| Electron-Ion Collider at Brookhaven National Laboratory | | | |
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| **Doc No.** EIC-SEG-PDN-009 | **Author:** K. Wilson | **Effective Date:** July 7, 2023 | **Review Frequency:** 5 years |
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Electron-Ion Collider Process Description

# EIC Technical Review Plan

## July 7, 2023

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| **Electron-Ion Collider at Brookhaven National Laboratory** | | | |
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## REVISION HISTORY

| Revision # | Effective Date | List of Reviewers | Summary of Change |
|---|---|---|---|
| 00 | 5/17/2023 | L2/System Managers, L3 Managers, T. Russo | Initial release. |
| 01 | 6/27/2023 | J. Fast, I. Graff, L. Lari, P. Mantica, K. Smith, F. Willeke | Revised per comments from DOE. Revised 8.6 reference. |
| 02 | 7/7/2023 | J. Fast, I. Graff, L. Lari, K. Smith, F. Willeke | Revised per comments from DOE. |

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## LIST OF ACRONYMS

| | |
|---|---|
| BNL | Brookhaven National Laboratory |
| BOE | Basis of Estimate |
| BORE | Beneficial Occupancy Readiness Evaluation |
| BSA | Brookhaven Science Associates |
| CAM | Control Account Manager |
| CDR | Conceptual Design Review |
| CF | Conventional Facilities |
| CMGC | Construction Manager/General Contractor |
| DOE | Department of Energy |
| EIC | Electron-Ion Collider |
| EPR | Engineering Peer Review |
| FDR | Final Design Review |
| FMEA | Failure Mode and Effects Analysis |
| ICD | Interface Control Document |
| IKC | In-Kind Contributor |
| IMP | Interface Management Plan |
| JLAB | Thomas Jefferson National Accelerator Facility |
| L2M | WBS Level 2 Manager |
| MIP | Manufacturing and Inspection Plan |
| MRR | Manufacturing Readiness Review |
| P6 | Primavera P6 Scheduling Software |
| PDR | Preliminary Design Review |
| PPD | Project Planning Document |
| PRR | Procurement Readiness Review |
| QA | Quality Assurance |
| QC | Quality Control |
| RLS | Resource Loaded Schedule |
| RMP | Requirements Management Plan |
| SAR | System Acceptance Review |
| SBMS | Standards Based Management System |
| SEG | Systems Engineering Group |
| SEMP | System Engineering Management Plan |
| SOW | Statement of Work |
| SRR | System Requirements Review |
| TD | Technical Director |
| TDMP | Technical Design Maturity Plan |
| TRP | Technical Review Plan |
| TRR | Transportation Readiness Review |
| WBS | Work Breakdown Structure |

# 1. INTRODUCTION

Brookhaven National Laboratory (BNL) and the Thomas Jefferson National Accelerator Facility (JLab) have partnered to design and build the Electron-Ion Collider (EIC) – a unique discovery machine that will probe the nature of quarks and gluons to understand the properties and structure of nucleons and nuclei. The EIC Project will involve domestic and international partners and leverage the worldwide accelerator and detector communities to deliver this ambitious machine.

As part of the planning and oversight strategy, a Technical Review Plan (TRP) specific to EIC is detailed in this document which establishes guidance and expectations for technical reviews at each phase of design and implementation. The following sections define the scope, guiding principles, stakeholder roles and responsibilities, procedures, and review classes and deliverables expected at each level of design and implementation.

Review milestones inserted in the P6 Resource Loaded Schedule (RLS) will be used to monitor technical progress and also to evaluate and demonstrate design maturity throughout the project.

# 2. SCOPE

This document defines the Technical Review Plan (TRP) that the EIC Project will use for systems, subsystems, and components under development at BNL and JLab, as well as at domestic and international partners including In-Kind Contributors (IKC). It applies to all EIC accelerators, experimental detector, and infrastructure systems, subsystems, and components delivered as part of the project scope. The reviews defined in this document apply to scope activities from technical design through implementation and acceptance.

This plan is intended to be flexible enough to accommodate the different needs and organizational structures of different areas of the project. System/L2 Managers will select the appropriate reviews to ensure sufficient monitoring and feedback for their scope. Not all reviews described herein will apply to all areas of scope. Other efforts may benefit from additional reviews which are not defined in this document. Omission from this document should not be interpreted as a limit on performing such reviews. This plan does not limit the ability of managers to require additional reviews of their scope.

# 3. ROLES AND RESPONSIBILITIES

With respect to this TRP, roles and responsibilities of the stakeholders are as follows:

## 3.1. **Technical Director**

The Technical Director (TD) is the highest technical design authority in the EIC organization, with authority over accelerator, detector, and infrastructure, and therefore has the overall responsibility to ensure the design, development, and integration processes for the EIC follow this TRP. The TD has the following authorities and responsibilities:

- Ensures all technical systems, subsystems, and components are reviewed in accordance with this plan.
- Reviews and approves review charges.
- Assesses each technical review closeout for compliance with this plan, assessed results, and resulting recommendations and actions.
- Assesses the overall design maturity of the project and provides guidance to the project on readiness for the next critical decision

The technical director may delegate these responsibilities as appropriate.

## 3.2. **Technical Integration Group**

The Technical Integration Group is responsible for providing guidance and coaching to ensure that reviews provide adequate coverage and assessment of scope design maturity and are applied consistently across the project. In particular the group:

- Generates processes, standards, and reference documents which establish the requirements for planning, execution and follow up of technical reviews,
- Ensures a consistent systematic approach to reviews across the project,
- Provides guidance and coaching on the review processes and expectations, and
- Supports the technical teams in planning, preparation, and execution of technical reviews.

### 3.3. System or WBS L2 Managers

System or Level 2 (L2) Managers are the highest-level work breakdown structure (WBS) managers. They have the responsibilities listed below.

- Ensure development of and approve Engineering Design and Review Plans at Level 3 or below as appropriate.
- Ensure the technical teams are familiar with and understand the guidance in this plan.
- Ensure technical design reviews, encompassing the entirety of the scope assigned to them, are planned and conducted in accordance with this plan.
- Oversee responses to questions/homework, closeout comments, and recommendations from reviews, and approves the response to the closeout report.
- Ensure that any recommendations arising from the review are responded to and tracked. Verify that recommendations are actionable and request clarification when needed.
- Ensure that review response actions under tracking are addressed and closed in a timely manner.
- Ensure that the TD is informed of technical review dates, review outcomes, including readiness to proceed to the next planned phase, committee recommendations and the technical response to recommendations.
- Ensure that the appropriate Subsystem Manager is tasked with the review activities listed in Section 3.4.
- Ensure that the technical reviews for systems, subsystem, and components in their L2 scope, are comprehensive and appropriately integrated.

Authority to execute these items may be delegated as appropriate, but the responsibility always remains with the System/L2 Manager.

### 3.4. Subsystem Managers

The Subsystem Managers (generally WBS L3 or L4 Managers) are generally responsible for coordinating the review preparation and execution, including identification, development, and presentation of the content addressing the scope under review. They have the responsibilities listed below.

- Ensure that their technical reviews encompass the entirety of the scope assigned to them.
- Oversee preparation of review documentation and presentations.
- Coordinate planning, preparation, and execution of the technical review with the administrative staff, the presenters, and the Technical Integration Group.
- Develop the review charge and agenda with concurrence from the L2/System Manager and Technical Integration Group and ensure the TD reviews and approves the charge.
- Select and contact review committee chair and members with concurrence from the System Manager, cognizant technical team members, and SMEs.
- Coordinate with administrative staff to create and manage the Technical Review Prep and final Review SharePoint sites.
- Assist the System Manager in ensuring that any recommendations arising from the review are responded to and tracked. Ask review chair for clarification on recommendations if needed.
- Coordinate with the corresponding L2/System Manager to ensure that team responses to recommendations from previous reviews are prepared and reviewed in advance of posting for the committee, including those prepared by partners.

### 3.5. **Review Committee Chair**

The Review Committee Chair is chosen to be a review topic subject matter expert. The Review Committee Chair serves as the primary point of contact for the review committee and has the following responsibilities:

- Coordinates questions and information requests ahead of and during the design review.
- Presents the committee's initial findings, comments, and recommendations during the close-out session at the end of the review.
- Authors review the report that answers all charge questions and includes the committee's final findings, comments, and actionable recommendations.
- Transmits the final review report to the System Manager.
- Ensures that any recommendations arising from the review are actionable.

## 3.6. **Review Committee**

The Review Committee is comprised of subject matter experts able to effectively evaluate the material presented. Reviewers may be internal or external to the project (internal reviewers should be external to the immediate project team) and may include partner-chosen reviewers when partner scope is impacted. When appropriate, the Review Committee should include representatives of ESH and QA. The Review Committee has the responsibilities listed below.

- Gives verbal and written feedback to the project on whether the system, subsystem, and components demonstrate technical and programmatic readiness based on the review type, scope and charge.
- Provides commentary and feedback on the completeness of the design deliverables and documents.
- Answers the charge questions.
- Provides written findings, comments, and actionable recommendations.

# 4. REVIEW PROCEDURE

## 4.1. General Timeline Guidance

The following are the minimum times recommended to complete key activities relative to the planned review date.

| | |
|---|---|
| Initiate review planning and preparation with administrative staff: | 8-12 weeks prior |
| Informal committee polling for availability: | 8-12 weeks prior |
| Begin development of draft charge and agenda: | 6-8 weeks prior |
| Formal invitation: | 4-6 weeks prior |
| Provide draft charge and agenda to TD for review: | 4 weeks prior |
| Provide approved charge to committee: | 2weeks prior |
| Begin preparation and posting of review backup documents: | 4 weeks prior |
| Begin preparation of presentation outlines: | 4 weeks prior |
| Presentation page turns: | 2-3 weeks prior |
| Presentation dry runs: | 2 weeks prior |
| Posting of all review materials to the final Review SharePoint site: | 1 week prior |

## 4.2. Presentation Materials and Support Documentation

The System/L2 and Subsystem Managers and critical project stakeholders (project subject matter experts, L3/L4 Managers, Technical Integration Group, etc.) all collaborate to plan and execute the review. Presentation materials and supporting documentation will be developed and posted to a review website (generally SharePoint) in advance of the review. The scope of the review, including WBS elements covered by the review, shall be clearly stated. The review committee will have appropriate site access to the designated document repository.

## 4.3. Review Report and Review Responses

The review report includes:

- The title and WBS element of the system, subsystem, and components under review.
- A brief designation of the system, subsystem, and components under review.
- The type of review.
- The dates of the review.

- The names and affiliations of the reviewers.
- The review agenda, including presenter names and their project roles.
- Answers to each charge question.
- Findings, comments, and recommendations, where:
  - Findings – general, factual observations about the material presented that require no response.
  - Comments – observations with value judgments, or "soft" recommendations that require action by the design/engineering team, but where a formal written response is not required.
  - Recommendations – actionable items that require formal response, tracking, and closing.

## 4.4. **Closing a Technical Review**

The review is considered closed when each recommendation has been acknowledged and is tracked. Acknowledged means that an action has been identified to address the recommendation but is not necessarily implemented yet. The System / L2 Manager will ensure that all responses to comments are adequately addressed, and recommendations are technically appropriate. A P6 schedule review milestone is achieved when a technical review is closed.

# 5. REVIEWS FOR ACCELERATOR AND DETECTOR SCOPE

The review sequence and deliverables defined in this section establish a guideline for System / L2 Managers to plan design and development milestones with their Subsystem Managers. System / L2 and Subsystem Managers will determine the specific design deliverables subject to review for systems within their authority, with reference to guidance provided in this document and the TDMP [8.4]. Typical review paths illustrating the sequence of reviews are provided for reference at the end of this document.

For a large or technically complex design scope, reviews may be organized or structured in stages or a series of reviews of smaller components of scope. This approach can be utilized as a best practice to ensure timely assessment of technical maturity at appropriate points while allowing the overall design effort to proceed efficiently. For example, at the discretion of the System / L2 Manager, in consultation with the Subsystem Managers and system, subsystem, and components technical leads, design reviews for a large piece of scope might be broken into PDR-1, PDR-2, FDR-1, FDR-2, etc.

The following subsections describe the EIC technical review types.

## 5.1. Peer Review

Peer Reviews are informal reviews that are typically conducted in the normal course of the design cycle at the request of a System Manager, Subsystem Manager, or Technical Lead to ensure the technical team makes adequate progress toward technical milestones. "Informal" means that Peer Reviews are not milestone reviews and are not required to be captured in the project P6 milestones unless desired by the System/ L2 Manager, although charges should still be used to ensure the reviews are productive. The outcome of a Peer Review may be included as part of the technical basis for other project technical reviews.

## 5.2. System Requirements Review

A System Requirements Review (SRR) is a review process conducted to ensure that system, subsystem, and components designs have their basis in technical design requirements and interface definitions. An SRR ensures that system requirements and interfaces are properly defined and validated against characteristics defined in the System Engineering Management Plan (SEMP) [8.1], Requirements Management Plan (RMP) [8.2], Interface Management Plan (IMP) [8.3], and Technical Design Maturity Plan (TDMP) [8.4]. The requirements are validated to ensure that they are correctly flowed down from their parents, and that nothing is missing or inaccurately defined with

respect to stakeholder needs. Requirements and interface definitions flow down to points in the requirements hierarchy where they belong (i.e., systems, subsystems, components, subcomponents, etc.).

SRRs may be conducted at several points during the conceptual, preliminary, and even final design phases, with maturity of requirements and interfaces in line with the expectations in the TDMP [8.4]. It is critical that the managers and the Technical Integration Group coordinate requirement and interface development and review closely.

System / L2 Managers are the owners of their systems and responsible for ensuring that requirement and interface definitions are developed, controlled and communicated to the team. System Managers must ensure that they and the technical teams are familiar with the documents and guidance relevant to requirement and interface definition. These include the SEMP [8.1], RMP [8.2], IMP [8.3] and TDMP [8.4]. System Managers and the technical teams must closely coordinate with the EIC Technical Integration Group to develop and validate their requirement and interface definitions. Designs cannot be completed without approved requirements and interfaces. A sufficient set of requirements is always necessary to begin engineering design work. However, the complexity, scale, and schedule of the EIC Project require that engineering designs proceed as much as practical prior to finalization of all requirement and interface definitions, since the development of requirements and interface definitions, and designs will require iteration in order to be completed.

SRRs may address the following topics, and should be performed with attention to the definitions and guidance in the SEMP [8.1], RMP [8.2], IMP [8.3] and TDMP [8.4]:

- Project level (Global) requirements
- Physics requirements
- Functional requirements
- Engineering requirements
- Interface requirements
- Requirement sources/justifications (where do requirements come from)
- Requirement margins (tolerance on requirements)
- Operations requirements
- Reliability requirements
- Flow down and traceability of requirements

- Requirements validity and consistency
- Requirements verification methods
- Requirements change and configuration management status

Following an SRR, the System Manager and their team typically make corrections, additions, deletions and then submit requirements for sign off, approval and release.

## 5.3. **Conceptual Design Review [30% Design Maturity]**

The Conceptual Design Review (CDR) will assess the conceptual layout of a system or a component and will ensure that the objectives and requirements of the design are understood and that the proposed design approach will achieve its purposes. The CDR should be scheduled early enough so that the concept can be modified without a major impact on the project. The emphasis will be on the requirements and their flow down, the proposed design concept, and the definition of the major system interfaces. The review should address major design alternatives considered, the relative risk for each, and the justification for the selection.

A CDR typically addresses the following items:

- Design objectives
- Requirements
- Interfaces
- Design concept
- Engineering analyses in support of the conceptual design
- New technologies required or R&D plan and rationale
- Trade-off studies/alternatives analysis
- Preliminary safety hazards analysis/prevention through design assessment
- Lessons learned from previous projects or experience
- Risks and risk mitigation concepts
- Rough order of magnitude budget and schedule

A successful CDR allows the design effort to proceed to the preliminary design phase.

## 5.4. **Preliminary Design Review [60% Design Maturity]**

Preliminary Design Reviews (PDRs) are technical reviews intended to assure the design meets the requirements and supports a high confidence estimate of scope, cost, and schedule. Designs should be sufficiently advanced to demonstrate compliance with requirements and support an engineering cost estimate. In cases of significant complexity or potential cost or schedule impact, a PDR (or FDR, next section) may be required to guide fabrication or procurement of pre-production prototypes, engineering demonstration units, etc.

Vendor technical reviews may also be performed as part of procurement oversight. These are discussed in Section 5.7. These do not necessarily replace or obviate appropriate technical reviews prior to the start of the procurement process. Vendor technical reviews are system dependent and should be carefully considered by the cognizant managers and the system, subsystem, and components technical leads.

A PDR typically addresses the following items:

- Subsystem organizational structure and team
- Subsystem scope and deliverables
- Requirements
- Interfaces
- Preliminary design that meets the physical, functional, and interface requirements (supported by engineering documents, drawings, schematics, software, etc.)
- Analysis of expected margin to relevant requirements
- Preliminary design of specialized tooling required to manufacture, assemble, or install the components
- Assumptions and limitations of the current state of the analyses
- Lessons learned from previous projects or experience
- Preliminary quality and safety assessments
- Preliminary risk analysis and mitigations
- Preliminary cost, schedule, and staffing
- Preliminary reliability and maintainability analyses
- Preliminary validation and verification plan
- Preliminary installation and integration plan
- Preliminary procurement/manufacturing plan
- Response to recommendations from previous reviews

PDR deliverables are as specified in the Engineering Design and Review Plan for the scope element. The completion of the PDR and the response to recommendations generated by the review establish the basis for proceeding with the final design phase.

## 5.5. **Final Design Review [90% Design Maturity]**

Final Design Reviews (FDRs) are technical and programmatic reviews conducted to give assurance that the completed design achieves all requirements, satisfies all interface requirements, and ensures that fabrication and/or procurements are ready to proceed with minimum risk of change orders. In cases of significant complexity and/or cost, an FDR may be required to guide fabrication or procurement of pre-production prototypes, engineering demonstration units, etc.

Vendor technical reviews may also be performed as part of procurement oversight. These are discussed in Section 5.7. These do not necessarily replace or obviate appropriate technical reviews prior to the start of the procurement process. This is system dependent and should be carefully considered by the cognizant managers and the system, subsystem, and components technical leads.

Final Design Reviews typically address the following items:

- Subsystem organizational structure and team
- Subsystem scope and deliverables
- Verification and validation that the final design meets requirements and interfaces
- Final engineering design (models, drawings, physical, functional, and interface requirements and schematics, etc.) that meets physical, functional, and interface requirements
- Prototype verification test results that demonstrate functionality and/or technology readiness needed to start production, if applicable
- Final procurement/manufacturing plan
- Final design of specialized tooling required to manufacture or install the components, and associated procurement plan
- Quality assurance/control plans that include requirements for parts and material selection inspection, acceptance, and process control during manufacturing and assembly
- Final safety assessment
- Final risk analysis and mitigations
- Reliability and maintainability analyses

- Final validation and verification plan
- Final installation and integration plan
- Transportation plans, if applicable
- List of code compliances and associated documentation
- Updated cost, schedule, and staffing
- List of identified outstanding problem areas/open issues
- Lessons learned from previous projects or experience
- Responses to recommendations from previous technical reviews

FDR deliverables are as specified in the Engineering Design and Review Plan for the scope element. The completion of the FDR and the response to recommendations generated by the review establish the basis for proceeding with the implementation phase.

## 5.6. **Procurement Readiness Review**

Procurement Readiness Reviews (PRRs) are reviews held prior to initiating the procurement cycle of critical, high-value, or other procurements. This final check ensures that the appropriate level of technical review has occurred, that the procurement documentation package, in particular Statement of Work (SOW) and Specification documents are complete and satisfies requirements, and that the procurement and technical teams are aligned to accomplish major procurements prior to formal solicitation.

The process and requirements for the PRR are specified in the TJNAF Master Acquisition Plan [8.5] and the EIC-PSD-PLN-005, Procurement Plan [8.6], according to each lab's procurement process requirements.

For an In-Kind Contributor (IKC), a PRR will consist of a review of the technical documents only.

## 5.7. **Vendor Technical Reviews**

Vendor PDR, FDR and MRR may be used as part of procurement and vendor oversight for procurements where the vendor performs design activities and/or iterates the design with the EIC technical representative and team. Vendor PDR, FDR and MRR requirements must be specified in the SOW for the procurement contract; the requirements, timeline, roles and responsibilities, scope, etc., for the reviews should be explicitly described, as well as, the requirement for the vendors to adhere to the relevant sections of this plan. The vendor design cycle is established during contract execution phase. The goals of the vendor PDR, FDR, and MRR following a procurement contract award are the same as described in this document, but the actual review process is specific to the vendor with guidance from the laboratory holding the contract. When these reviews are implemented, design review deliverables are cooperatively defined between the partner lab and the vendor as early as possible.

Vendor technical reviews do not replace or obviate appropriate technical reviews prior to the start of the procurement process. This is system dependent and should be carefully considered by the cognizant system managers and the system, subsystem, and components technical leads.

## 5.8. **Manufacturing Readiness Review**

Manufacturing Readiness Reviews (MRR) may be required prior to the start of component manufacture. MRRs are required prior to component manufacture where changes occur to designs, specifications, or requirements following FDR. This can occur for example when a change is identified which improves manufacturability. MRRs are not required for all system, subsystem, and components, but should be conducted for complex, high-risk, or highly technical system, subsystem, and components and included as milestones at the discretion of the System Manager. MRRs are valuable when design improvements for manufacturability are identified post-FDR. MRRs also ensure the fabrication effort produces what the project requires using the latest technical information. The successful conclusion of an MRR authorizes component manufacturing to begin.

The completion of the MRR and the response to recommendations generated by the review establish the basis for proceeding with the manufacturing phase.

For IKC, an MRR will consist of a review of the manufacturing documents only.

An MRR will typically contain the following items and address:

- Final of bill of material and parts list
- Final released manufacturing drawings for assembly, test, and handling fixtures
- Final production verification test plans, inspection and test travelers, and associated QA/QC documents such as travelers, component routing and handling procedures
- Final plans for manufacturing workflow, including scheduling
- Cost and schedule updates based on manufacturing workflow plan details
- Final manufacturing control documents

MRR deliverables typically include:

- Project
  - Updated production schedule
  - Updated procurement cost

- Design
  - Final approved manufacturing drawing sets and technical specification documents
  - Final design files for all electronic items
  - Final assembly procedures and travelers
  - Final integrated component technical specification

- Production
  - Final Bill of Materials and parts list
  - Final Manufacturing and Inspection Plan
  - Manufacturing control documents identifying hold points
  - QC Plan
  - Weld Procedure Specification
  - Weld Procedure Qualification
  - Procedure Qualification Record
  - Quotation or purchase order descriptions for procured items integrated during component manufacture
  - Final transportation and delivery instructions

- Acceptance and Verification
  - Final Acceptance Criteria Document
  - Final Verification Test Plan and Procedure describing all tests to verify subsystem code compliance, requirements, and interfaces

## 5.9. **Transportation Readiness Review**

Transportation Readiness Reviews (TRRs) are held to ensure that sensitive equipment can be safely transported both onsite and from production facilities (partner laboratories and institutions, industrial partners, IKC, etc.) to BNL or other designated facility. TRRs should be held for complex or delicate devices where standard packaging/crating considerations are inadequate (e.g., cryomodule transport). The review should be scheduled with enough time before the end of production (start of transportation) to allow the final design, review, and fabrication of appropriate transportation fixtures, shipping frames, and other required equipment. In some cases, a separate design cycle with milestone reviews may be required for the shipping tooling depending on complexity. TRRs will typically contain the following scope items and address:

- Demonstrate that the plan adequately protects equipment from damage
- Determine whether transportation risks are well understood
- Demonstrate that the transportation plans conform to relevant laws and safety regulations
- Determine whether staffing, descriptions of roles and responsibilities, and resource allocation is adequate
- Determine whether the monitoring/verification plan is adequate to verify successful transport
- Lessons learned from previous projects or experience

Typical TRR Deliverables include:

- Project
  - Updated Risk Register

- Design
  - Engineering analysis to assess component risk (including FMEA or equivalent)
  - Transportation Requirements Specification detailing criteria required to protect all components during transport
  - Shipping infrastructure design and analysis

- Transportation Plan
  - Analysis of transportation method
  - Analysis of travel route
  - Instrumentation and data collection plan
  - Instrumentation specifications
  - Rigging, handling and transportation procedure

- Procurement
  - Key shipping contract provisions
  - Shipping contractor evaluation criteria

- Acceptance and Verification
  - Acceptance Criteria Documents
  - Verification Test Plan
  - Draft Verification Procedures

### 5.10. **System Acceptance Review**

System Acceptance Reviews (SARs) enable the transfer of ownership and technical risk associated with deliverables to the EIC Project. SARs are used for all IKC deliverables and may be utilized for other scope as well (though acceptability of components procured under contract is typically addressed through the inspection process or contractually-required factory acceptance testing).

SARs occur in two phases and are defined as SAR1 and SAR2 with each identified by the milestone in the schedule. Prior to delivery to the project, each IKC, with the support of the cognizant System/L2 and Subsystem Managers, will conduct a SAR1 to allow the project to formally review and accept the deliverable. At the completion of the SAR1, the IKC confirms the deliverable meets all technical specifications, requirements, and acceptance criteria, and that all documentation is complete. The EIC Project also confirms that the documentation is complete and authorizes the IKC to ship.

The Project conducts a SAR2 after an IKC deliverable arrives at BNL (or other designated location) for integration, and confirms that the deliverable meets all technical specifications, requirements, and acceptance criteria after transportation and that all documentation is received and complete as agreed upon in the EIC Project Planning Document (PPD). At the completion of the SAR2, the ownership of the deliverable shall be documented and transferred where appropriate.

SARs will confirm the following:

- Acceptance criteria are verified and documented
- Non-conformances are resolved and accepted
- Vendor-supplied documentation is complete, including as-built documentation
- IKC-produced documentation, including travelers, test reports, and bills of materials, are complete

## 6. REVIEWS FOR INFRASTRUCTURE

The design and construction of the conventional facilities follow a Construction Manager/General Contractor project delivery method where a Construction Manager is involved in the design development process with the Architect-Engineering firm and the Construction Manager oversees scheduling, cost control, constructability, project management, building technology, the bidding on or negotiating of construction contracts and construction.

EIC Project members and Laboratory stakeholders are responsible to review and approve the design at the 30% preliminary design (1st step), 60% preliminary design (2nd step), 30% detailed design (3rd step), 60% detailed design (4th step) and 90% detailed design (5th step) in accordance with the schedule milestones in statement of work document EIC-IFD-SOW-004, "Architectural and Engineering Services." [8.7] For the purpose of this Technical Review Plan only the 60% preliminary design, 30% detailed design and 60% detailed design are considered in establishing equivalencies to the reviews established for the accelerator and detector scope which verify technical maturity; the 60% Detail Design Review is equivalent to a CD-2 review, and the 90% Detail Design Review is equivalent to a CD-3 review. The submittal-ready levels of maturity are defined below. All technical information associated with these reviews are collected and distributed electronically to the stakeholder reviewers.

The technical reviews for the EIC Conventional Facilities (CF) scope are conducted using the Standards-Based Management System (SBMS) subject area Engineering Design, pending development of EIC project specific design control procedures. The SBMS subject area Engineering Design procedure may be supplemented with EIC project specific guidance and/or Architect-Engineering firm specific guidance related to stakeholder identification and participation.

### 6.1. 30% Conceptual Design Review [Equivalent to 60% Preliminary Design (2nd step)]

A lab-wide comment and compliance review following the SBMS subject area Engineering Design is held to assure the preliminary design meets the technical requirements. The 60% conceptual design review is submitted when the overall conventional facility design is approximately 20% completed. Please note that a design review is not conducted for the EIC accelerator and experimental detector at 20 % Design Maturity, thus this review is distinctive for Infrastructure. This review is intended to review the preliminary designs for 1) appropriateness of proposed systems, 2) impacts on existing systems and operations, 3) specific technical requirements to be incorporated into the design and 4) compliance with best and required practices of authorities having jurisdiction in the area of fire protection, building code and SBMS compliance. and environment, safety, and health.

### 6.2. 60% Preliminary Design Review [Equivalent to 30% Detail Design (3rd step)]

A lab-wide comment and compliance review following the SBMS subject area Engineering Design is held to assure the preliminary design meets the technical requirements. The 30% detailed design review is submitted when the overall conventional facility design is approximately 30% completed and is equivalent to Preliminary Design Review (60 % Design Maturity) described in section 5.3. This Design Maturity is considered a further advancement of the conceptual design completed prior to CD-1 approval. This review is intended to review the detailed designs for 1) appropriateness of proposed systems, 2) impacts on existing systems and operations, 3) specific technical requirements to be incorporated into the design and 4) compliance with best and required practices of authorities having jurisdiction in the area of fire protection, building code and SBMS compliance. and environment, safety, and health.

### 6.3. 90% Final Design Review [Equivalent to 60% Detail Design (4th step)]

A lab-wide comment and compliance review following the SBMS subject area Engineering Design is held to assure the preliminary design meets the technical requirements. The 60% detailed design review is submitted when the overall conventional facility design is approximately 60% completed and is equivalent to the Final Design Review (90% Design Maturity) described in section 5.5. At 60% Design Maturity the Infrastructure scope is considered stable and sufficiently mature to support development of the project baseline and performance of a Final Design Review with 80 – 90 % confidence. This review is intended to review the detailed designs for 1) appropriateness of proposed systems, 2) impacts on existing systems and operations, 3) specific technical requirements to be incorporated into the design and 4) compliance with best and required practices of authorities having jurisdiction in the area of fire protection, building code and SBMS compliance. and environment, safety, and health.

## 6.4. **Procurement Readiness Review [Equivalent to 90% Detail Design (5th step)]**

Under the CM/GC project delivery model the construction manager retains the responsibility for subcontracting and procurement of materials for the project, having the design reach the complete maturity. Per statement of work document EIC-IFD-SOW-007, "Construction Manager/General Contractor (CM/GC) Services" [8.8] the CM/GC shall procure materials for construction in accordance with their approved Quality Assurance Plan which is expected to include procedures and/or internal processes equivalent to a Procurement Readiness Review. For subcontracting and procurement of materials outside of the scope of the CM/GC a procurement readiness review will only apply to high value equipment required for conventional facilities under the responsibility of BSA to execute (i.e., CF long lead procurement items). A PRR is held to initiate the procurement cycle for owner furnished high value capital equipment and subcontracts. The PRR for CF elements will include the following:

1. EIC Infrastructure signoff of the construction specifications and/or the procurement specifications for high value owner furnished capital equipment and subcontracts that indicates the documents are ready to be issued for procurement.
2. Review by BNL Procurement and Property Management of the solicitation documents to ensure they are ready for competitive solicitation.

This review milestone is complete when the deliverables identified above are completed.

## 6.5. **Manufacturing Readiness Reviews**

Under the CM/GC project delivery model the construction manager retains the responsibility for subcontracting and procurement of materials for the project. Per statement of work document EIC-IFD-SOW-007, "Construction Manager/General Contractor (CM/GC) Services" [8.8] the CM/GC shall procure materials for construction in accordance with their approved Quality Assurance Plan which is expected to include procedures and/or internal processes equivalent to a Manufacturing Readiness Review. For subcontracting and procurement of materials outside of the scope of the CM/GC a manufacturing readiness review will only apply to high value equipment required for conventional facilities under the responsibility of BSA to execute (i.e., CF long lead procurement items).

This review milestone is complete when the MRR deliverables defined in section 5.7 are completed.

## 6.6. **Transportation Readiness Reviews**

Under the CM/GC project delivery model the construction manager retains the responsibility for subcontracting and procurement of materials for the project and transportation of materials for the project. Per statement of work document EIC-IFD-SOW-007, "Construction Manager/General Contractor (CM/GC) Services" [8.8] the CMGC shall procure materials for construction in accordance with their approved Quality Assurance Plan which is expected to include procedures and/or internal processes equivalent to a Transportation Readiness Review. For subcontracting and procurement of materials outside of the scope of the CMGC, a transportation readiness review will only apply to high value sensitive equipment required for conventional facilities under the responsibility of BSA to execute (i.e., CF long lead procurement items).

## 6.7. **Beneficial Occupancy Readiness Evaluation**

Beneficial Occupancy Readiness Evaluation process is completed as part of the transfer of the conventional facilities to operations, accelerator and detector. This process is conducted using the Standards-Based Management System (SBMS) subject area Readiness Evaluations. The procedure for Beneficial Occupancy Readiness Evaluation (BORE) ensures that the workspace meets the requirements for environment, safety, and health before use.

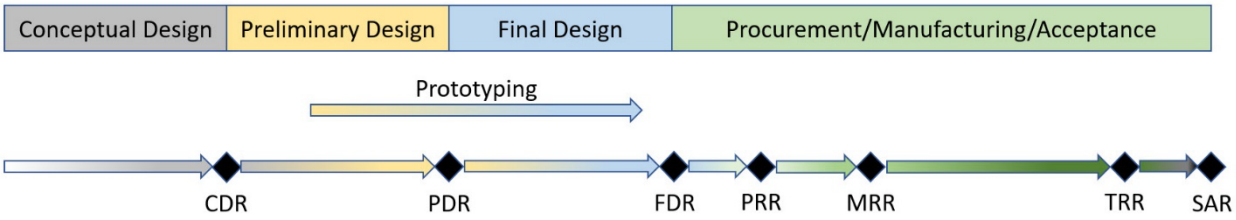
This review milestone is complete when the BORE process is completed.

## 7. REVIEW SEQUENCES

A tailoring approach to technical reviews should be taken to ensure that the technical reviews of a given scope are beneficial and productive, and that design maturity is adequately assessed. System Managers, with concurrence from the cognizant project managers, Technical Integration Group, and engineering leads, will determine the specific set of reviews required, their sequence and the design deliverables subject to review. Design reviews and their deliverables are itemized in the respective Engineering Design and Review Plans.

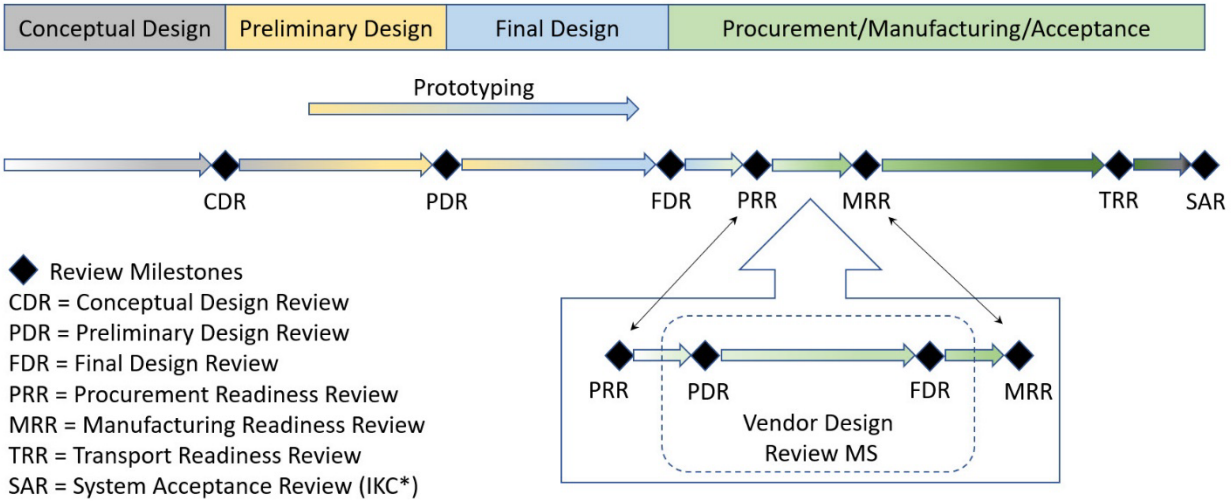
Examples of typical technical review milestone sequences are shown below as a reference.

### 7.1. Technical Review Milestones for Accelerator/Detector/IKC

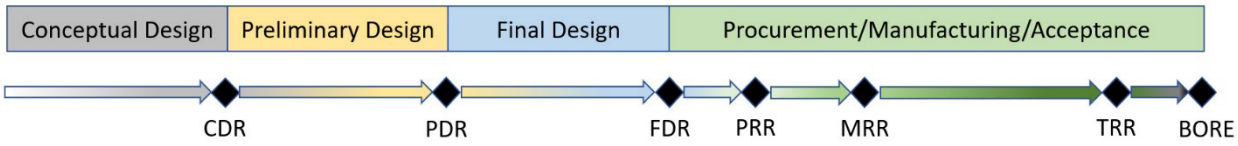



◆ Review Milestones
CDR = Conceptual Design Review
PDR = Preliminary Design Review
FDR = Final Design Review
PRR = Procurement Readiness Review
MRR = Manufacturing Readiness Review
TRR = Transport Readiness Review
SAR = System Acceptance Review

## 7.2. Technical Review Milestones for Vendor Contracted Design and Manufacture




## 7.3. Technical Review Milestones for Infrastructure




Review Milestones
CDR = Conceptual Design Review (equivalent to 60% Preliminary Design*)
PDR = Preliminary Design Review (equivalent to 30% Detail Design*)
FDR = Final Design Review (equivalent to 60% Detail Design*)
PRR = Procurement Readiness Review
MRR = Manufacturing Readiness Review
TRR = Transport Readiness Review
BORE = Beneficial Occupancy Readiness Evaluation (not defined in this document)

** In accordance with the with the schedule milestones in statement of work document EIC-IFD-SOW-004, "Architectural and Engineering Services".*

## 8. REFERENCES

8.1 EIC-SEG-PLN-022, System Engineering Management Plan
8.2 EIC-SEG-PLN-016, Requirements Management Plan
8.3 EIC-SEG-PLN-020, EIC Interface Management Plan
8.4 EIC-SEG-PDN-010, Technical Design Maturity Plan
8.5 EIC-PRG-PLN-002, TJNAF Master Acquisition Plan
8.6 EIC-PSD-PLN-005, Procurement Plan (next revision)
8.7 EIC-IFD-SOW-004, Architectural and Engineering Services
8.8 EIC-IFD-SOW-007, Construction Manager/General Contractor (CM/GC) Services