



FESHM 2010: PLANNING AND REVIEW OF ACCELERATOR FACILITIES AND THEIR OPERATIONS

Revision History

Author	Description of Change	Revision Date
J. Donald Cossairt	Incorporate extensive changes intended to meet the revised requirements of DOE O420.2C (7-21-2011)	May 2013
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1.0 INTRODUCTION

This FESHM chapter describes the formal review procedures established by the Laboratory to assure that accelerator facilities and their operations comply with Fermilab ES&H standards and with DOE O 420.2C, *Safety of Accelerator Facilities* (7-21-2011). This review system shall be applied to new projects or when significant modifications, including decommissioning, occur. The level of detail required in the Preliminary Hazard Analysis Reports (PHARs)¹, Preliminary Safety Assessment Document (PSADs), and Safety Assessment Documents (SADs) that are developed as part of this process and the amount of resources expended in the accelerator readiness review (ARR) and its accompanying documentation should be commensurate with the programmatic importance and potential ES&H impact of the facility and its activities. The [Fermilab Environment, Safety and Health Manual \(FESHM\)](#), inclusive of the [Fermilab Radiological Control Manual \(FRCM\)](#), specifies a set of physical and administrative conditions that define the bounding conditions for safe operation of accelerator facilities or portions thereof. FESHM 2010 is based on the content of DOE G 420.2-1, *Accelerator Facility Safety Implementation Guide for DOE O 420.2B, Safety of Accelerator Facilities* (7/2/05) or its successor Guidance document.

Fermilab is currently (as of April 2013) in a long-term process of instituting a single SAD for all of its facilities. Individual analyses shall be written as modules (i.e., chapters) of the overall SAD. See the [Fermilab SAD Table of Contents](#) for a list of areas expected to be included in the Fermilab SAD.

Most accelerator improvements and the design, construction, and decommissioning of them are conducted as part of projects of varying sizes and funding types. [FESHM 2001](#) summarizes environment, safety, and health requirements that pertain to all Fermilab projects and identifies other types of work planning tasks that shall be performed for all projects, including accelerator projects. Documentation requirements related to work involving ionizing radiation are covered in the FRCM.

The Fermilab Director, as advised by the ESH&Q Director, determines the applicability of this Chapter and notifies the responsible division/section/center and gives guidance on the level of details required. Divisions, sections, and centers are responsible for maintaining their SAD modules and associated Accelerator Safety Envelope (ASE) components up-to-date by revising them when necessary. SAD modules shall be reviewed not less than every 5 years. At a minimum, all SAD modules shall have the Document number, Revision Date, and Issue Date in accordance with [Director's Policy Manual No. 13.000](#). Revised SADs and ASEs shall be reviewed and approved in accordance with the procedures of this chapter. SADs and ASEs are reviewed by the Safety Assessment Document Review Subcommittee of the Fermilab ES&H Committee (FESHCom). SADs are approved by the Fermilab Director and the ASEs are

¹ The term Preliminary Hazard Assessment Document (PHAD) is sometimes used and for purposes of this Chapter is synonymous with Preliminary Hazard Analysis Report (PHAR).



approved by the DOE-FSO. The charter of this subcommittee is at: [FESHCom SAD Review Subcommittee Charter](#).

SADs commonly include a radiation shielding assessment or incorporate the results of a separate Shielding Assessment document. Requirements and guidance concerning the shielding of ionization radiation and the preparation and approval of shielding assessments are described in FRCM Chapter 8. Shielding assessments are reviewed by the Shielding Assessment Review Subcommittee of the Fermilab ES&H Committee (FESHCom) and approved by the ESH&Q Director. The charter of this subcommittee is at: [FESHCom Shielding Assessment Review Subcommittee Charter](#).

It is not uncommon for accelerator installations to exist in “standby” or “idle” conditions for lengthy periods of time upon completion of their mission pending final decisions concerning their future use or disposition. The SADs or SAD modules that address these installations shall be revised or updated with addenda, and reviewed and approved in accordance with the provisions of this chapter, to assure proper assessment and mitigation of the hazards during this post-operational stage. The documentation, if appropriate, can be used to certify the termination of applicability of the SAD or SAD module.

2.0 SELECTED DEFINITIONS (Where applicable, adapted from DOE O420.2C and its associated Contractor Requirements Document)

- **Accelerator:** A device employing electrostatic or electromagnetic fields to impart kinetic energy to molecular, atomic or sub-atomic particles and, for the purposes of this chapter (FESHM 2010), capable of creating a radiological area as defined by Regulation 10 CFR Part 835, “Occupational Radiation Protection”, and the FRCM.

The following devices are exempt from DOE O 420.2C and hence this FESHM Chapter, but are otherwise subject to FRCM Article 362. These are facilities that can be safely managed under the provisions of 10 CFR Parts 835 and 851 that are non-complex in nature and that produce only local work area impacts. Other types of exemptions are subject to approval by DOE as stated in O420.2C. Under O420.2C, DOE may in certain instances also impose alternate safety standards called “equivalencies”. These equivalencies are normally associated with facilities or modules thereof and their operation where nuclear criticality is a possibility, conditions that do not exist at Fermilab.

Examples of exemptions to O420.2C include:

- (a) Radiation or current generating devices that incidentally produce ionizing radiation;
- (b) A room-sized accelerator with a single external/extractable beam, an active safety system, and a single point of entry into the room;



(c) X-ray generators (below 10 MeV) or neutron generators (accelerating potential below 600 KeV) that are bench top in size and that have a single external/extractable beam and a single operator such as those that are operated in accordance with American National Standards Institute (ANSI) N43.3-2008, or National Council on Radiation Protection and Measurements (NCRP) Report 72-1983 or other applicable Program consensus standard; and

(d) Unmodified commercially available equipment including, but not limited to, electron microscopes, ion implant devices, and x-ray generators.

- Accelerator Component: Components used within an accelerator such as but not limited to radio-frequency (RF) cavities, electrostatic separators, kickers, pingers, and choppers when tested by themselves, do not by themselves meet the definition of an accelerator, although these devices may produce x-rays. These devices are managed in accordance with 10 CFR Part 835 as implemented in the FRCM, and with provisions of the FESHM. They do not require a separate Safety Assessment Document (SAD) or Accelerator Safety Envelope (ASE) when tested and operated as a stand-alone component. Documented hazard assessments of stand-alone facilities used in testing and research and development of such components are required to be conducted as part of Fermilab's implementation of Integrated Safety Management Systems (ISMS) and Radiation Protection Program (RPP) guidance in accordance with provisions of FESHM and FRCM.
- Accelerator Facility: The accelerator and associated roads within site boundaries, plant and equipment utilizing, or supporting the production of, accelerated particle beams and the radioactive material created by those beams to which access is controlled to protect the safety and health of workers, the public or the environment. The term facilities includes injectors, targets, beam dumps, detectors, experimental halls, non-contiguous support and analysis facilities, experimental enclosures and experimental apparatus utilizing the accelerator, etc., regardless of where that apparatus may have been designed, fabricated, or constructed, including all systems, components and activities that are addressed in the Safety Analysis.
- Accelerator Readiness Review (ARR): A structured method for verifying that hardware, personnel, and procedures associated with commissioning and/or routine operation are ready to permit the activity to be undertaken safely. Upon satisfactory completion of the review and close-out of significant issues, *approval to operate* is signified by signatures on the PSAD/SAD/ARR Documentation form attached to this chapter.
- Accelerator Safety Envelope (ASE): A set of physical and administrative conditions that defines the accelerator/storage ring beam bounding conditions for safe operations. Operations outside the ASE require the activity to be terminated and notification made to Laboratory management and DOE-FSO. The activity may not be restarted without DOE approval. See also the definition of Operations Envelope provided below.



- **Commissioning:** A phase of an accelerator facility operation that is typically used to conduct beam testing and to verify specifications in a new or designed functional mode. Commissioning periods may be tailored to the needs of each facility and there may be great variations in their duration, breadth, and formality, but in all cases the activities will be bounded by an ASE and preceded by an ARR. At its conclusion, the accelerator is ready for performance of an ARR for routine operations, or directly for routine operations if the ARRs were part of the commissioning process.
- **Credited Controls:** Controls determined through safety analysis to be essential for safe operation directly related to the protection of personnel or the environment. See also Machine Controls. The Credited Controls for Fermilab are:
 - ✓ Radiation Safety Interlock System
 - ✓ In-Place Oxygen Deficiency Monitors/Alarm System
 - ✓ Flammable Gas Detection System
 - ✓ Pressure Relief Systems for Cryogenic Vessels
 - ✓ Passive Radiation Shielding Configurations for Accelerators and Beamlines
- **Exclusion Area:** An area that is locked and interlocked by the Radiation Safety Interlock System to prevent personnel access while the accelerator is in operational status.
- **Experimenters:** All persons directly involved in experimental efforts at the accelerator utilizing the accelerator or its beams, including visiting scientists, students and others who may not be employees of Fermi Research Alliance, the DOE Management and Operating (M&O) contractor for Fermilab.
- **Hazard:** A source of danger (i.e., material, energy source, or operation) with the potential to cause illness, injury, or death to personnel or damage to a facility or to the environment.
- **Hazard Analysis:** A tool used to plan work not specifically otherwise addressed by this chapter. See [FESHM 2060](#).
- **Idle State:** A condition in which a facility is being not scheduled for future operation and is being maintained in a safe condition pending plans for repurposing and/or demolition.
- **Machine Controls:** Machine controls are other administrative controls and machine protection systems that may be used in addition to credited controls defined here to limit the duration of beam loss. These and their use in the shielding analysis are described in [FRCM Chapter 2 Appendix 2C](#).
- **Operations Envelope:** A set of physical and administrative conditions that may be defined within the ASE for individual subsets of operations or modules of the accelerator/storage ring beam. The operations envelope defines nominal operating parameters beyond which the operating procedures would require adjustments to be made. An operations envelope serves to prevent the ASE from being exceeded. Variations of operating parameters within an appropriate operations envelope are



considered within the scope of normal operations. Variation outside the operations envelope but within the ASE merits appropriate attention; it does not require termination of activities or notification of DOE.

- **Preliminary Hazard Analysis Report (PHAR)**: A preliminary formal review document to analyze Laboratory projects, operations and experiments for possible hazards and possible ways to mitigate them. The PHAR is one of the requirements of DOE O413.3B, *Program and Project Management for the Acquisition of Capital Assets*, 11-29-2010.
- **Preliminary Hazard Assessment Document (PHAD)**: A synonym of PHAR. The two terms are equivalent for purposes of this Chapter.
- **Preliminary Safety Assessment Document (PSAD)**: A preliminary formal review document to analyze Laboratory projects, operations and experiments for possible hazards and possible ways to mitigate them with a focus on accelerator-specific topics. For a major project, Fermilab may choose to prepare a PSAD to support deliberations leading to *approval to initiate construction*. The preparation of a PSAD may be incorporated into the Preliminary Hazard Analysis Report (PHAR) process established to also meet the requirements of DOE O413.3B, *Program and Project Management for the Acquisition of Capital Assets*, 11-29-2010.
- **Project Leader**: The individual assigned primary responsibility for the overall conduct of a given activity subject to the provisions of this chapter (FESHM 2010). This is the person to whom Fermilab management has assigned the responsibility for schedule and performance specifications and financial stewardship. This individual may also be designated the Project Manager in conformance with project management requirements specified by DOE Orders.
- **Radiation Protection Program (RPP)**: The documented program, approved by DOE, including but not limited to the plans, schedules, and other measures developed and implemented to achieve and ensure continuing compliance with 10 CFR Part 835 and apply the “as low as reasonably achievable” (ALARA) process to occupational and environmental radiation dose (see FRCM).
- **Risk**: A quantitative or qualitative expression of possible harm, which considers both the probability that a hazard will cause harm and the amount of harm. The risk assignment methodology in [Quality Assurance Manual chapter 12030](#) should be used for this purpose unless superseded by methodologies otherwise specified.
- **Routine Operation**: Routine operation commences at the point where authorization has been granted either (1) because the commissioning effort is sufficiently complete to provide confidence that the hazards are both understood and acceptable and the operation has appropriate safety bounds, or (2) to permit the re-introduction of a particle beam after being directed to cease operation by DOE because of an environment, safety, or health concern that has been assessed and resolved to the satisfaction of both the Director and DOE-FSO.



- Safety Analysis: A documented process to systematically identify the hazards of a given operation; including a description and analyses of the adequacy of measures taken to eliminate, control, or mitigate the hazards and risks of normal operation; and identification and analyses of potential accidents and their associated risks.
- Safety Assessment Document (SAD): A document containing the results of a safety analysis for an accelerator facility pertinent to understanding the risks of operating the accelerator facility.
- Standby State: A condition in which a facility is presently operational but in which operations may be resumed at an indefinite time in the future.
- Unreviewed Safety Issue (USI): A significant increase in the probability of or consequences from (1) a planned modification that creates a previously unanalyzed postulated accident or condition that could result in a significant adverse impact or (2) a previously analyzed postulated accident or condition.

3.0 PROCESS DESCRIPTION

The Accelerator PHAR or PSAD, SAD and the associated ARR process is initiated with either a recommendation by the ESH&Q Director to the Fermilab Director concerning the applicability of PSAD/SAD for a proposed project, operation or experiment or a similar determination by the division/section/center head(s) responsible for the activity. Often, multiple divisions/sections/centers may share these responsibilities. For projects of limited scope, the PSAD step may not be required. For projects for which DOE O413.3B is applicable, the PHAR process may be inclusive of the analysis that otherwise might constitute a PSAD under DOE O420.2C. These determinations shall be documented using the Unreviewed Safety Issue Determination (USID) form found in the technical appendix of this chapter and whether or not a PHAR or PSAD is required at the earliest possible stage of conceptual design. The flowchart at the end of this section illustrates this process. The ESH&Q Director shall maintain records of all USIDs completed by division/sections/centers or by the ESH&Q Director.

Following this determination of applicability, if required, the responsible division/section/center will prepare a PHAR or PSAD, the approval of which allows initiation of more detailed design and/or construction.

The role of the PHAR or PSAD is largely to identify the environment, safety, and health issues that are not adequately addressed by common industrial practices performed within boundaries set by federal regulations and by standard-setting bodies (e.g., ANSI, AMSE, NFPA). The PHAR or PSAD is not intended to describe all mitigation measures.

The role of the SAD is to document the measures taken to successfully mitigate these issues and how these mitigative measures are to be folded into routine operation of the accelerator or accelerator module. Thus, if required, the PHAR or PSAD is prepared at the earliest stage of



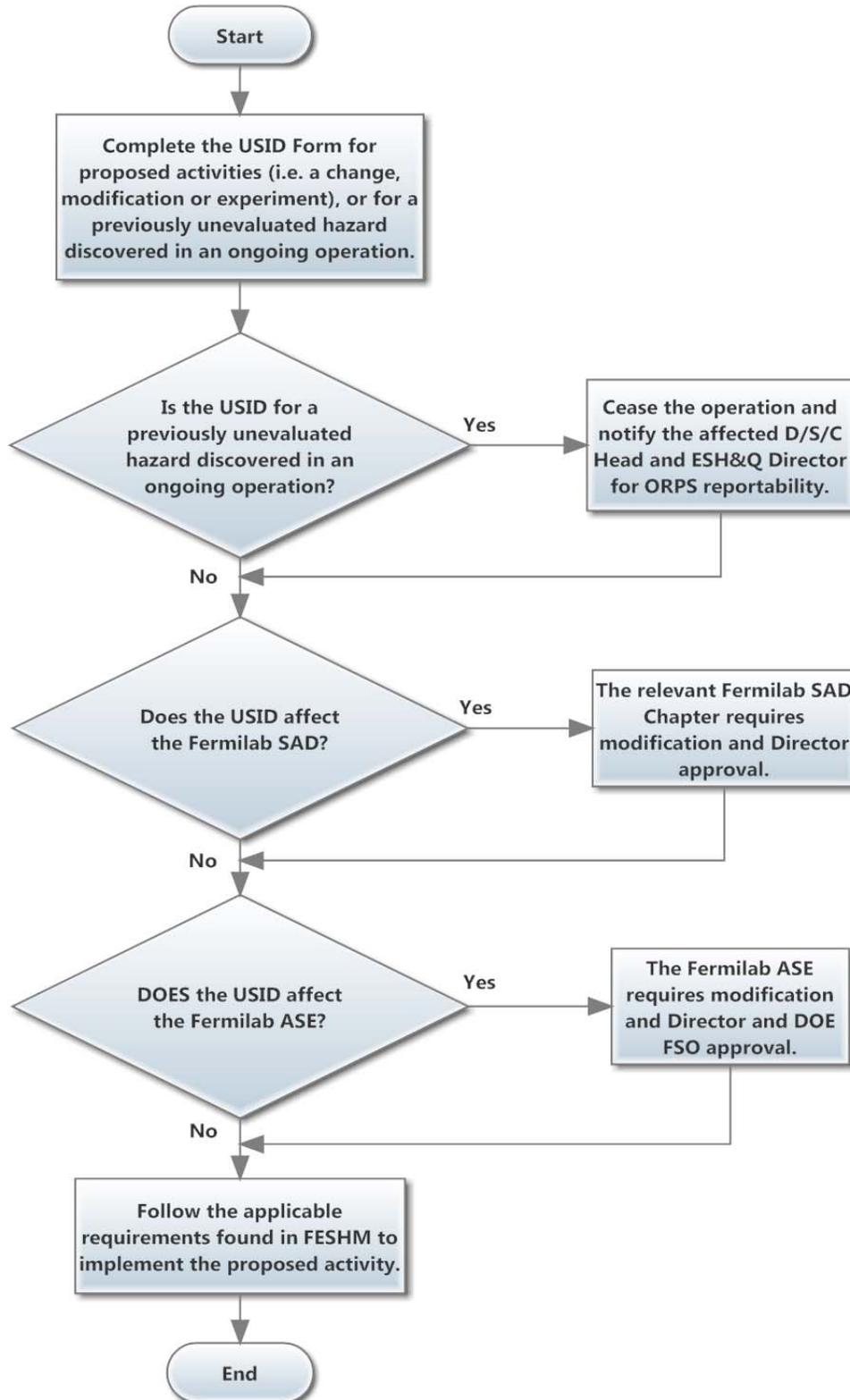
project development; when the necessary broad conceptual understanding of potential project ES&H issues of required information is available. Then, when detailed hazard analyses and mitigation methodologies are better understood (e.g., a more advanced stage of design), the SAD is prepared. The SAD shall incorporate a risk assessment conducted using a systematic methodology. The risk assignment methodology stated in [Quality Assurance Manual chapter 12030](#) is recommended. Alternates may be used but should clearly be stated or referenced in the SAD. Completed PHARs, PSADs or SADs shall be submitted to the Chair of the Safety Assessment Document Review Subcommittee or to the ESH&Q Director for review.

For new projects or for those that have been significantly modified, a documented ARR lead by the ESH&Q Section at a time prior to commissioning activities but at a sufficiently advanced stage of the project to assure validity must be completed. The schedule for the ARR should be done with concurrence between the ESH&Q Director, the project management leader as assigned by Fermilab management, and the hosting Division/Section/Center Head. The ARR may result in a list of items that need to be completed (punch list) before the approval to operate is granted. Upon successful completion of the review by the ESH&Q Section and close-out of all significant issues, the ESH&Q Director then recommends approval of the final SAD/ARR to the Fermilab Director using the SAD/ARR documentation form found in the Technical Appendix of this Chapter.

Experience has indicated that this process is greatly enhanced by timely, effective collaboration and communication between the responsible division/section/center(s) and the Safety Assessment Review and Shielding Assessment Review Subcommittees along with ESH&Q Section. Involvement of representatives of the DOE-FSO at an early stage of project planning has also been found to be highly beneficial.



The process specified by this chapter is illustrated in the following flowchart.





Each one of the above steps is described in detail below. These steps should be followed in sequential order.

1. Unreviewed Safety Issue (USI)

A USID is to be completed for proposed modified activities, **this includes all DOE O413 projects**, (e.g., a significant change to operations and possibly the associated hazards), or for a previously unevaluated hazard discovered in an ongoing operation. The USID form, found at the end of the technical appendix to this chapter, should be completed when there is a reasonable chance that a proposed activity or previously unevaluated hazard discovered in an ongoing operation could affect the probability or consequence of an accident from that evaluated in the Fermilab SAD or introduce an accident or malfunction of a different type than any evaluated in the SAD.

A USID may be initiated by division/section/center line managers, project managers, project engineers, system engineers, or ESH personnel. The initiator completes the USID form providing a description of the proposed modifications or discovered situation in an ongoing operation, identifies the relevant SAD sections as appropriate, identifies any affected sections of the ASE, and answers the six key questions to determine if a USI exists. If a “Yes” is answered to any of the six key questions, a USI is determined to exist. If a “No” is answered to all six questions, a USI does not exist.

The completed form is then reviewed by the ESH&Q Section Deputy Head, ESH&Q Section Associate Head, or the SAD Review Subcommittee Chair and approved by the ESH&Q Director. An electronic copy of the approved form is posted to the [USID document](#) in the ESH&Q Section Document database and the original sent to the ESH&Q Section for records retention.

If a USI is determined not to exist, with all six key questions answered “No”, the proposed change may be implemented following the applicable FESHM or FRCM chapter requirements.

If a USI is determined to exist for a proposed modification since one or more of the six key questions answered with a “Yes”, the activity may not commence without the prior approval of the Director through the attached form. In cases where a change to the ASE is required, the activity may not commence without prior DOE-FSO approval of the ASE revision.

If a USI is determined to exist in an ongoing operation subsequent to the issue of a SAD, the discovery of a USI as defined by this chapter (FESHM 2010) could possibly constitute a reportable occurrence to be addressed and reported in accordance with DOE O 420.2C and [FESHM 3010](#). Activities stopped as a result of an identified USI shall not resume or commence operations without written approval of the DOE-FSO Manager.

Procedure for Addressing Un-reviewed Safety Issues (USIs)

- a. Upon discovery, the event that might constitute a USI should be reported by the responsible division/section/center(s) to the ESH&Q Director and the Fermilab Director.
- b. The ESH&Q Director shall determine whether the event is a USI as defined by DOE O 420.2C and document that decision. The process of determining USI status may be discussed with DOE-FSO as part of the overall determination process.
- c. Identified USIs shall be reported to DOE-FSO along with relevant support documentation. Operation of the identified accelerator module or facility will be stopped until such time as the USI is resolved and approval to return to operations is provided.
- d. Corrective actions to address the USI shall be documented in the DOE Occurrence Reporting System (ORPs) if the USI is deemed to constitute reportable occurrence.
- e. Where necessary, SADs and ASEs shall be revised and reviewed on the basis of the new information obtained from the USI and submitted to DOE-FSO in accordance with the provisions of this chapter.
- f. The USI shall be resolved to the satisfaction of DOE-FSO prior to a Fermilab request for DOE-FSO approval to commence or resume routine operations.
- g. DOE-FSO may require a technical briefing on the status of the USI as part of the process to request resumption of operations. Approval by DOE-FSO will be contingent on resolution of the USI and completion of any technical review of the circumstances leading to the USI.
- h. DOE-FSO approval will be required before resumption of operations



2. Determination of Applicability

In addition to the Unreviewed Safety Issue process, the ESH&Q Director regularly reviews projects, operations, and experiments for applicability of the provisions of this chapter and makes corresponding recommendations to the Fermilab Director concerning PHAR/PSAD/SAD applicability. Part of this is conducted by reviewing Project Request Forms that are approved by the Chief Operation and Chief Financial Officers. This is done by the ESH&Q Director as a member of the Fermilab Senior Management Team. Division/section/center head(s) shall inform the ESH&Q Director of new projects, operations, and experiments that are candidates for SADs or SAD modifications at the earliest reasonable stage by completing the USID form. Fermilab-authorized operations that originate outside the Laboratory are also reviewed for applicability of the requirements of this chapter.

Following the determination of applicability, the ESH&Q Director notifies the responsible division/section/center(s) of the PHAR/PSAD/SAD applicability. This formal notification is not needed if the responsible organization(s) have already determined that a PHAR/PSAD/SAD is to be revised or prepared through the USI process. This determination and subsequent PHAR/PSAD/SAD initiation must occur during the earliest phases of the activity to facilitate early hazard identification and mitigation. The documentation for the determination of applicability shall be inventoried and filed with the ESH&Q Section regardless of the conclusion.

A new PHAR/PSAD/SAD is not required for upgrades to an existing facility or operation that are within the scope of its existing SAD. Documentation demonstrating that the upgrade is within the scope of the existing SAD shall be written by the responsible division/section/center(s) by completing a USID form and be filed with the ESH&Q Section. Addenda to existing SADs provide a venue for maintaining up-to-date safety assessment documentation. SAD addenda proceed through the same approval process as does a new SAD.

3. Hazard Analysis

The PHAR or PSAD should follow the guidelines outlined in the technical appendix to FESHM 2010, FESHM 2010TA. The hazards associated with construction, installation, operation, and decommissioning should be identified. In general, the hazard analysis in the PHAR or PSAD should start with the Written Hazard Analysis Guideline found in [FESHM 2060](#). For large or complex projects, the Issues List appended to this chapter is recommended for providing a technical basis for such a hazard analysis. This Issues List was originally generated as part of the Necessary and Sufficient Process carried out at Fermilab in 1995 and is the result of a comprehensive analysis of the hazards present on the Fermilab site. It is also found on the ESH&Q DocDB at: [Issues List](#). This Issues List is a starting point; the required comprehensive analysis could identify additional issues.



Once the hazards associated with the project through construction, installation, operations, and decommissioning are identified, the initiating event, consequences of an incident associated with each hazard, and its mitigation should be identified.

For the most part, the common industrial or environmental hazards associated with a project which do not pose any additional hazard by virtue of their association with the project's construction, installation, commissioning, operation, or decommissioning are addressed by implementing the provisions of other FESHM chapters. For such hazards, it can simply be stated that the [Work Smart Standards](#) (WSS) or commonly accepted standards (e.g., ASME, ANSI, NFPA) will be followed just as they would for other operations on site.

Preliminary shielding assessments for ionizing radiation may be performed separately from the PHAR or PSAD. Summaries of the analysis shall be incorporated into the PHAR or PSAD documentation. Recognizing that the PHAR or PSAD often must be written before the construction drawings are detailed enough to perform the preliminary shielding assessment such preliminary radiation shielding assessments may of necessity be "iterative" in nature, conducted concurrently with facility design. Formal radiation shielding assessments shall be conducted in accordance with provisions of [FRCM Chapter 8](#) prior to the bidding of construction bid packages when designs are final, or very near final.

4. SAD Hazard Analysis

The SAD should follow the same guidelines as those given for the PHAR or PSAD while documenting the mitigation of unique hazards found throughout the commissioning and operational life of the project as well preliminary plans for the eventual decommissioning of the facility module. The conclusions of the SAD will support the parameters of the associated Accelerator Safety Envelope (ASE). Commonly, the ASE constitutes a chapter or a portion of a chapter of the SAD.

The division/section/center(s) commonly choose to review new projects or facilities by means of one or more safety review panels. Such safety panels may consist of laboratory staff or experts from outside the Laboratory. The responsible division/section/center may request assistance from the Fermilab ES&H Committee (FESHCom) and its subcommittees to review projects, answer specific safety questions, recommend solutions to ES&H problems, assist in setting ES&H policy, or evaluate requests for exemptions from existing policies. The results of these reviews should be incorporated into SAD documentation.

Shielding assessments for ionizing radiation may be performed separately from the SAD. However summaries of the analysis shall be incorporated into the SAD documentation. Radiation shielding assessments shall be conducted in accordance with provisions of [FRCM Chapter 8](#) (see above).



5. Review of PHAR/PSAD/SAD

The Safety Assessment Document Review Subcommittee of the Fermilab ES&H Committee (FESHCom) is responsible for reviewing the results of each safety assessment document chapter for completeness and compliance with this FESHM Chapter as specified in more detail in its charter ([FESHCom SAD Review Subcommittee Charter](#)). As part of its duties, this subcommittee is charged with submitting reports to the ESH&Q Director recommending acceptance or rejection for cause of SADs based on the consensus of the subcommittee. For SADs/Accelerator Readiness Reviews concerned with strategic or major system projects (as defined by DOE) or line item projects, one or more representatives of DOE-FSO may be included as observers on the assigned review team preparatory to the official transmittal for concurrence by DOE-FSO. The list of reviewers of each SAD shall be documented along with any review comments they contribute.

6. PHAR/PSAD/SAD and ARR Approval

- a. The ESH&Q Director coordinates the reviews of PHARs/PSADs and SADs and their approval by the Fermilab Director.

Following completion of the Fermilab review, all SADs that result in a new or revised Accelerator Safety Envelope (ASE) are transmitted to DOE-FSO for written concurrence with the SAD and written approval of the ASE. Normally, PHAR/PSADs are not formally transmitted to the DOE-FSO for concurrence but might be sent to DOE-FSO for informational purposes as part of project oversight activities.

The final sign-off sheet to be used for PHAR/PSAD/SAD and ARR approval appears as the third page of the technical appendix to this chapter, FESHM 2010TA. PHAR/PSAD/SAD and ARR approval and approval to commence commissioning/operation requires the following signatures which shall be routed in the following order:

1. Project Leader
2. Fermilab Division/Section/Center Head(s)
3. Fermilab ESH&Q Director
5. Fermilab Director

- b. The SAD along with any new or revised ASE, and documentation of any applicable ARR process shall be sent to the DOE-FSO Manager for concurrence and approval of the ASE before commissioning or operations ensue. This formal transmittal should occur after completion of the internal review process documented by the above signatures. If no comments or replies are received within 30 calendar days, it will be assumed that the SAD or ARR are sufficient unless the DOE-FSO Manager has established a different review schedule. This comment period will normally be 15 calendar days provided that a SAD that has



undergone preliminary review by the ESH&Q Section, complete with proposed ASE, is informally provided to the DOE-FSO Manager at least 30 calendar days prior to the formal submittal of the signed, completed SAD and ASE. ASEs must be approved by DOE in accordance with DOE O420.2C.

The DOE-FSO Manager will be informed of the readiness review before its occurrence and be given the opportunity to observe the review. Experience has shown that early involvement of representatives of the DOE-FSO can enhance the effectiveness of this review process.

7. Documentation

The completed, original PHAR/PSAD/SAD and specific supporting documentation related to the review shall be inventoried and filed with the ESH&Q Section in a manner consistent with applicable records retention requirements.



ISSUES LIST OF HAZARDS IDENTIFIED ON THE FERMILAB SITE

This list was developed as a part of the Necessary and Sufficient Standards process carried out in 1995 and is intended to be a starting point for analysis. The code numbers were those associated with the 1995 exercise but can still be used as an aid in the hazard analyses specified by this chapter.

- 001. Bio - animals
- 002. Bio - bacteria (water)
- 003. Bio - bloodborne pathogens
- 004. Bio - insects
- 005. Bio - plants
- 006. Chem - acids, solvents, toxic agents and haz. liquids
- 007. Chem - carbon monoxide
- 008. Chem - carcinogens
- 009. Chem - chemical exposures exceeding PEL.
- 010. Chem - chemical reactions
- 011. Chem - cutting and burning
- 012. Chem - heavy metals such as lead
- 013. Chem - nuisance dusts
- 014. Chem - pesticides
- 015. Chem - toxicity in smoke or fumes
- 016. Chem - use of toxic materials
- 017. Chem - welding fumes
- 018. Construction - compressed gasses
- 019. Construction - demolition
- 020. Construction - dewatering hazard
- 021. Construction - earth cave-in and collapse
- 022. Construction - earth moving equipment
- 024. Construction - earth clearing
- 025. Construction - fall hazards
- 027. Construction - hand tools
- 028. Construction - heavy equipment
- 029. Construction - high winds
- 030. Construction - ladder
- 032. Construction - materials handling
- 033. Construction - possibility of hitting utilities
- 034. Construction - scaffolding
- 035. Construction - transportation
- 036. Electricity - battery
- 037. Electricity - exposed conductors / >50 volts
- 038. Electricity - high voltage
- 039. Electricity - high power
- 040. Electricity - lightning
- 041. Electricity - high current conductors / <50 volts
- 042. Electricity - stored energy / capacitors
- 043. Electricity - stored energy / inductors
- 044. Env - air emissions / nonrad
- 045. Env - air emissions / rad
- 046. Env - cultural resources
- 047. Env - asbestos
- 048. Env - drinking water quality
- 049. Env - endangered species
- 050. Env - groundwater protection
- 051. Env - hazardous waste
- 052. Env - offsite radiation protection / penetrating



- 053. Env - ozone depleting substances
- 054. Env - PCBs
- 055. Env - pesticide application and use
- 056. Env - regulated chemical waste / non-hazardous
- 058. Env - sanitary and sewer discharges
- 059. Env - solid waste management units and inactive waste sites
- 060. Env - surface water
- 061. Env - transformer oil / non-PCB
- 062. Fire - boiler, heating systems, and (commercial) appliances
- 063. Fire - cigarette smoking
- 064. Fire - electrical
- 065. Fire - flammable liquids and gases
- 066. Fire - mobile structures
- 067. Fire - special hazardous materials
- 067B. Fire - hydrogen targets
- 068. Fire - special occupancies / accelerator and beam line enclosures
- 069. Fire - spontaneous combustion
- 070. Fire - stationary combustion engines
- 071. Fire - storage of combustibles
- 072. Fire - transportation / rail, vehicle, and fueling
- 073. Fire - welding near combustibles
- 074. Fire - spark producing tools near combustibles
- 075A. HazMat transport - bad road conditions / offsite
- 075B. HazMat transport - bad road conditions / onsite
- 076A. HazMat transport - emergency response and spill clean up / offsite
- 076B. HazMat transport - emergency response and spill cleanup / onsite
- 077A. HazMat transport - fire and explosion / offsite
- 077B. HazMat transport - fire/explosion / onsite
- 078A. HazMat transport - loading and unloading / offsite
- 078B. HazMat transport - loading and unloading / onsite
- 079A. HazMat transport - packaging hazardous materials / offsite
- 079B. HazMat transport - packaging hazardous materials / onsite
- 079C. HazMat transport - transportation of radioactive materials
- 080A. HazMat transport - prolonged periods of driving / offsite
- 080B. HazMat transport - prolonged periods of driving / onsite
- 081A. HazMat transport - spills and chemical releases /offsite
- 081B. HazMat transport - spills and chemical Releases / onsite
- 081C. Hazardous material transport - spills and chemical releases
- 082. Magnetic fields - bioelectric implants
- 083. Magnetic fields - fringe fields
- 084. Magnetic fields - high magnetic fields
- 085. Magnetic fields - quench effects
- 086. Material handling - chemical spills
- 087. Material handling - cranes and hoists
- 088. Material handling - elevators used for hazardous material
- 089. Material handling - falling objects
- 090. Material handling - forklift operation
- 091. Material handling - hazardous tools equipment and machinery
- 092. Material handling - lifting objects
- 093. Material handling - moving objects
- 094. Material handling - storage and handling of toxic materials.
- 095A. Material handling - transportation / offsite
- 095B. Material handling - transportation / onsite
- 096. NIR - intense light sources
- 097. NIR - lasers



- 098. NIR - radiofrequency radiation
- 099. NIR - ultraviolet light
- 101. ODH - cryogenic gas or liquid leaks
- 102. ODH - cryogenic spills
- 103. ODH - gaseous argon or other detector gas
- 104. ODH - leak of supplied gas
- 105B. ODH - mechanical refrigeration systems
- 106. Other mechanical hazards - general environmental control
- 107. Other mechanical hazards - machine guarding
- 108. Other mechanical hazards - machinery and rotating parts
- 109A. Other mechanical hazards - medical and first aid, blood borne pathogens, lead, noise, asbestos, and respiratory protection
- 109B. Surveillance - tuberculosis
- 110. Other mechanical hazards - powered platforms
- 111A. Other mechanical hazards - pressurized tanks and containers
- 111B. Other mechanical hazards - pressurized lines and piping systems
- 112. Other mechanical hazards - material grinding, cutting, and drilling
- 113. Other mechanical hazards (also fire) - means of egress
- 114. Other mechanical hazards - moving vehicles, carts, and forklifts
- 115. Other mechanical hazards - special hand tools and power driven nail guns, etc.
- 116. Other mechanical hazards - work with roads and grounds equipment
- 117. Other personal hazards - confined space
- 119. Other personal hazards - hazards requiring PPE
- 120. Other personal hazards - high noise levels
- 121. Other personnel hazards - housekeeping
- 122. Other personnel hazards - ice/walking surfaces
- 123. Other personal hazards - lifting and carrying heavy objects
- 124. Other mechanical hazards - pinch points
- 125. Other personal hazards - repetitive motion
- 126. Other personal hazards - sharp edges
- 127. Other personnel hazards - slips, trips & falls
- 128. Other personnel hazards - traffic hazards
- 129. Other personnel hazards - vacuum tanks
- 130. Other personal hazards - vibration
- 131. Other personnel hazards - work on wet surface
- 132. Other personnel hazards - working at heights
- 133. Radiation - radioactive contamination
- 134. Radiation - special nuclear materials (SNM) and nuclear materials
- 135. Radiation - mixed waste
- 136. Radiation - prompt radiation
- 137. Radiation - radioactive sources
- 138. Radiation - radioactivated soil
- 139. Radiation - radioactive liquids and gases
- 140. Radiation - radioactive waste
- 141A. Radiation - residual contamination
- 141B. Radiation - residual activity
- 143. Radiation - storage and handling of radioactive materials
- 144. Thermal - battery bank and UPS equipment
- 145. Thermal - cold work environments
- 146. Thermal - cryogenics
- 147. Thermal - high temperature equipment
- 148. Thermal - hot work environments
- 149. Thermal - ultraviolet radiation / sun exposure
- 151. Thermal - wet work environments



- 152. Emergency preparedness - severe weather
- 153. Emergency preparedness - safeguards and security
- 154. Emergency preparedness - generic
- 155. Env - underground storage tanks
- 156. Other mechanical hazards - aviation
- 159. Emergency preparedness - hazardous materials
- 160. Emergency preparedness - toxicity in smoke or fumes
- 161. Env - general environmental protection planning
- 163. Occupational safety administrative requirements
- 164. Occurrence Investigation and Reporting
- 165. Radiation - radiological emergency response (see 154.)
- 166. Radiation - radiological training
- 167. Radiation - monitoring and measurement of radiation
- 168. Radiation - record keeping in occupational radiation protection
- 169. Radiation - exposure control
- 170. Radiation - QA in occupational radiation protection
- 171. Safety analysis and documentation
- 172. Fire - emergency responder safety



2010TA

4.0 TECHNICAL APPENDIX TO FESHM 2010

PHAR/PSAD/SAD GUIDELINES

The PHAR/PSAD/SAD documents may contain references to other PHARs/PSADs/SADs, procedures and documents as appropriate rather than repeating large portions of an existing document. Summaries of reference documents should be included where appropriate.

Where commissioning is to be accomplished in discrete modules, the SAD and/or the ARR may be conducted incrementally also. Each module shall require separate authorization.

The PHAR/PSAD/SAD can be written in accord with the following suggested outline, as applicable:

I. Introduction/Project Description

Provides a brief description of the project:

- Location
- Purpose of Project
- Organizational Responsibilities
- Identification of the Appropriate Safety Design Criteria and/or Standards

II. Inventory of Hazards and Mitigation

The PHAR/PSAD/SAD may present the hazards and discuss their mitigation in a chronological order, i.e. hazards associated with the construction phase, installation, operations, and finally D&D. [FESHM 2060](#), Table 1 and the Issues List appended to FESHM 2010.

Hazard mitigation often includes:

- Shielding analysis
- Engineering design
- Operational constraints
- Training requirements
- Procedural requirements
- Applicable administrative controls
- Accelerator Safety Envelope



The safety envelope may contain or reference other sections of the SAD that address the following issues as requirements for operation:

- * Power limits (particles, energy, duty factor, or equivalents)
- * Personnel specifications (e.g. operator training)
- * Safety systems which must be operational (e.g. radiation safety interlocks, electrical interlocks, fire protection, etc.) If reference is made to Credited Controls, terminology should be consistent with that used for Credited Controls.
- * Environmental limits (e.g. potential air emissions, contamination of the groundwater)

III. Accelerator Readiness for Commissioning and Operation

Defines the required readiness elements, including those identified in the SAD that are required to be in place during the commissioning and operation stages to ensure safe operation. Requirements from other documents should be included, as appropriate, for completeness. The elements that should be described are:

IV. Qualification of Personnel

- Readiness of safety systems
- Shielding readiness and/or administrative procedures required
- Plan for commissioning/operation
- Environmental monitoring considerations.

IV. Decontamination and Decommissioning (D&D)

[FESHM 8070](#) provides Fermilab requirements on this topic. This chapter shall discuss particular D&D provisions made for the accelerator or module covered by a given SAD.

V. Conclusion

At this point it should be possible to briefly conclude that the construction, operation and the final D&D may be conducted in manner acceptable by safety and environmental standards.



SAFETY ASSESSMENT DOCUMENT
ACCELERATOR READINESS REVIEW
DOCUMENTATION FORM

This form records the PHAR/PSAD/SAD/ARR review process required for operations at Fermi National Accelerator Laboratory.

PHAR/PSAD/SAD/ARR TITLE AND DATE: _____

THIS DOCUMENT DESCRIBES:

New Facility _____ New Experiment _____
Existing Facility _____ Major Modification _____
Entire Program _____ Decommissioning _____
Readiness Review _____

FERMI NATIONAL ACCELERATOR LABORATORY

Safety Assessment Document Approval _____ Completion of Readiness Review _____
Authorization to Operate Facility _____ Program/Facility Requires PSAD _____

Project Leader/Date: _____

Fermilab Division/Section/Center Head(s)/Date: _____

Fermilab ESH&Q Director/Date: _____

Fermilab Director/Date: _____
(if appropriate)

**Unreviewed Safety Issue Determination (USID) Form**

Title of USID: _____

Description of Proposed Activity: _____

Does the proposed activity or discovered condition affect information in the [Fermilab SAD](#) regarding safety analyses, administrative controls, or credited controls? If so specify the relevant sections. _____

Does the proposed activity or discovered condition affect any of the requirements in the [Fermilab ASE](#)? If so specify the relevant sections. _____

_____**USI Determination Criteria:**

- Yes No Could the change significantly increase the probability of occurrence of an accident previously evaluated in the SAD?
- Yes No Could the change significantly increase the consequence of an accident previously evaluated in the SAD?
- Yes No Could the change significantly increase the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the SAD?
- Yes No Could the change significantly increase the consequence of a malfunction of equipment important to safety previously evaluated in the SAD?
- Yes No Could the change create the possibility of a different type of accident than previously evaluated in the SAD that would have a potentially significant safety consequence?
- Yes No Could the change increase the possibility of a different type of malfunction of equipment important to safety than any previously evaluated in the SAD?

Justification: (use attachment if necessary) _____



USI Determination: A USI is determined to exist if the answer to any of the 6 questions above is “Yes”. If the answer to all 6 questions is “No”, then no USI exists.

- Yes DOE approval is required prior to implementation.
- No Proposed activity may be implemented following the applicable FESHM or FRCM chapter requirements.

Check documents requiring creation or modification

- PHAR/PHAD
- PSAD
- Shielding Assessment
- SAD
- ASE
- Other _____

Preparer _____ Date _____

Reviewer _____ Date _____

Approval:

ESH&Q Director _____ Date _____

Comments:

Note: Contact your SSO or ESH Coordinator with any questions regarding this form.