

PIP-II Integrated Environment, Safety and Health Management Plan

Document number: *Document v7, 02 April 2020, [pip2-Docdb-141]*

Document Approval

Signatures Required	Date Approved
Originator: John E. Anderson Jr., ES&H Manager	Approvals in DocDB
Approver: Marc Kaducak, Project Manager	Approvals in DocDB
Approver: Arkadiy Klebaner, Technical Director	Approvals in DocDB
Approver: Lia Meringa, Project Director	Approvals in DocDB

Revision History and Version Control

This version of the document may not be the current or approved revision. The current revision is maintained in PIP-II's Document Management System (DocDB) where all internal Project document approvals are managed. DocDB can be accessed through the web by authorized users (<http://pip2-docdb.fnal.gov/>) and this document can be identified by the document and version number as indicated in the Version Control Table below. Note that the version number in the table below and DocDB may not match. The current approved version is always available in DocDB.

DocDB	Version	Responsible Person	Version Date	Description of Changes
141	1	Vic Kuchler	02/22/2017	Original Document
141	2	Teri Dykhuis	08/14/2017	Update Signatories
141	3	John Anderson Jr.	11/5/2018	Reformat of document, update signatories, miscellaneous document updates and clarifications
141	4	John Anderson Jr.	02/8/2019	Removed requirement for an ES&H Management Plan for Construction as this is incorporated in the PIP-II Construction Safety and Health Plan
141	5	John Anderson Jr.	06/26/2019	Updated document; added references, additional information for National and International Partner expectations, codes and code equivalencies, and electrical standards.
141	6	John Anderson Jr.	08/01/2019	Updates to partner expectations, added appendix for partner ES&H Management Plan information for inclusion in the Project Planning Documents.
141	7	John Anderson Jr.	04/02/2020	Updated 450.4A title and ISO 14001 and OHSAS 18001 references. Modified appendix for partner PPD ES&H Management Plan.

Table of Contents

Revision History and Version Control.....	3
1. Acronyms and Abbreviations	7
2. References	8
3. ES&H Policy, Purpose and Scope	9
3.1. PIP-II Project ES&H Policy	9
3.2. Fermilab ES&H Health Policy	10
3.3. Purpose and Scope	10
4. Integrated Safety Management System.....	11
4.1. Principles of Integrated Safety Management.....	11
4.1.1. <i>Worker and Line Management Responsibility for Safety</i>	11
4.1.2. <i>Clear Roles and Responsibilities</i>	12
4.1.3. <i>Personnel Experience, Knowledge and Skill</i>	12
4.1.4. <i>Balanced Priorities</i>	12
4.1.5. <i>Safety Standards and Requirements</i>	13
4.1.6. <i>Hazard Controls Tailored to Work Being Performed</i>	13
4.1.7. <i>Authorization Agreement</i>	13
4.2. Core Functions of an Integrated Safety Management System	13
4.2.1. <i>Define the Scope of the Work</i>	14
4.2.2. <i>Identify and Analyze Hazards associated with the Work</i>	14
4.2.3. <i>Develop and Implement Hazard Controls</i>	14
4.2.4. <i>Confirm Readiness and Perform Work within Controls</i>	14
4.2.5. <i>Provide Feedback and Seek Continuous Improvement</i>	14
4.3. Roles and Responsibilities for ISMS Implementation	15
4.3.1. <i>Senior Management</i>	15
4.3.2. <i>Line Managers at all Institutions</i>	15
4.3.3. <i>PIP-II ES&H Management</i>	15
4.3.4. <i>PIP-II Project Team</i>	15
4.3.5. <i>National and International Partners</i>	16
4.3.6. <i>Contractors and Subcontractors</i>	16
5. ES&H Program Elements	17

- 5.1. Program Expectations 17
- 5.2. Safety Analysis and Reviews for Hazard Identification and Control 19
 - 5.2.1. Preliminary Hazards Analysis 19
 - 5.2.2. Hazard Analysis Report 19
 - 5.2.3. Safety Assessment Documents 20
 - 5.2.4. Authorization of Use and Possession (AUP) 20
 - 5.2.5. Commissioning and Accelerator Readiness Reviews 20
 - 5.2.6. Work Performed During Construction, R&D and Commissioning Activities 21
- 5.3. NEPA Compliance 21
- 5.4. Code Compliance 22
 - 5.4.1. Code Equivalencies 22
 - 5.4.2. Electrical Standards 23
- 5.5. Sustainable Design 23
- 6. Appendix 1 – ES&H Management Plan Guidance Template and Expectations for Partners 24
 - 6.1. Partner ES&H Coordinator 24
 - 6.2. Partner ES&H Programs 24
 - 6.3. Codes and Standards 24
 - 6.4. Accident and Incident Investigation and Reporting 25

1. Acronyms and Abbreviations

AHJ	Authority Having Jurisdiction
APM	Associate Project Manager
ARR	Accelerator Readiness Review
ASE	Accelerator Safety Envelopes
AUP	Authorization of Use and Possession
CD	Critical Decision
CFR	Code of Federal Regulations
DocDB	Document Management System
DOE	Department of Energy
EA	Environmental Assessment
EPA	Environmental Protection Agency
ES&H	Environment, Safety, and Health
Fermilab	Fermi National Accelerator Laboratory
FESHM	Fermilab ES&H Manual
FONSI	Finding of No Significant Impact
FSO	Fermilab Site Office
FRCM	Fermilab Radiological Control Manual
FRS	Functional Requirements Specifications
GP	Guiding Principles
HA	Hazard Analysis
HAR	Hazard Analysis Report
ISMS	Integrated Safety Management System
ISO	International Standards Organization
ITNA	Individual Training Needs Assessment
NEPA	National Environmental Policy Act
NRTL	Nationally Recognized Testing Laboratory
OHSAS	Occupation Health and Safety Assessment Series
PHAR	Preliminary Hazards Assessment Report
PIP-II	Proton Improvement Plan II
PPD	Project Planning Document
QA	Quality Assurance
QAM	Quality Assurance Manual
R&D	Research and Development
SAD	Safety Assessment Document
SEMP	Systems Engineering Management Plan
USGBC	U.S. Green Building Council

2. References

1	<u>DOE Title 10 CFR Part 851, <i>Worker Safety and Health Program</i></u>
2	<u>DOE P 450.4A, <i>Integrated Safety Management Policy</i></u>
3	<u>Fermilab ES&H Manual</u>
4	<u>Fermilab Radiological Control Manual</u>
5	<u>Fermilab Quality Assurance Manual</u>
6	<u>PIP-II Project Construction Safety and Health Plan</u>
7	<u>PIP-II Organization Chart</u>
8	<u>PIP-II Project Management Plan</u>
9	<u>Fermilab Accelerator Safety Envelope</u>
10	<u>DOE Accelerator Safety Order, DOE O 420.2C, <i>Safety of Accelerator Facilities</i></u>
11	<u>National Environmental Protection Act (NEPA)</u>
12	<u>DOE Title 10 CFR Part 835, <i>Occupational Radiation Protection</i></u>
13	<u>DOE Title 10 CFR 850, <i>Chronic Beryllium Disease Prevention Program</i></u>
14	<u>DOE Guide 414.1-2B, <i>Quality Assurance Program Guide</i></u>
15	<u>PIP-II Quality Assurance Plan</u>
16	<u>PIP-II Hazard Analysis Report</u>
17	<u>PIP-II Risk Register</u>
18	<u>PIP-II Risk Management Plan</u>
19	<u>PIP-II Systems Engineering Management Plan</u>
20	<u>PIP-II Preliminary Hazard Analysis Report</u>
21	<u>PIP-II Hazard Analysis Report</u>
22	<u>PIP-II ARR Plan</u>
23	<u>DOE P 451.1, <i>National Environmental Policy Act Compliance Program</i></u>
24	<u>PIP-II Environmental Assessment and FONSI Determination</u>
25	<u>Code Equivalency Studies</u>
26	<u>UL 498, <i>Standard for Attachment Plugs and Receptacles</i></u>

3. ES&H Policy, Purpose and Scope

3.1. PIP-II Project ES&H Policy

A strong Environment, Safety and Health (ES&H) program is essential to the successful completion of the PIP-II Project at Fermi National Accelerator Laboratory (Fermilab). The Project is committed to ensure a safe and drug-free work environment for PIP-II workers and to protect the public from hazards associated with construction and operation of PIP-II. The Project is also committed to perform work in a manner that preserves the quality of the environment and prevents property damage. Accidents and injuries are preventable, and it is important that we work together to establish an injury free workplace.

The Project complies with the Fermilab ES&H policies and all applicable regulatory requirements including Department of Energy (DOE) Title 10, Chapter III, Code of Federal Regulations (CFR) Part 851, *Worker Safety and Health Program* [1] for work performed at the Fermilab site and is committed to enforcing these requirements in all our work. PIP-II will ensure that procedures are established to support the following ES&H policy statements:

- Line managers are responsible for environmental stewardship and personal safety at the PIP-II work site.
- Line managers, supported by the PIP-II, Fermilab and other collaborating institutions, will provide consistent guidance and enforcement of the ES&H program that governs the activities of workers at each site where work is being performed.
- Incidents, whether they involve personal injuries or other losses, can be prevented through proper planning. All PIP-II Project work is planned.
- Workers are involved in the work planning process and continuous improvement, including the identification of hazards and controls.
- Working safely and in compliance with requirements is vital to a safe work environment. Line managers will enforce disciplinary policies for violations of safety rules.
- Each of us is responsible for our own safety, and for that of our co-workers. Together we create a safe work environment.
- A strong program of independent audits, self-assessments and surveillance will be employed to periodically evaluate the effectiveness of the ES&H program.
- Any incidents that result or could have resulted in personal injury or illness, significant damage to buildings or equipment, or impact of the environment, will be investigated to determine corrective actions and lessons that can be applied to prevent recurrence. PIP-II encourages open reporting of errors and events.

To achieve the culture and safety performance required for this project, it is essential that ES&H be fully integrated into the project and be managed as tightly as quality, cost and schedule. The Project will

implement the Fermilab ES&H Management System which includes an Integrated Safety Management System consistent with the requirements of DOE Policy 450.4A, *Integrated Safety Management Policy* as a means of achieving this vision [2].

3.2. Fermilab ES&H Health Policy

The Fermilab Director has issued ES&H Policies through the Fermilab Environment, Safety and Health Manual (FESHM) [3], inclusive of the Fermilab Radiological Control Manual (FRCM) [4] and Fermilab Quality Assurance Manual (QAM) [5] that apply to all work performed by employees, contractors and guests while working at Fermilab. All workers are expected to take personal responsibility to adhere to these principles. Accordingly, PIP-II will be designed, constructed and operated in a manner consistent with these values:

- Environment:** We protect the environment, conserve resources and prevent pollution.
- Safety:** We maintain a safe workplace and we plan our work and perform it safely. We take responsibility for the safety of ourselves, coworkers and guests.
- Security:** We protect people, property, information, computing systems and facilities.
- Health:** We protect human health within our boundaries and in the surrounding community.
- Compliance:** We achieve and maintain compliance with applicable ES&H requirements.
- Community:** We maintain open, proactive and constructive relationships with our employees, neighbors, regulators, DOE, other funding agencies and our other stakeholders.
- Continuous Improvement:** We continually improve ES&H performance.

All parties are invited to provide PIP-II management or the Fermilab Director with input on the Project performance relative to either the PIP-II ES&H Policy or the Fermilab ES&H Policy, or on the policies themselves.

3.3. Purpose and Scope

This plan establishes the framework and expectations for the ES&H program for the PIP-II Project which are based on the premise that a strong ES&H program is essential to the successful completion of the PIP-II Project. The Project believes that accidents and injuries are preventable and that an injury-free workplace can be achieved through implementation of the program described in this document.

There will be major activities in support of the PIP-II Project taking place at national and international partner institutions. The Project is committed to working with partner institutions to ensure in-kind

contributions meet applicable design and construction standards for installation and operations at Fermilab; and to working within the ESH policies of the collaborative institution when at a partner site.

This plan and its requirements apply to all work carried out by Project staff. When required, this plan will be supplemented by additional documents that provide more detailed ES&H program requirements and establish implementing procedures to carry out the program elements described in this document. For example, a *PIP-II Project Construction Safety and Health Plan* [6] has been developed to define additional program requirements that will be implemented by Contractors while working on the PIP-II site.

4. Integrated Safety Management System

The Project utilizes the concept of an Integrated Safety Management System (ISMS) as its overarching philosophy and approach to integrating safety systematically into work activities. ISMS is an organized process whereby work is planned, performed, assessed, and systematically improved to promote the safe conduct of work. These concepts will be described as they apply to this project in the balance of this section.

4.1. Principles of Integrated Safety Management

The fundamental principles described in *DOE P 450.4A* are incorporated into PIP-II Project processes to ensure that all work is planned and conducted safely as outlined below.

4.1.1. Worker and Line Management Responsibility for Safety

Line management is responsible and accountable for establishing a safe working environment. Management expectations regarding ES&H goals shall be clearly communicated to all personnel. Management is responsible for ensuring that the tools necessary to perform work safely are provided and for soliciting feedback to continuously improve the safe execution of work.

Line managers are responsible for training, motivating, and enabling their workers to understand and comply with the project's commitment to safety as expressed in this plan. They shall ensure that work is executed as defined in work planning documents and complies with ES&H requirements. Line managers are also responsible to lead by example and to enable their workers to create an environment in which everyone involved meets the project's commitment to safety. Managers and supervisors shall also ensure that guests or visitors are properly trained and understand their personal responsibility for safety.

All workers within the Project facilities and at the construction site are expected to plan their work in compliance with ES&H requirements. It is very important for each worker to:

- 1) Take personal responsibility for his/her own safety and that of co-workers while performing work.
- 2) Follow established procedures for safe work practices.

- 3) Conduct work as trained and as authorized by his/her supervisor.
- 4) Be thoughtful at all times and maintain vigilance even when performing simple and routine tasks.
- 5) Re-evaluate controls and discuss with supervisors or other knowledgeable persons when conditions change or are not found to be as expected.
- 6) Provide feedback to supervisors regarding work experiences to continuously improve safety and performance.

Workers and supervisors are accountable for the implementation of their responsibilities.

4.1.2. Clear Roles and Responsibilities

The Project organizational structure [7] defines reporting lines within the Project. Clear and unambiguous roles and lines of responsibility, authority, and accountability have been established through the development of individual roles and responsibilities for project staff outlined in the *PIP-II Project Management Plan* [8]. ES&H responsibility will be integrated into the project work activities, and interfaces for processes and organizations will be clearly established during work planning to provide for clear understanding and communication.

4.1.3. Personnel Experience, Knowledge and Skill

Everyone associated with the project shall possess the experience, knowledge, skills and abilities necessary to perform his or her responsibilities effectively and safely. Line managers shall ensure that their workers are trained and have the competencies required to safely accomplish assigned work. Managers assess personnel training requirements at Fermilab by completing an Individual Training Needs Assessment (ITNA) for each of their subordinates. All Project members receive an ITNA which defines applicable training requirements based on job duties. Workers are responsible to remain current with their training.

Each contractor and subcontractor working at the project construction site is required to assign a competent workforce to the project, so work is performed safely and efficiently. Contracted employees shall abide by all requirements established in this plan.

4.1.4. Balanced Priorities

The Project will allocate enough time and resources to ensure that work is performed safely. All staff and contractors must take the time to complete training, plan work properly, and conduct work in a manner that adequately controls hazards.

All employees and subcontractors have the responsibility and authority to stop work when they believe the activity in which they are involved, or which they observe, is unsafe.

4.1.5. Safety Standards and Requirements

Hazards associated with an activity shall be evaluated and controls established to protect workers, the public and the environment before work is performed. For work conducted at Fermilab, these controls shall be established based on the requirements in FESHM Chapter 2060, *Work Planning and Hazard Analysis* and supplemented by requirements specific to PIP-II that will be developed as needed. For work performed at partner institutions, PIP-II personnel will follow FESHM requirements and the ES&H requirements of the partner institution.

4.1.6. Hazard Controls Tailored to Work Being Performed

Elimination, substitution, engineering controls and administrative controls are established to address hazards of the work. Wherever feasible, the order of preference should be given to hazard elimination, substitution, and engineered controls respectively; administrative controls are used to supplement other controls as appropriate. These controls are established through the work planning process for ongoing work or through review for the evolving design of the new facility. It is important that the controls are tailored appropriately to match the hazard and associated risk using a graded approach.

4.1.7. Authorization Agreement

The conditions and requirements necessary for operations to be initiated and conducted are clearly established and agreed on by the responsible line managers and workers prior to the start of work. This authorization agreement can take many different forms, ranging from a simple discussion at the work site between supervisor and worker to a complex Accelerator Safety Envelope (ASE) [9] signed by Fermilab and DOE management.

4.2. Core Functions of an Integrated Safety Management System

DOE P 450.4A describes the core functions of an Integrated Safety Management System. The five core functions provide a necessary structure for any work activity that may affect the worker, the public, or the environment. The functions form a continuous cycle which is not necessarily sequential. Rather, the functions are linked and interdependent, such that outcomes during the accomplishment of one may affect others. In particular, identifying and implementing opportunities for improvement may arise at any stage of the work process.

The five core functions that constitute the work planning process are: Define the Scope of Work, Identify and Analyze Hazards, Develop and Implement Hazard Controls, Perform Work within Controls, and Provide Feedback and Continuous Improvement. It is important to apply this process to all work that is performed, but it should be understood that the method of planning and its degree of rigor and formality depends on the hazards and complexity of the work being discussed. Some work will require extensive

work planning documents and a formal work permit. Other work may be addressed through standing job risk assessments conducted by supervisor, workers and ES&H staff.

4.2.1. Define the Scope of the Work

Defining the scope of work entails identifying and describing all the steps needed to complete a job safely. Defining the scope of work is a critical element of the work planning process, since it sets the stage for the scope and depth of hazard identification and analysis.

4.2.2. Identify and Analyze Hazards associated with the Work

Hazard identification requires a definition of the hazards which will be encountered while performing a particular task, as well as the hazards introduced from other work in progress. At Fermilab, a Hazard Analysis (HA) shall be performed in accordance with FESHM Chapter 2060 for each type of work activity to identify such hazards.

4.2.3. Develop and Implement Hazard Controls

The development and implementation of hazard controls require the identification of those controls to prevent and mitigate hazards and establishing safe work limits. It is important that the controls and their application be fully understood by all workers who are involved in the work.

4.2.4. Confirm Readiness and Perform Work within Controls

Confirmation of readiness is the process of verifying that safety controls that have been identified have been implemented before starting work. Performing work within controls entails adherence to the established requirements such that activities remain within the established safety boundaries. Readiness assessments may entail a wide range of complexity, ranging from as simple as a pre-job review by a worker to ensure that conditions and controls are as expected, to as complicated as an extensive and lengthy review conducted by Fermilab and DOE management prior to the start of an accelerator, beamline, or experimental facility for the first time.

4.2.5. Provide Feedback and Seek Continuous Improvement

Feedback on the adequacy of controls and the work planning process is vital to continuous improvement. Such feedback may be collected from several sources; it is particularly important to get feedback from workers performing the task, but information collected from oversight provided by management or independent organizations is also an essential source of feedback. It is important that feedback information be assessed and opportunities for improvement be identified and implemented.

4.3. Roles and Responsibilities for ISMS Implementation

4.3.1. Senior Management

The PIP-II Senior Management team is responsible for overall successful execution of the PIP-II Project and has overall responsibility for ES&H performance for the duration of the Project. Managers at all WBS levels are responsible to ensure implementation of ES&H requirements applicable to the activities within their areas of responsibility.

4.3.2. Line Managers at all Institutions

Line managers provide the primary operating interface with employees, as well as with guests, visitors and contractors/vendors at all institutions performing work for the PIP-II Project. Within the framework of the Fermilab ES&H Management System, line managers are expected to contribute to work planning, pre-job communication of hazards and controls, work monitoring and evaluation of results.

Effective integration of support from ES&H professionals into line activities is essential to achieving excellence in ISMS. Line management is responsible for defining and providing an adequate level of subject matter expert support, either from its own staff or from external sources, as appropriate for the particular line organization and ES&H discipline involved.

4.3.3. PIP-II ES&H Management

The PIP-II ES&H Manager is responsible for providing overall policy and guidance on ES&H issues, and for working with the line organizations to make available necessary input from ES&H professionals and other support. Fermilab ES&H personnel will be enlisted to assist the Project in ensuring that the standards, requirements and ES&H policies are effectively translated into suitable controls for work activities.

The PIP-II ES&H Manager will also regularly assess the effectiveness with which ISMS is being applied and will coordinate the ES&H assessments conducted by others.

The PIP-II ES&H Manager is responsible for safety analyses, determining hazard classification, generating safety assessment documents as defined in Sections 5.2 and 5.3 below, and obtaining appropriate approvals.

4.3.4. PIP-II Project Team

All PIP-II personnel are responsible to uphold the PIP-II and Fermilab ES&H policies. All personnel are expected to conduct their work in compliance with ES&H requirements applicable to their work, including prescribed safety and health equipment, reporting unsafe conditions/activities, preventing avoidable accidents and working in a safe manner.

All team members are responsible for becoming knowledgeable of and maintaining awareness of the hazards associated with their work, for contributing to the formulation of hazard controls, for conducting their work safely in accordance with those controls, and to exercise stop-work authority in cases of imminent danger to health and safety of workers or the public, or threat to the environment or property.

All team members are responsible to identify ES&H issues in their workplace and to work with their management to identify improvements and to resolve concerns. Work performed at institutions other than Fermilab will be in conformance with FESHM Chapter 1011, Environment, Safety and Health Expectations when Working at Laboratories other than Fermilab.

4.3.5. National and International Partners

National and International Partners are expected to perform work at their home institution in accordance with their institution's ES&H policies.

For the purpose of developing lessons learned and sharing of applicable information between PIP-II Partners, the ES&H Coordinator at a National or International Partner site shall notify the PIP-II ES&H Manager of any injuries occurring at a partner site related to PIP-II activities requiring more than local first aid treatment. The ES&H Coordinator at a National or International Partner site shall notify the PIP-II ES&H Manager of any significant Near Misses that could have resulted in an injury requiring more than local first aid treatment or could have posed a significant compromise in the ability of the PIP-II Project to attain its budget, schedule or key performance parameters.

Components and operating procedures provided from partner institutions for the Project will conform to this PIP-II Project Integrated ES&H Plan.

When National or International Partners are performing work at Fermilab, those work activities shall be conducted in accordance with this PIP-II Project Integrated ES&H Plan and Fermilab ES&H policies. The PIP-II ES&H Manager can assist in identifying those requirements, developing an HA to support the partner work activities and identify any site-specific training requirements in advance of coming to work at Fermilab.

PIP-II Partners shall include the information from the guidance template, Appendix 1, ES&H Management Plan Guidance Template and Expectations for Partners within the Quality Assurance and Safety Section of the Partner Planning Documents (PPD) Part 2, Section 6.3.

4.3.6. Contractors and Subcontractors

PIP-II contractors are expected to incorporate safety into the planning of each task, assure the safety of their personnel, provide all personal protective equipment necessary for their employees, establish a safe and drug-free work environment and confirm that their equipment meets the applicable safety standards.

PIP-II contractors are responsible for any actions of their personnel that may endanger or otherwise expose other participants to potential hazards on the project.

PIP-II contractors will submit a written ES&H Plan for review and approval by PIP-II management as appropriate for the work being performed. Contractor ES&H Plans will meet or exceed all applicable PIP-II Project safety requirements defined in the PIP-II Project Construction Safety and Health Plan, must comprehensively address all anticipated hazards for executing the construction and must identify the appropriate protective measures that will be used to mitigate the hazards. All subcontractors to any prime contractor must follow the requirements in the prime's ES&H Plan.

5. ES&H Program Elements

All work associated with this project will be conducted in a manner that ensures protection of the workers, the public and the environment. Implementing procedures and additional guidance to ensure accomplishment of these expectations shall be established and communicated to all staff, contractors and vendors. At the end of the construction of PIP-II and the commencement of routine operations, the PIP-II ES&H program will transition to the appropriate Fermilab institutional ES&H programs.

5.1. Program Expectations

The PIP-II project shall address its ES&H responsibility by:

- 1) Establishing an ISMS, as defined above, that implements the philosophy outlined in DOE Policy 450.4A, *Integrated Safety Management Policy*, the FESHM, and the requirements of the DOE Accelerator Safety Order, DOE O 420.2C, *Safety of Accelerator Facilities* [10]. The program shall protect the environment and the safety of workers and the public by assuring that:
 - Facilities, systems and components needed to meet mission requirements are fully defined, and are designed, constructed and operated in accordance with applicable Fermilab and DOE requirements;
 - Potential hazards to personnel associated with all PIP-II systems, structures and components are identified and controlled through the timely preparation of safety assessment documents;
 - Potential risks to the environment are addressed through the timely and comprehensive preparation of appropriate National Environmental Protection Act (NEPA) [11] documentation for construction work performed at Fermilab;
 - Fermilab ES&H Management System contains implemented policies and procedures to assure that all ES&H risks are identified and addressed;

- Requirements in 10 CFR Part 835, *Occupational Radiation Protection* [12], Part 850, *Chronic Beryllium Disease Prevention Program* [13] and Part 851, *Worker Safety and Health Program* are fully implemented to protect worker safety and health at the Fermilab site;
 - Research and development activities and all other project work are conducted in accordance with the applicable local institution work planning requirements to ensure control of hazards and proper authorization of work; and
 - ES&H program performance is monitored and assessed to evaluate effectiveness and to identify opportunities for improvement.
- 2) Implementing a Quality Assurance (QA) program that follows the intent of DOE Guide 414.1-2B, *Quality Assurance Program Guide* [14] and aligns with the quality requirements established by the *Fermilab QAM*. The PIP-II Quality Assurance Program is documented in the *PIP-II Quality Assurance Plan* [15].
 - 3) Implementing an effective construction safety program to ensure worker safety on the PIP-II sites during construction. All work performed on the PIP-II sites will be conducted in accordance with the *PIP-II Project Construction Safety and Health Plan*.
 - 4) Performing independent design reviews on systems, structures and components designated as safety significant in the *PIP-II Hazard Analysis Report* [16], PIP-II Risk Register [17] and the *PIP-II Risk Management Plan* [18]. The design review process for PIP-II is defined in the *PIP-II Systems Engineering Management Plan (SEMP)* [19].
 - 5) Providing appropriate training to ensure that project staff is adequately trained and qualified to perform their assigned work safely. Training needs assessments will be conducted for all project team members to ensure knowledge of job-related hazards and their controls. All project team members are responsible for ensuring that their training and qualification requirements are fulfilled, including continuing training to maintain proficiency and qualifications.
 - 6) Developing and implementing operating procedures to control work on PIP-II technical systems and to implement requirements of FESHM and work planning and control program.
 - 7) Performing and documenting safety inspections of all project facilities and work areas and ensuring prompt correction of any issues identified in the inspection.
 - 8) Reporting and investigating occurrences in accordance with the Occurrence Reporting Processing System. Any incident, accident, or other abnormal event which occurs at the Fermilab site will be properly communicated and investigated via established Fermilab incident investigation procedures.

5.2. Safety Analysis and Reviews for Hazard Identification and Control

PIP-II structures, systems, components, operations and work processes will be analyzed to ensure proper identification and control of hazards. To accomplish this requirement, hazards and potential accidents will be analyzed in progressively more detail in each stage of design. Safety personnel will work closely with project engineers to develop a common understanding of the facility, systems and processes; possible hazards including hazardous materials; and the envisioned operation of the facility. This analysis will assist in defining requirements and standards for incorporation into the facility design. It is vital that designers know how to control the hazards posed by the systems, structures and components within their scope of work.

In addition, during the transition from construction to partial or complete use of a building, additional reviews are required to ensure that ES&H requirements for the proposed use are addressed. These “readiness reviews” will be performed prior to initial occupancy of the building for installation and commissioning of equipment and will be conducted in accordance with the FESHM. Commissioning activities associated with operation of an accelerator will be subject to the Accelerator Readiness Review (ARR) requirements of the DOE Accelerator Safety Order 420.2C, *Safety of Accelerator Facilities*.

5.2.1. Preliminary Hazards Analysis

A *Preliminary Hazards Analysis Report* (PHAR) [20] was drafted during the conceptual design phase of the Project. The PHAR identifies all hazards anticipated with the construction and operation of PIP-II and the mitigating controls that will be employed to eliminate or reduce risk of the hazards to manageable levels. A preliminary fire and life safety assessment has been completed which reviews fire and life safety hazards and requirements associated with the operation of PIP-II and identifies building and facility fire protection criteria that are needed to reduce the risk of harm to workers and to minimize the potential of property loss due to fire. The PHAR is available in PIP-II’s document management database.

5.2.2. Hazard Analysis Report

The *Hazard Analysis Report* (HAR) [21] is a continuation of the analysis initiated with the PHAR. This document was prepared as the preliminary design developed and more rigorous analysis of PIP-II hazards and controls became possible. However, it is understood that civil design and facility engineering may not have had sufficient detail to provide for a complete assessment at this stage. The HAR is prepared as a tool to identify issues that must be addressed during final design relating to construction, commissioning, operation and decommissioning. The HAR will be completed and approved as part of the Critical Decision (CD) -2 ES&H deliverables. The current version of the HAR is available in PIP-II’s document management database.

The HAR for the PIP-II design and operations will become more detailed as the design advances. An updated HAR will be completed and approved during final design and prior to CD-3. The updated HAR

considers design maturity of both conventional construction as well as accelerator and experimental systems. The HAR provides a mechanism to document the issues that must be addressed during subsequent design, construction, operation and decommissioning of the accelerator.

5.2.3. Safety Assessment Documents

The HAR will be used in developing the *Safety Assessment Document* (SAD) for the PIP-II facilities. The SAD must be prepared prior to the commissioning and routine operations of the accelerator and beamline systems. The purpose of the SAD is to describe in sufficient detail all significant accelerator specific hazards presented by the facility and its operations, and the controls by which these hazards will be managed. The safety analysis is used to identify hazards, credible impacting events, initiators of events, assumptions used in estimating impacts and consequences of an event, controls required to reduce risks, and post-mitigation risks to workers, the public and the environment. The SAD will define the controls and standards that must be incorporated into the facility design and operating procedures. It provides the technical basis for the ASE that must be prepared and approved by Fermilab and the DOE Fermi Site Office (FSO) management prior to commissioning and eventual routine operation of the facility. A complete facility SAD and ASE must be completed and approved prior to CD-4.

5.2.4. Authorization of Use and Possession (AUP)

During the latter portions of conventional facilities construction, there will be a transition to installation, assembly, testing, and eventual operation of the accelerator and beamline systems and to the cryogenic infrastructure at Fermilab. These incremental changes in occupancy of the facilities will be subject to formal review and approval in accordance with the procedures outlined in FESHM Chapter 7005, Facility Construction, Modification and Inspection.

Readiness evaluations are performed to verify that personnel, hardware, administrative requirements and procedures are ready to permit the activity to be undertaken in a safe and environmentally sound manner. These reviews will be performed in accordance with FESHM Chapter 2005, Operational Readiness Clearance.

5.2.5. Commissioning and Accelerator Readiness Reviews

As noted previously, PIP-II accelerator systems will be commissioned at different intervals. A *PIP-II Beam Commissioning Plan* will be developed to describe the objectives of each phase of commissioning. All accelerator-commissioning activities will be conducted as prescribed in the Commissioning Plan and within the boundaries defined in an applicable ASE.

ARRs must be performed before approval for accelerator commissioning and routine operation or as directed by the Project or DOE management. An ARR is conducted to verify that the necessary safeguards and procedures are in place to permit safe operation of the facility or sub-facilities. Where

commissioning of an accelerator facility is accomplished in phased and discrete segments, the ARR must also be performed incrementally. All ARRs will be conducted as described in FESHM Chapter 2010, *Planning and Review of Accelerator Facilities and Their Operations*. The scope and schedule of each commissioning phase will be established in the PIP-II ARR Plan [22] and updated to support each commissioning phase. The PIP-II DOE Federal Project Director will monitor and/or arrange DOE participation in the ARR and will authorize the module's commissioning and routine operations after determining that documentation and readiness are acceptable.

5.2.6. Work Performed During Construction, R&D and Commissioning Activities

The *PIP-II Project Construction Safety and Health Plan* has been prepared to define responsibilities and to establish safety and health expectations that all contractors must address during construction. Each contractor will be required to prepare an ES&H plan addressing their phase of work. Each contractor's ES&H plan will be reviewed and approved by PIP-II and Fermilab and will be subject to enforcement during the execution of the work by the PIP-II Project and Fermilab ES&H personnel.

All routine non-administrative work conducted by PIP-II project team members shall be evaluated using an HA. The HA shall identify the work to be performed, the hazards anticipated, and the actions to be taken to address the hazards. The HA shall be prepared in accordance with FESH 2060 with participation of worker(s) performing the tasks. When work changes or unanticipated conditions are encountered, the HA shall be revisited and revised as necessary. The Hazard Analysis process can be developed in either a verbal or written format depending on the complexity of the task.

All DOE funded work activities with significant environmental aspects will be evaluated through process reviews as a part of the Fermilab ES&H Management and are subject to additional work planning prior to authorization for work.

All routine work is subject to local institution work planning requirements and must be performed by workers who are trained and qualified and authorized by their supervisor to carry out the work.

5.3. NEPA Compliance

In compliance with NEPA and in accordance with DOE Policy 451.1, *National Environmental Policy Act Compliance Program* [23], the PIP-II project performed an Environmental Assessment (EA) evaluation of its potential environmental impacts and the safety and health hazards during construction and operation of the project. The EA analyzed the potential environmental consequences of the facility and compared them to the consequences of a "No Action Alternative." The assessment included detailed analysis of all potential environmental, safety and health hazards associated with construction and operation of the facility. The public release draft EA was completed in October 2018 and posted for public comments. A "Finding of No Significant Impact" (FONSI) was issued by the DOE Fermi Site Office on January 25, 2019 [24].

5.4. Code Compliance

Codes and consensus standards are developed to protect the public health, safety and welfare. Codes and standards function as requirements for engineers and designers of buildings and equipment. Structures and equipment built for the PIP-II project are required to meet applicable national consensus codes, standards or code equivalencies as defined in the Functional Requirements Specifications (FRS) for the deliverable. The FRS flow down includes Technical Requirements Specifications which identify the key codes, standards and best practices to be followed during the design process.

5.4.1. Code Equivalencies

The PIP-II project will rely on significant contributions from National and International Partners. In many cases, an International Partner will contribute equipment for installation at Fermilab that is built per one of the International Standards or Directives. Fermilab has established a process, detailed in FESHM Chapter 2110, to establish code equivalency between U.S. and International engineering design codes and standards. This process enables the Laboratory to accept in-kind contributions from International partners or purchase equipment designed per International standards while assuring an equivalent or greater level of safety.

At the time of this writing, Fermilab has completed the following code equivalency studies.

Study	Component Type	National Consensus Code	International Code
1	Pressure Vessels	ASME BPVC VIII	EN13445
2	Process Piping	ASME B31.3	EN13480
3	Pressure Relief Devices	ASME BPVC VIII	EN4126
4	Structure	IBC/ASCE7, AISC360, ADM1	Eurocode EN1990, EN1991, EN1993 and EN1998
5	Electrical Equipment for Measurement, Control and Laboratory use	UL 61010	IEC 61010

As necessary, the laboratory code equivalency process will be followed to establish equivalency to other international codes and standards. The current list of completed code equivalencies can be found in the ES&H Section Document Database document #3303, *Code Equivalency Studies* [25].

5.4.2. Electrical Standards

Electrical equipment designed for use at Fermilab must operate on a standard US voltage and frequency, e.g. 120/208/277/480 V 60 Hz single or three phase. Specialty cryogenic compressors or high horsepower motors may operate on 4.16-kV, 7.12-kV or 13.8-kV 60 Hz three phase. Plug and cord equipment must conform to standard US plug conventions as defined in UL 498, *Standard for Attachment Plugs and Receptacles* [26].

Fermilab has established an electrical equipment inspection program detailed in FESHM Chapter 9110, *Electrical Utilization Equipment Safety*, that uses the following acceptance hierarchy.

- Equipment marked by a Nationally Recognized Testing Laboratory (NRTL) is accepted as is for use at the laboratory providing the equipment is being used within its listing and per manufacturer's instructions. No additional inspections are required.
- CE marked equipment follows reduced inspection criteria by the Fermilab Electrical Authority Having Jurisdiction (AHJ).
- Other specialty equipment not having a NRTL or CE certification is inspected by the Fermilab Electrical AHJ in accordance with FESHM Chapter 9110TA. This inspection uses a NRTL inspection checklist.

5.5. Sustainable Design

The PIP-II Conventional Facilities will be constructed utilizing the federal Guiding Principles (GP) for High Performance and Sustainable Buildings. The GP were first officially articulated in the 2006 Federal Leadership in High Performance and Sustainable Buildings Interdepartmental Memorandum of Understanding, which was signed by 20 federal departments. The five GP are as follows:

- 1) Employ Integrated Assessment, Operation and Management Principles
- 2) Optimize Energy Performance
- 3) Protect and Conserve Water
- 4) Enhance Indoor Environmental Quality
- 5) Reduce Environmental Impact of Materials

The PIP-II Project will evaluate proposed PIP-II facilities using the GP criteria and is committed to meeting as many of the GP requirements as is reasonably feasible, recognizing that compliance in many of the planned facilities for PIP-II may not be straightforward. In these cases, PIP-II will take every opportunity to inform design decisions by taking advantage of resources such as the U.S. Green Building Council (USGBC) and Labs2 – a joint Environmental Protection Agency (EPA)/DOE partnership program to improve the environmental performance of U.S. and other nations' laboratories.

Design reviews and safety assessments of facility systems and operations will be conducted during preliminary and final design to minimize waste generation in the operation of PIP-II and to evaluate opportunities for pollution prevention. Members of the Fermilab ES&H organization will participate in the reviews during the preparation of preliminary and final designs to ensure compliance with sustainable design principles.

6. Appendix 1 – ES&H Management Plan Guidance Template and Expectations for Partners

The PIP-II Project is committed to establishing a safe work environment for all workers contributing to the Project. Partners are to include the following ES&H Management Plan elements in Section 6.3, Quality Assurance and Safety section of the Part 2, Project Planning Document package.

6.1. Partner ES&H Coordinator

The Partner Institution is to include contact information for the ES&H Coordinator overseeing PIP-II activities. The contact information will be used to share relevant lessons learned for accidents and incidents related to the PIP-II project.

ES&H Coordinator	Email	Phone

6.2. Partner ES&H Programs

The Partner Institution is to provide a high level summary of ES&H program and anticipated project hazards the program covers for the scope of work included in the PPD.

*Example text: **Partner** has strong Health and Safety, and Environmental Protection (HSE) programs in place. These programs evaluate and mitigate hazards from scientific, technical and administrative activities.*

*The ES&H programs cover risk assessment and hazard mitigation for the industrial, chemical and radiation safety hazards anticipated during the R&D and construction of in-kind contributions. These programs follow the safety regulations and standards in effect at **Partner**.*

6.3. Codes and Standards

The Partner Institution is to provide a high level summary of how in-kind contributions will comply with US codes and standards.

*Example text: To ensure in-kind contributions comply with US codes and standards, **Partner** will design, manufacture, assemble and test in-kind contributions as per the Functional Requirement Specifications (FRS) and Technical Requirements Specifications (TRS) documents.*

*Adherence to codes and standards identified in the FRS and TRS documents is verified through design, procurement, manufacturing, and transportation review plans and system acceptance testing procedures further outlined in the **Partner** PIP-II Quality Assurance Plan.*

6.4. Accident and Incident Investigation and Reporting

As identified in section 4.3.5, partners are expected to investigate and report accidents, incidents and near-miss events to the PIP-II ES&H Manager that may have the potential of effecting other partners, design, manufacturing or assembly procedures.

*Example text: Communications and lessons learned are one of the components of the accident and incident investigation processes. As outlined In the PIP-II Integrated ES&H Management Plan, the **Partner** ES&H Coordinator will notify the PIP-II ES&H Manager of significant incidents or injuries that occur at **Partner** site during the R&D and manufacturing stages of in-kind contributions for PIP-II activities that may have the potential of effecting other partners, design, manufacturing or assembly procedures.*