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# Design Review Plan

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<b>Author(s)</b>	

## APPROVALS AND SIGNATURES

*Include the following personnel:*

- *Project director (if applicable)*
- *Project Manager*
- *Project Engineer(s)*
- *Representatives from partner laboratories and institutions, if appropriate*

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Insert Name	Date
Role/title	

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*Repeat as needed...*

## CHANGE LOG

*Note: You may wish to include a disclaimer, such as the one below, that the printed version of this document may not be the most recently approved version:*

This version of the document may not be the most current approved revision. The current revision is maintained in the Project's Document Management system (DocDB, etc.), where all internal Project document approvals are managed. The current approved version is always available in the Document Management system. This document will be reviewed and updated annually or as needed. The Project Manager is responsible for maintaining an up-to-date version and obtaining required signatures, though they may delegate this responsibility, if desired.

Revision/Version	Date	Revision Description
V12	2/24/2016	Added Final Design Plan language for CD-3

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## 1 INTRODUCTION

### NOTES TO AUTHOR:

1. *Italicized text in red in this template is guideline information to assist you in creating this document. Please delete all such text in each section, prior to submitting this document.*
2. **Highlighted text in red** is information that may require customization/modification as per project requirement.
3. *Only your Project-specific information must appear in the final version of the document.*



## 2 GUIDING PRINCIPLES OF REVIEWS

Project commissioned design reviews can provide an independent assessment of the ability of the Project to meet its technical, schedule, and budget commitments, if done consistently and well. A well-defined program of design reviews outside the Director's and DOE reviews can be of great assistance to the Project Manager, the lab, and the funding agencies by providing validation or direction and correction throughout the lifecycle of the project. All Project systems, subsystems, components, installation and start up activities follow the Fermilab design review process. The goal of the Fermilab system of project design reviews is to increase the likelihood of success by identifying potential or actual design problems as early as possible in order to minimize the cost, schedule, and performance impact. For the **XXX** Project, periodic independent reviews appropriately phased to the DOE 413.3b Critical Decision stage and Director's readiness reviews will occur throughout the life cycle of the project.

Reviews offer an opportunity to add value to the projects and to the sharing of knowledge by inviting outside experts to provide confirmation of the approach and/or recommend options. They serve as a tool for communication by formally providing an opportunity to organize, assess, and communicate critical data and information. Unsatisfactory review outcomes sometimes lead to difficult decisions to revisit some or all of the effort leading to it. This makes frequent and early reviews highly desirable, so that the project has time to start over if needed, and before the sunk costs and schedule drive them to accept a less than satisfactory system.

This document provides the Project staff with the guidelines for design reviews consistent with and complementing the Fermilab engineering [manual](#). The design review's minimum requirements for technical and programmatic deliverables are provided, establishing roles and responsibilities of the presenters and the review committee. The level and depth of review will be commensurate with the complexity, safety impact, and cost of the design, following the guidance given in the engineering manual. It also defines what role the review process plays in authorizing the transition to the next phase of the technical deliverable.

### 3 MAJOR CLASS OF REVIEWS

The features of major review classes are provided to guide Project Managers in the formulation and implementation of a series of hierarchical reviews appropriate to the project design maturity and Critical Decision phase. Reviews provide the opportunity to confirm the approach or offer options, if needed, and communicate progress and risks toward meeting the requirements. The output of the reviews will typically be in written form, and will be treated as controlled documents. The output can be in the form of findings, comments, and recommendations, as a report document tailored to the projects needs, or other as defined by existing laboratory policy. These outputs are used as inputs into subsequent reviews such as Director’s or DOE Critical Decision reviews as appropriate to ensure alignment between providers, customers, and stakeholders, and ensure proper tracking and disposition of issues.

The primary responsibility for planning and executing the series of reviews for each component or system rests with the Project management, either with the Project Office or the Level 2 managers or in some cases the CAM’s. They develop a review plan for each element based on guidelines from the engineering manual and thresholds determined by the project. That plan is entered into the Projects Resource Loaded Schedule and updated as needed to remain consistent with overall project planning changes. If desired to combine reviews, the responsible planning manager(s) must present a request to the project manager to do so, along with an analysis of the benefits and how the combined reviews will meet the design review objectives. The goal is to maximize the probability of successful execution and completion. The types of project driven reviews described here are as follows:

- Requirements and Specifications Review (RSR)
- Conceptual Design Review (CDR)
- Preliminary Design Review (PDR)
- Safety Review (SR)
- Final Design Review (FDR)
- Production Readiness Review (PRR)
- Installation Readiness Review (IRR)
- Operations Readiness Review (ORR)
- Progress Reviews

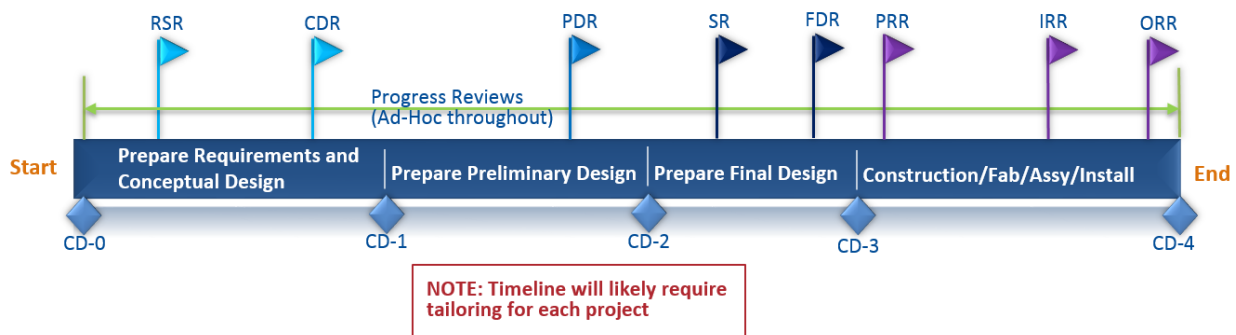


Figure 1 - typical review phasing relative to DOE Critical Decisions

While there is not an exact matching of these reviews to the DOE critical decision stages, the CDR's, PDR's, and FDR's are usually phased to the DOE critical decision 1,2, and 3 reviews.

Civil construction reviews are different from the science project reviews that are the main focus of this document, and follow standard practices for construction reviews, etc., although the best practices for design reviews described below frequently are applicable. For conventional/civil construction, FESS will perform lab-wide Comment and Compliance Reviews (CCR's) at each phase of design per FESS Engineering Procedures. FESS CCR's are performed at 95% design maturity at the various phases; Conceptual, Preliminary and Final, typically 3-4 weeks prior to finalizing that design phase. This lab-wide review of the 95% design complete equates to 30% final design at conceptual design phase, 60% final design at preliminary design phase and 95% final design at final design phase.

## 4 ROLES AND RESPONSIBILITIES

### 4.1 Review Coordinator

The Review Coordinator is appointed and charged by the Project Office. The Review Coordinator organizes and plans the review and has the following responsibilities/roles:

- Forms an appropriate review committee.
- Provides the committee with a written purpose and goal of the review, along with a template report to be completed by the committee.
- Identifies special boundary conditions for the review, or caveats.
  - Schedule constraints may necessitate proceeding to a design review to obtain approval for fabrication or procurement, prior to meeting all of the design review deliverables. The Project Manager will approve these special boundary conditions.
  - Technical areas covered by the review should be clearly described to prevent confusion from the review committee and will be approved by the Project Manager.
- Works with the Project technical team to create an appropriate agenda that meets the review deliverables as outlined in this document.
- Ensures that the Project technical team is organized and prepared to for the review, and review packages and associated slides are available prior to the review. The goal should be complete the dry run practice sessions, and to have the material available one week prior to the review.
- Sends out the review announcement to the Project mailing list along with the links to the formal documentation.
- Sends out the review password and site for the review material.
- Provides opening statement and slides explaining the goal and providing instructions to the review committee and audience.
- Assists the chair in leading the executive sessions throughout the reviews.
- Obtains the final report from the committee, posts it in the Projects document storage system, and electronically notifies Project management of the completion of the review and a summary of the outcome.
- Records attendance and attaches it electronically to the final review report.

### 4.2 Review Committee Chair

The Review Committee Chair(s) is appointed by the Review Coordinator after approval by the Project Manager, serves as the primary point of contact with the review committee or focused technical area committee sub-team, and has the following responsibilities:

- Collects questions and requests ahead or during (for multiple day reviews) the review that require additional material to be generated to address concerns
- Presents findings, comments, and recommendations during the close-out session at the end of the review if appropriate for that type of review.
- Performs final factual accuracy checks of draft Final Report with reviewee's.
- Transmits the final report to the Review Coordinator and Project Manager.

### 4.3 Review Committee

Review teams consist of knowledgeable, independent experts from outside the Project. Their evaluation supports the approval process by providing expert recommendations and supporting data needed to arrive at decisions either to proceed, rework, or not to proceed with project deliverables. Evaluations during the planning phases assess if the reviewed systems support the Project goals and are achievable within allocated resources and applicable constraints. Evaluations during the implementation phases assess if system planning and design are being successfully executed, and provides recommendations for enhancing the technical and programmatic performance.

The Review Committee is selected by the Review Coordinator, is approved by the Project Manager, and in general:

- Consists of at least one reviewer external to the project.
- Provides verbal and written feedback to the project on whether the subsystem has successfully demonstrated their technical and programmatic readiness as described in this document.
- Documents their assessment.

### 4.4 Project Engineering

The relevant Project Engineer (Mechanical, Electrical, System, Civil) has the following responsibilities:

- Verifies that the Design Review Plan is being executed, that it follows the Fermilab engineering manual or other relevant requirements, and maintains the plans and forms to support the reviews.
- Tracks the “recommendations” and reports summary status to the Project Office.
- Ensures that these action items are closed out in a timely fashion.

## 5 PROCEDURE

### 5.1 Presentation Materials and Support Documentation

The following guidelines are used for preparing presentation materials and documents:

- All reviews are prepared using the latest Project review template document.
- First slide (title/cover) will contain the title of the review, the preparer's name and the date of the review.
- The presentation(s) will cover all the applicable deliverables as stated in this document.
- Presentation material will be distributed in advance of the review. Preferably a few days before the review.
- All presentation material and supporting documents will be placed in a web accessible project owned location, and viewable to both the reviewers and the Fermilab team members.
- Presentation materials will be posted to the project document database, using controlled numbers, and released as records after completion of the review.
- The committee's draft report, attendance and agenda will be posted to the web accessible project owned location where the presentation material is located, and will be viewable for comment to the reviewers, the project, the collaboration, and Fermilab management.

### 5.2 Review Report

The review report follows these guidelines:

- The report is completed by the review committee and the moderator and posted in the projects document database.
- The report uses a controlled number and released as a record after completion and submittal of the report.
- Prior to the review, the purposes and goals of the review will be written and circulated by the review moderator. They will also list any special boundary conditions for the review.
- The review committee will complete and provide to the review coordinator an introduction and outcome Summary of the Review. This will contain overall impressions (subjective but expert judgment) and general conclusions. A final recommendation about whether to proceed to the next phase of the project will be made.
- If in "Findings, Comments, Recommendations" format, the report should also contain:
  - Findings – these are general, factual observations about material presented, and require no response.
  - Comments – these are observations with value judgments, or "soft" recommendations that require action by the design/engineering team, but where a formal written response is not requirement.
  - Recommendations – these are items that require immediate formal action and closure in writing prior to receiving approval to move into the next phase of the project, or items that require formal action and closure in writing prior the next review. They will be completed by the review committee, and tracked by the Project manager or their designee, typically the relevant Project Engineer.

### **5.3 Announcement and Attendance**

Announcements and attendance are handled as follows:

- Announcements will be made in advance of the review. Preferably one month prior to the date of the review.
- An E-mail announcement giving relevant details of the major reviews, such as the system being reviewed, the location of relevant documents, time and location, etc., will be sent to the Project, and the PMG and collaboration mailing lists.
- Attendance records will be kept and posted in the Project document database, and should be appended to the Design review Report.

## 6 REVIEW DELIVERABLES

The following list is intended to provide the external project reviewers the minimal technical and programmatic content required to meet the design review deliverables. These are split out one on each page to allow for easy use during a review.

### 6.1 Requirements and Specifications Review

Review of the project requirements and specifications is intended to ensure alignment between the science drivers and those requirements. An early and thorough requirements process can capture many critical elements needed for project success that otherwise might not be included in the projects planning. Examples of common requirements that are frequently forgotten in a first pass are the needs for alignment/metrology services, computing infrastructure, particularly networking, and other “infrastructure” such as test facilities that are assumed to be available when the project needs it, which sometimes leads to unpleasant surprises, schedule delays, and unplanned expense.

- Project level requirements
- Goal - Validate the objectives/functionality and performance requirements of the Project.
- Presents the following
  - Science including breadth of applications possible with the Project
  - Objectives/Functionality and the requirements of the system:
    - Project Level Requirement Document complete and ready for sign off
  - Requirement Margins
  - Operations
  - Reliability
  - Traceability to Science Requirements.
  - Validation Process
  - Verification Process
- After closure of action items, the review outcome will be used to assist the Project in setting the baseline Project level requirements and continuation of engineering specifications and component conceptual designs.

### 6.2 Conceptual Design Review

Conceptual Design Reviews (CDR’s) are the first of the six major review steps, and are a technical and programmatic review of the functionality and requirements of the deliverables. The presenters should demonstrate that functionality and requirements are well understood, including the impacts of requirements that are unresolved, as well as that the conceptual design meets these requirements. Also, a clear understanding of the interfaces and requirements is needed to understand the integration of the system with the rest of the project. The CDR’s are conducted prior to the Director’s CD-1 readiness review, and should occur early enough that the concept can be modified without a major impact to the program. The preliminary design should be at a minimum of 15% complete at the time of this review, with a clear plan to be at the required stage of readiness at the time of the Director’s and DOE reviews.

The review should present the major design alternatives considered, the relative risk for each and the justification for the selection.

Conceptual Design Reviews will contain the following scope items and address these issues:



- Sub-System or Hardware Specific
- Goal:
  - Validate the objectives/functionality and performance requirements of the hardware.
  - Validate the related sub-system specifications & conceptual design
  - Validate development plans to fabricate prototypes
- Presents the following:
  - Key requirements/specification:
    - Specifications have been completed and have been reviewed by the appropriate Project Engineer for Conceptual Design readiness. All of the specification terms have been identified and the driving requirements are defined.
    - Risk has been assessed on specifications that are to be resolved or to be determined, or with other issues.
    - Includes traceability and validation and verification process
  - Risk Registry completed (including mitigation of technical, cost & schedule risk) as appropriate.
  - Conceptual design that meets the requirements.
  - New technologies developed or R&D plan and risk assessment
  - Development plans & progress including rationale
  - Engineering analyses to support conceptual design
  - Major system interface points identified, both organizational and technical:
    - Control system implementation plan recommended
    - Draft Interface agreements
  - Major design alternatives considered (Value Management)
  - Consideration for quality control, reliability
  - Completed Hazard List. Identify planned hazard reports
  - Cost and schedule update

After closure of immediate request for action by the Project Engineer team, this review should validate the Conceptual Design specifications and conceptual design approach. It will assist the Project in determining if the project is on track for Director's and DOE CD-1 IPR review, and the transition to Preliminary design.

### 6.3 Preliminary Design Review

Preliminary Design Reviews (PDRs) are the second of the six major review steps, and are a technical and programmatic review of the basic design approach to assure the approach will meet the technical requirements. Verification planning, cost and schedule, and interface compatibility are also addressed during the review. The PDR's are conducted prior to the Director's CD-2 readiness review and/or CD-3a long lead procurement review. The preliminary design should be at a minimum of 50% complete at the time of this review, with a clear plan to be at the required stage of readiness at the time of the Director's and DOE reviews.

The Preliminary Design Reviews will contain the following scope items and address these issues:

- Scope:
  - System or Hardware Specific design
  - Final design details at the component level are not required.
- Goal:

- Validate the preliminary design, with confirmation that it meets all technical requirements and interface agreements
- Assessment of the viability of verification test plans
- Validate plan to complete preliminary design and start detail drawings
- Validate plan to fabricate test articles
- Validate long duration procurement plans
- Presents the following:
  - Sub-system current organizational structure and team
  - Sub-system current scope and deliverables
  - Science/technical objectives, requirements, general specification
  - Requirements are complete, traced, validated, and released, including verification plans
  - Identified issues to be determined or resolved, and the plan for doing so.
  - Interface Control Documents are complete at Preliminary Design level and released
  - Preliminary design that meets the requirements: includes design studies, block diagrams, use cases and sequence diagrams, as appropriate for all mechanical, electrical and software aspects.
  - Engineering analyses should show predicted performance and expected margin to every requirement. Show assumptions and describe limitations of current state of the analyses. Show stresses and margins against allowable limits for all key components and a draft list of critical items and single-failure point items and their analysis compared to specifications
  - Summarize prototype design and present test result performance against requirements
  - Show detailed design and prototyping test plan. It should be clear to the reviewer what the planned prototypes are aiming to address.
  - Show manufacturability, with vendor information when applicable, with fabrication, assembly, and test plans. This should include high level assembly procedures and high level test plans for final hardware
  - Show parts selection, inspection, process control, and test plans and compare them to the Projects Quality and reliability criteria.
  - Show current risk assessment and mitigation of technical, cost and schedule risk. Link to previously presented prototyping effort
  - Updated Hazard List and drafts of any hazard reports
  - Demonstrate control of hazards by showing analysis of design for engineering controls, administrative controls and design based mitigations
  - Cost and schedule
  - Summary of resolution of recommendations from previous reviews
- Deliverables:
  - Updated Technical Design Report Chapter related to area being reviewed
  - Spreadsheet with preliminary design requirements complete and requirements verification method complete
  - All design specifications, including sub-system specifications should be listed and numbered. All specifications related to sub-system requirements should be met.
  - All specifications covering performances across sub-system components should have a supporting document, which is usually a spreadsheet
  - All identified interface control documents should exist, with no place holders. All interface control documents to other sub-systems or components already at Final Design level, or expected to be purchased as long duration items, should be complete.

- Finalized test reports documents from past prototypes. Production preliminary test procedures for long duration items.
- System and sub-system CAD models compatible with the overall Project system for incorporation
- Preliminary drawings of major components, final drawings of long duration items to be purchased
- Preliminary design level schematics of major electronics systems, final schematic and layout or long duration items
- Software functional architecture and infrastructure
- Updated risk registry with current assessment status refreshed no more than a month prior to the review
- Updated hazards documentation, with current assessment and status refreshed no more than a month prior to the review
- Preliminary Hazard Analysis (PHA) section related to area being reviewed updated
- Resolution in the Project tracking tool of all previous review recommendations related to the sub-system.
- Updated schedule, cost estimates, Basis of Estimates, and Baseline Change Requests.

After closure of action items, preliminary design and long lead procurement items should be on track for Director's and DOE CD-2/3a IPR review, and the transition to final design.

## 6.4 Environmental, Safety, and Health Reviews

Subject-matter-specific Environmental, Safety & Health (ES&H) Reviews are held as part of the run-up to a subsystem's Final Design Review. These reviews constitute one part of the ES&H program at Fermilab (FESHM) and have been adopted by the Project to assure that subsystem designs and equipment that is delivered to Fermilab meet or exceed DOE and Fermilab ES&H requirements. Thus, these form part of the ES&H assurance and review processes for all subsystems, regardless of the origin of the design and hardware. The Fermilab requirements for ES&H for Projects is defined and described in the Fermilab ES&H Manual (FESHM 2001). The [NEPA process](#) for Projects is covered in FESHM 2001, but not elsewhere in this document.

ES&H Reviews are technical reviews addressing the personnel hazards and equipment protection issues associated with subsystem design, manufacture, assembly and test, and operation. They are intended to provide assurance that hazards have been sufficiently analyzed, that appropriate controls are planned to mitigate or eliminate the hazards, and that the activity conforms to FERMILAB ES&H policies. ES&H review elements are incorporated into the Final Design Review, the Production Readiness Review and the Installation Readiness Review.

## 6.5 Final Design Review

Final Design Reviews (FDRs) are the third of the six major review steps, and are a technical and programmatic review to provide assurance that the completed design of the selected configuration meets all functional and performance specifications as well as interface agreements. The technical areas addressed during the review include the design configuration and integrity of the selected design; verification planning, requirements, and compliance; operations planning and requirements;

lab and observatory support equipment requirements and specifications; and systems compatibility. The FDR's are conducted prior to the Director's CD-3 readiness review. The subsystem designs and drawings are typically at the 80-90% design complete stage, with a clear Final Design Plan to be at the required stage of readiness at the time of the Director's and DOE reviews. That Final Design Plan should be a written, reviewable plan for presentation and assessment at the Director's and DOE CD-3 readiness reviews. It should contain milestones and sign-offs as needed to assure readiness for construction. Final Design Reviews contain the following scope items and address these issues:

- Scope:
  - Component specific analysis and design
  - Performance analysis and design details at the component level are required
- Goal:
  - Validate the final design, cost and schedule
  - Validate plan to complete detail and assembly drawings
  - Validate plan to start procurement and fabrication, including detailing and fabrication of fixtures, test equipment, and fabrication procedures
- Presents the following:
  - Sub-system organizational structure and team.
  - Sub-system scope and deliverables
  - A final design that meets the requirements, with drafts of all key/high-value components and assemblies, along with a complete indented drawing list, complete set of use cases and sequence diagrams for all mechanical, electrical and software aspects.
  - Description of engineering analyses conducted, and predicted performance and margins to every requirement. This should include tabulation of stresses and margins against allowable limits for all components and a complete list of critical items, their analysis, and fabrication and test plans per applicable specifications
  - Prototype test results that demonstrate functionality and/or technology readiness needed for start of production, including margins relative to requirements
  - Fabrication, assembly, and test plans, along with lists of procedures, fixtures, and flow of work for component and sub-system fabrication, assembly, and test, and rough drafts of key procedures
  - Draft operations and maintenance plans, including list of operating and maintenance procedures
  - Quality assurance plans that include requirements for parts and material selection, inspection, and process control during manufacturing
  - Updated technical, cost and schedule risk analysis, with focus on manufacturing risks
  - Updated Hazard Analysis reflecting final design
  - Cost and schedule
  - List of identified outstanding problem areas/open issues
  - Summary of resolution of request for action from previous reviews since PDR (Tier 1 and Tier 2)
- Deliverables:
  - Updated Technical Design Report Chapter related to area being reviewed
  - Sub-system specifications, with all requirements completed, with traceability information and expected margin
  - All interface documents and drawings should be complete, and released with clear deliverables.

- Finalized test reports documents from past prototypes. Completed Verification Test Plan that defines all tests, test equipment, expected results, and description of test software, as well as a completed list of test procedures and draft procedures for key tests.
- Required CAD models should be complete and compatible with the overall Project model.
- Final drawings of critical components should be available. Preliminary drawings of minor components should be available in draft form.
- Final schematic of all electronics systems and final layout or critical boards or board section should be available. Preliminary layout of minor boards and board areas should be available in draft form.
- Software final functional architecture and infrastructure (OSI model summary).
- Risk registry updated within previous month with current assessment of risk, including schedule and cost risk
- Updated Hazard Analysis section from the PHA version related to area being reviewed (document to become the Final Hazard Report or FHA)
- Resolution in the Project recommendation tracking tool of post-Preliminary Design Review recommendations related to the sub-system.
- Up to date schedule and Cost Estimate
- Updated BOE spreadsheet.
- Baseline Change Requests to date.

After the closure of action items, final design is approved; detail drawings and assemblies can be completed, items can be purchased, and part fabrication can begin.

## 6.6 Production Readiness Review

Production Readiness Reviews (PRRs) are the fourth of the six major reviews steps. PRRs are generally held as needed following CD-3 approval, and prior to the start of manufacturing and testing of major subsystem assemblies. PRRs are largely technical reviews, but include assessment of the planned cost, schedule, and personnel needs to complete the manufacturing processes that are covered. These are ad hoc reviews in that the number and extent of subsystem PRRs depend on the nature of the design and manufacturing plans. However, at least one PRR is expected for each subsystem, with PRRs recommended for every major deliverable assembly

Production Readiness Reviews will contain the following scope items and address these issues:

- Scope:
  - Part and sub-assembly specific fabrication and assembly material
  - Manufacturing and test procedures at the part and sub-assembly level are required
- Goal:
  - Approval of plans and procedures for manufacturing sub-assemblies
  - Validate plan to start manufacturing
  - Approval to proceed with power-on testing of completed assemblies, after appropriate safety review sign-offs, or establishment of a required set of Test Readiness Reviews
- Presents the following:
  - Status of sub-assembly and detail drawings
  - Status of bill of material and part list
  - Final drafts of drawing for assembly, test, and handling fixtures, and specifications or drawings for assembly and test equipment

- Present verification test plans, inspection and test travelers, and associated QA/QC documents
- Present final plans for manufacturing workflow, including scheduling, personnel needs, time-and-motion studies, floor space requirements, facilities requirements and procedures (e.g., clean room protocols) Status of procurement and manufacturing: update on procurements and how they support manufacturing workflow plans
- Present update on safety documentation, including close-outs of Hazard Reports, draft sections for commissioning and operations as required
- Review closeout recommendations from the Final Design Review
- Risk registry updated within previous month with current assessment of risk, including manufacturing risks
- Cost and schedule updates based on manufacturing workflow plan details
- Deliverables:
  - Final Drawings for all mechanical items
  - Final PCB GERBER design files for all electronics items
  - Assembly drawings where applicable
  - Bill of material and part list for all components with contamination assessment if inside the cryostat
  - Quotes or purchase order description for procured items (including computing infrastructure items for software deployment)
  - Procedures and travelers: final drafts of fabrication and assembly procedures and travelers, including in-process inspection steps, equipment used
  - Verification test plan describing all tests for verifying subsystem requirements and interfaces that include description of deliverable
  - Plans and final drafts of procedures for acceptance and verification tests
  - Final plans for manufacturing, including scheduling, personnel needs, time-and-motion studies, floor space requirements, facilities requirements and procedures (e.g., clean room protocols)
  - Hazard Reports, if applicable
  - Resolution in the Project recommendation tracking tool of post-FDR review recommendations related to the sub-system.
  - Current schedule and Cost Estimate
  - Updated BOE
  - Baseline Change Requests to date

After the closure of action items, the component/sub-assembly manufacturing, assembly, and test commences, unless otherwise modified by requirements for a Test Readiness Review.

## 6.7 Installation Readiness Review

Installation Readiness Reviews (IRRs) are the fifth of the six major review steps. IRRs are generally held as needed following procurement or production of subsystem components, and prior to the start of installing and commissioning of major subsystem assemblies. IRRs are largely technical reviews where the number and extent of subsystem IRRs depend on the nature of the design. They usually have a focus on ensuring that the equipment to be installed meets specifications and will operate safely. They are typically a valuable input to the operational readiness review process. At least one IRR is expected

for each subsystem, with IRRs recommended for every major deliverable assembly. For conventional facilities, this is equivalent to the commissioning readiness review done when conventional facilities are complete and almost ready to be commissioned.

Installation Readiness Reviews will contain the following scope items and address these issues:

- Scope:
  - Produced part and sub-assemblies
- Goal:
  - Approval of readiness to install sub-assemblies
  - Approval to proceed with post installation power-on testing of completed assemblies and suitability for larger scale commissioning tests, after appropriate safety review sign-offs.
- Presents the following:
  - Final drawings and specifications of produced equipment
  - Update on safety and QA/QC documentation, including close-outs of Hazard Reports, draft sections for commissioning and operations as required
  - Review closeout recommendations from the Production Readiness Review
- Deliverables:
  - Final Drawings for all mechanical items
  - Final GERBER design files for all electronics items
  - Assembly drawings where applicable
  - Bill of material and part list for all components with contamination assessment if inside the cryostat
  - Plans for installation, including scheduling, personnel needs, floor space requirements, facilities requirements and procedures
  - Resolution in the Project recommendation tracking tool of post-PRR review recommendations related to the sub-system.

## 6.8 Operational Readiness Reviews

Operational Readiness Reviews (ORRs) are the last of the six major review steps. ORRs are generally held as needed between CD-3 and CD-4 approvals, prior to the start of commissioning and operation of major subsystem assemblies. ORRs are largely technical reviews commissioned by the division the project is located in, and charged and approved by the appropriate Division head. For example, the process for a project in PPD or ND requesting Operational Readiness Clearance (ORC) is located [here](#). They include assessment of the readiness, from the safety, regulation, and overall completion level to begin operation. These are ad hoc reviews in that the number and extent of subsystem ORRs depend on the nature of the design and manufacturing plans. However, at least one ORR is expected for each subsystem, and an overarching ORR review and approval is expected for the entire project before physics operations can begin. For conventional facilities, this is equivalent to the less formal O&M review where the punchlist for completion is developed, maintenance training plan is reviewed, handover of all O&M documentation done, and where FESS/Ops, building manager, building occupants are the primary participants. Accelerator systems are covered by different procedures, FESHM Chapter 2010 *Planning and Review of Accelerator Facilities and Their Operations*

<http://esh-docdb.fnal.gov/cgi-bin/ShowDocument?docid=348>

Chapter 2010 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*. The chapter addresses the Preliminary Hazard Analysis Reports (PHARs), Preliminary Safety Assessment Document (PSADs), and Safety Assessment Documents (SADs) that are developed to document the hazards from accelerator operations. It also contains information about the accelerator readiness review (ARR) process. The SAD process can be found at this link: <https://indico.fnal.gov/getFile.py/access?resId=0&materialId=1&confId=7445>

## 6.9 Progress Reviews

At times, Progress reviews are needed to assess and approve changes to requirements, designs, or plans, or to provide framework for evaluating and making down-select decisions when there are choices to be made between competing options. These reviews are ad hoc, and are generally needed when the changes are of sufficient magnitude that they affect multiple interfaces, include changes to the design of entire sub-assemblies, or impact entire classes of requirements or their verification.

- Scope:
  - Sub-Assembly or Component Specific.
  - Review charge dependent
- Goal:
  - Expert examination of changes to the baseline design and/or requirements, with confirmation that the changes continue to meet all scope requirements, especially technical requirements and interface agreements
  - Direction to exercise the BCR process to re-enter the design development path towards the next major review, fully incorporating the changed baseline. This may include approval of additional development work or modifications of existing prototype hardware
- Presents the following:
  - Changes to requirements and their impact on higher level requirements
  - Changes to the design, rationale for the changes, and evidence that the modified design meets the requirements: includes design studies of change impacts, and modifications of existing design documentation as appropriate
  - Results of value engineering studies and other alternative evaluations to justify the rationale for the changes; this should include impacts on cost, schedule, technical performance, and risk
  - Updated engineering analyses that suggest or require design changes, along with impact on predicted performance and margins to requirements
  - Changes to sub-system interfaces and ICDs, along with impacts on opposite side of the interface
  - Changes to fabrication, assembly, or test plans that impact production or manufacturing plans and processes
  - Assessment of the impact of changes on risk exposure, identified and new hazards and their mitigations, hazard control and protection plans, reliability of the system and components
- Deliverables:



As required by the charge. Generally they should be a subset of the deliverables listed under the previous major review as defined in sections 6.2 through 6.9 affected by the changes presented under this review.

After the closure of action items, initiate formal change control as needed, using the review outcome as an input to the process.

## 7 ABBREVIATIONS AND ACRONYMS

ARR	Accelerator Readiness Review
ALARA	As Low As Reasonably Achievable
CAD	Computer Aided Drafting
CDR	Conceptual Design Review
CE	Cost Estimate
CCR	Comment and Compliance Review (FESS)
ESH&Q	Environment, Safety, Health & Quality
FESHM	Fermilab Environmental, Safety & Health Manual
FDR	Final Design Review
FHA	Final Hazard Analysis
IRR	Installation Readiness Review
ICD	Interface Control Document
NEPA	National Environmental Policy Act
ORR	Operational Readiness Review
ORC	Operational Readiness Clearance
OSI	
PHA	Preliminary Hazard Analysis
PHAR	Preliminary Hazard Assessment Report
PRR	Production Readiness Review
PSAD	Preliminary Safety Assessment Document
SAD	Safety Assessment Document
SR	Safety Review
SRR	System Requirements Review

