA’s as appropriate and provide technical input into covered process area design and reassessments.
3. Address any assigned action items and/or recommendations generated from the PHA process.

Process Safety Program Manager – EHS Department:

1. Oversee all aspects of the University’s Process Safety PHA program.
2. Manage PHA Reports, PHA Master Schedule and track completion of Action Items.
3. Track and report metrics established for this element to affected groups and senior leadership as appropriate.
4. Maintain a list of individuals meeting the PHA Team Leader requirements
5. Coordinate auditing of PHA element requirements.

Employees:

1. Participate in PHA’s and provide technical input into covered process area design and reassessments.
2. Address any assigned action items and/or recommendations generated from the PHA process.
3. Report Process Safety issues or concerns to appropriate line management and/or the Process Safety Program Manager.

**4.0 Definitions:**

*Covered Process* - any process where a highly hazardous chemical / biological agent or extremely hazardous substance deemed by Penn State is used, handled or stored. This also includes critical process operations identified by the University that would benefit from PSM program implementation.

*Block Flow Diagram –* diagram used to show the major process equipment and interconnecting process flow lines and show flow rates, stream composition, temperatures, and pressures when necessary for clarity.

*Facility Siting -* the location of process equipment containing a highly hazardous chemical/biological agent and their proximity to other process equipment, storage areas, equipment control rooms, classrooms, research facilities, maintenance shops, public gathering locations, buildings, location of fresh air intakes, etc.

*Operations/Facility Manager* – a person who has control / oversight of building use, stewardship, operation, repair, and general administration of campus facilities. Also includes the operational responsibility of a specific unit operation within a facility.

*Physical Plant Supervisors* – group of individuals in first-line management who monitors and regulates employees in their performance of assigned or delegated tasks (e.g. trains, evaluates, hires, and discipline employees; approves time & attendance; administers the University / Teamster contract, manages absences; plans & rotates overtime work, etc.).

*Piping & Instrumentation Diagram (P&ID) -* is to be generated for each stage of a covered process. It should reflect the as-built equipment setup, instrumentation & controls, safety systems and interlocks included in a covered process. A P&ID is the one document that when properly completed shows the most information pertaining to the technology of the covered process. It is generally considered to be the single most vital document that must be used when performing a Process Hazard Analysis (PHA).

*Process Hazard Analysis (PHA) -* is an analytical tool that is used to identify the inherent causes and subsequent consequences of potential accidents or hazard scenarios that involve fires; explosions; releases of toxic, reactive or flammable chemicals/biological agents; and major spills of hazardous chemicals/biological agents and to recommend corrective measures to prevent such occurrences.

*Process Hazard Analysis Team Leader* – an individual formally trained in leading PHA’s and responsible for preparing the necessary documentation for the review and written report. In addition, in conjunction with the responsible senior leadership will select the PHA Team members.

*Safeguards* – an engineering or administrative control either in the design or operation of the process that may prevent a scenario from occurring, or that mitigates the consequences should it occur. It is an existing measure that detects or warns of a hazard or consequence, prevents a hazard or consequence, or mitigates the effects of a hazard or consequence.

**5.0 Procedure:** The PHA element is one of the most important components of the Penn State PSM Program. The PHA provides information which will assist the University and its employees in making decisions for improving safety and reducing the consequences of unwanted or unplanned releases of highly hazardous chemicals/biological agents. The PHA is directed toward analyzing potential causes and consequences of fires, explosions, releases of toxic or flammable chemicals/biological agents and major spills of highly hazardous chemicals / biological agents.

 For new facilities covered by the PSM Program, a PHA shall be performed and recommendations resolved or implemented before startup. For existing operations identified to be included within the PSM Program, the PHA shall be performed within one (1) year of the process being deemed covered.

The following steps outline the requirements relating to conducting a PHA:

1. Once a new facility / process has been approved to proceed and has been identified as covered within the PSM Program, the Director of the Design and Construction group will ensure the PSPM is notified of the associated design and construction schedule for the project. Based on this schedule the PSPM will assign the PHA Team Leader considering appropriate PHA preparation time. For new covered processes, the PHA shall be conducted at the pre-construction or design stage of the new process. Conducting the PHA at this phase provides sufficient time to implement any significant changes that may be necessary to the equipment design or safe guards required.
2. For existing operations the PSPM is part of the review and evaluation team to assess applicability of the PSM Program to the specific process in question. After the decision to include an existing operation in the PSM Program, the PSPM will assign the PHA Team Leader considering appropriate PHA preparation time and requirement to complete the assessment within one (1) year after applicability determination.
3. All PHA’s shall be conducted by a Team that has the necessary technical knowledge and/or experience to thoroughly assess the inherent causes and subsequent consequences of potential accidents or hazard scenarios that involve fires, explosions, releases of toxic materials, reactive or flammable chemicals/biological agents and major spills of hazardous chemicals/biological agents. The Team should also be able to recommend corrective measures to prevent such occurrences.
4. Every PHA Team will have a PHA Team Leader that is responsible for selecting the remaining members of the team. The Team Leader must be someone who is trained or has significant experience in the methodology used to conduct the PHA. In addition, the PHA Team Leader is responsible to collect or assign members on the review team to acquire the necessary documentation required to complete the PHA.
5. The PHA Team Leader will select the team members and shall include:
	1. At least one person who has experience and knowledge in the specific PHA methodology planned to be used;
	2. At least one person who has experience and knowledge in the operation of the specific process being reviewed
	3. At least one person who is familiar with the equipment that is used in the process
	4. Other members could include individuals with expertize and/or knowledge in the following disciplines:
	5. Engineering principles
	6. Instrumentation
	7. Equipment design/set-up
	8. Research and Development
	9. Maintenance
	10. Environmental, Health & Safety

Note: it is not necessary to have a different person for each of the areas of expertise referenced above. One person may satisfy two or more of the areas as appropriate.

1. The PHA is an analytical tool that is used to identify the inherent causes and subsequent consequences of potential accidents or hazard scenarios. As such the following factors will be an area of focus during the PHA since they can have an adverse impact on the safe operation of a covered process:

6.1 Process Equipment

6.2 Instrumentation & Controls

6.3 Utilities

6.4 Safety Systems and Interlocks

6.5 Human Factors

6.6 Facility Siting

6.7 External Factors (e.g. extreme weather, transportation incidents, seismic activity,

 etc.)

1. There are several methodologies that can be used by Penn State when conducting a PHA. The methodology selected is based on the capability of the method to thoroughly identify all hazards, defects, failures, possibilities, etc. for the process being studied. The following methodologies may be utilized by the University when conducting a PHA:

7.1 What-If

7.2 Checklist

7.3 What-If / Checklist

7.4 Hazard and Operability Study (HAZOP)

7.5 Failure Mode and Effect Analysis (FMEA)

7.6 Fault Tree Analysis

7.7 An appropriate equivalent methodology

The University will typically utilize the What-If / Checklist methodology since it is flexible and can be customized to fit the various covered process areas determined to be within the scope of the PSM Program . A What-If / Checklist template will be utilized to provide the basis for the range of covered processes anticipated within the University’s PSM Program.

1. For the PHA Team to effectively assess the factors outlined in 5.6, certain information is required to be provided to the team well in advance of the PHA. The information included can vary by the complexity of the process but should include:
	1. A summary of the process technology to include:
		1. Chemical/Biological Agent name and inventory amounts (include current Safety Data Sheets)
		2. Any reactions and associated chemical equations describing the reactions (included exothermic or endothermic nature along with rate of energy generation or consumption)
		3. Chemical/Biological Agent name of any generated intermediates or waste streams
		4. Utilities required for the process (e.g. steam, ethylene glycol, natural gas, etc.)
		5. Description of how the utilities support the process
	2. Complete and up-to-date process operating procedures
	3. Accurate and up-to-date P&ID’s
	4. Block Flow Diagram or Simplified Process Flow Diagram
	5. Computer Logic Diagrams or Descriptions of Computer Software actions (if applicable)
	6. Facility Plot Plans identifying location
	7. Information on the equipment to be used in the process, including:
		1. Equipment name and number
		2. Type and volume
		3. Purpose/function in process
		4. Electrical classification
		5. Materials of construction
		6. Pressure rating
		7. Corrosion/Erosion data
	8. Any other pertinent documents or information that would be beneficial for the PHA Team during the process review

For new processes that are under design/construction, the appropriate information required for the PHA is to be compiled by the Design and Construction Services group. For existing processes that have been deemed covered within the University’s PSM Program, the Engineering Services group is responsible for compiling the appropriate information.

1. The PHA Team Leader will ensure the appropriate information is collected and as appropriate distributed to the review team to afford sufficient time for review. This information should be distributed at least three (3) weeks before the scheduled PHA meeting.
2. PHA members must come prepared to the PHA meeting(s) with an understanding of the general process and the information distributed by the Team Leader prior to the PHA.
3. During the PHA, the Team Leader team must ensure each piece of process equipment and pipeline associated with a particular step in the process is appropriately assessed. A PHA Study Worksheet (see Attachment A) will be used by the team to document the consequence scenarios identified for each step in the process. As the study progresses the team will make sure the following issues are addressed:

11.1 Safe operating limits for process parameters (e.g. flow rate, temperature, pressure, pH, etc.) have been identified and reviewed

11.2 Operation of any interlock system is reviewed and thoroughly studied

11.3 Design basis for the process equipment’s emergency relief devices and vent systems is reviewed and thoroughly studied

11.4 Any other safety systems (e.g. fire suppression) present in the process are reviewed and thoroughly studied

11.5 Facility siting concerns are considered

11.6 Human factor concerns are considered

11.7 Any process equipment that is designated as being critical to the safe operation of the process is identified and a notation made for the Mechanical Integrity Element (#11)

11.8 Applicable emergency response procedures are developed

11.9 Consequences of failure of any engineering or administrative controls that have been incorporated into the process

11.10 A qualitative evaluation of the range of the possible safety and health effects on employees, students and public should failure of these controls occur

1. The PHA Team Leader is responsible to document the PHA utilizing the PHA Worksheet and associated assignment of Action Items generated through the review process. A PHA Report will be prepared by the Team Leader and forwarded to the PSPM within 21 days after the final PHA meeting. The information collected as part of the PHA, including the Final Report will be maintained by the PSPM within the Process Safety Master File for the specific unit operation.

Actions items generated through the PHA will be managed in accordance with the requirements outlined in the Management System to Address Action Items procedure (PSM-SOP-UN-014).

1. The PSPM is responsible to maintain the PHA Master Schedule for the University. The Master Schedule will outline the date of the original PHA and document the appropriate PHA Review timeline initially established for the covered process.
2. The PSPM will periodically audit compliance to the requirements within this element including status and effectiveness of Action Items identified by the PHA Team.

**6.0 Attachments**

* 1. Attachment A - PHA Worksheet