

Technical Evaluation Study

Next Generation Nuclear Plant Design Control White Paper



The INL is a U.S. Department of Energy National Laboratory
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Idaho National Laboratory

**NEXT GENERATION NUCLEAR PLANT
DESIGN CONTROL WHITE PAPER**

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1. PURPOSE

This white paper outlines the objectives, guidance, and a suggested process for a Design Control program. The design control program will mature and expand as the design proceeds through the Definition, Execution, and Transition/Closeout Phases for the NGNP. The Project Phases and corresponding Critical Decision points used in this White Paper are defined in DOE O 413.3A, *Program and Project Management for the Acquisition of Capital Assets*. It should be understood that, while this white paper may provide a pattern for developing elements of the configuration management plan, it should not be construed in any way as absolutely prescribing the content of that plan nor the nature of future configuration management process.

The design control program includes provisions to control design inputs, outputs, changes, interfaces, records and organizational interfaces within the NGNP and vendors for items that are subject to the provisions of the Quality Assurance Program Plan PLN-2021, Project No. 23843 “Quality Assurance Program Plan (QAPP) for the Next Generation Nuclear Plant Project (NGNP).” These provisions assure that design inputs (such as design bases and the performance, regulatory, quality, and quality verification requirements) are correctly translated into design outputs (such as analyses, specifications, drawings, procedures, and instructions) so that the final design output can be related to the design input in sufficient detail to permit verification.

Currently, design control of the NGNP conceptual design process is rather complex in that three independent reactor vendors are concurrently working on reactor designs but in isolation to one another. Design Control and configuration management of the detailed design process will be performed by the vendors per their Quality Assurance Programs. Thus, the elements of Design Control specifically addressed within this paper are:

- A. Establishment of the technical Design Baseline
- B. Establishment a line of a technical communications interface for Design Control
- C. Identification of the Design Control methodologies.

2. ESTABLISHING A DESIGN BASELINE FOR THE NGNP PROJECT

An established design baseline provides traceability throughout the design process and is the critical element in maintaining the connection between the conceptual design and system alternatives through preliminary design to final design and construction. The earlier the design baseline can be identified and defined, the more effectively and efficiently the NGNP project will progress through the various design phases and meet project baselines, agreements, and commitments. The design baseline ultimately forms the foundation for the entire NGNP program.

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2.1 Design Baseline Documentation

One key issue is the identification of design documents that are required to be managed under the design control program. At a minimum the design baseline will be “snapped” at defined milestones (Critical Decision points) throughout the design process. Additional design baselines may be snapped as necessary to support other NGNP objectives including the development of licensing and environmental submittals. The design baseline may be revised in between these milestones as addressed in Design Control Methodology.

The Design Phases and Critical Decision points addressed by this paper are:

2.1.1 Definition Phase

CD-1: Completion of the project Definition Phase, the time in which the conceptual design is developed. This is an iterative process to define, analyze, and refine project concepts and alternatives. This process uses a systems methodology that integrates requirements analysis, risk identification and analysis, acquisition strategies, and concept exploration to evolve a cost-effective, preferred solution to meet a mission need.

2.1.2 Execution Phase

CD-2: Completion of preliminary design is the first major milestone in the project Execution Phase. Preliminary design is complete when it provides sufficient information for development of the Performance Baseline founded on a mature design, a well-defined and documented scope, a resource-loaded detailed schedule, a definitive cost estimate, and defined key performance parameters.

CD-3: Completion of design and engineering allows for Approval of Construction. Once design and engineering are essentially complete, a final design review performed, all environmental and safety criteria met, and all security concerns addressed, the project is ready to begin construction, implementation, procurement, or fabrication.

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2.1.3 Transition/Closeout Phase

CD-4: Completion of criteria defined in the Project Execution Plan and approval of transition to operations. This decision is predicated on the readiness to operate and/or maintain the system, facility, or capability. Transition and turnover does not necessarily terminate all design activity. Rather, it marks a point at which the operations organization assumes responsibility for Design Control.

2.2 Controlled Software

Computer software will play an essential part to nearly all aspects of the design, development, construction, and operation of the NGNP program. Computer software used in the NGNP design will be managed and controlled over its entire life cycle in a manner consistent with the requirements of Subpart 2.7 of NQA-1 and applicable IEEE Standards for Information Technology (IT) software, as described in the NGNP QAPP. All software will be developed in a traceable, planned, and orderly manner.

NGNP vendors who develop computer software will have an established process to manage and control the software development in accordance with the NGNP Standard for Software Management. Documentation requirements for software used in the NGNP Project are considered part of the design baseline.

3. DESIGN CONTROL INTERFACE

As a part of the design control program key interfaces are identified to coordinate the design efforts among participating organizations. The interface controls identify the assignment of responsibility among participating design organizations.

3.1 Design Authority

The Idaho National Laboratory (INL), under the direction of the DOE, will lead the development of the NGNP by integrating, conducting, and coordinating all necessary research and development (R&D) activities and by organizing project participants. The INL is also the established Design Authority (DA) for the NGNP Program.

In implementing the DA role, individual engineers, known as Cognizant Engineers (CE) will be assigned. The CE will be responsible for oversight of work plans that contain the Statements of Work (SOWs) that identify conceptual design requirements. The CE will ensure that design output documents accurately reflect the design basis of the work plans. The CE will be the primary technical contact to the vendors design organization and will participate in vendor design peer reviews.

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3.2 Design Agency

Individual vendors will serve as the design agency responsible for the performance of the design activities, particularly those associated with design analysis and calculations.

Within the design agency, Cognizant Design Engineers (CDE) will be the direct counterpart to the CE. The CDE will be directly responsible for the design control. The CDE will ensure design control and ultimate technical adequacy of the vendors design process. CDE roles and responsibilities for design control include:

- Point of contact for any document change against the design baseline
- Initiates the design change approval process
- Organizes and conducts all peer design reviews.

4. DESIGN CONTROL METHODOLOGY

Design control for NGNP consists of managing both Design Inputs, including INL and external requirements, and Design Outputs reflecting the current Technical baseline. Change control of all baseline design documents will be achieved through design/document reviews and a formal change control program. Design inputs will be transmitted by the CE to the CDE via formal documents controlled in accordance with NGNP Document Control procedures.

4.1 Design Control During Project Definition

Establishment of the CD-1 Technical Baseline will be through vendor issuance and CE acceptance of the Conceptual Design Report and supporting design and safety documentation.

Vendor initiated changes to the CD-1 technical baseline will be controlled by CDE and will require submittal of revised documents to the CE for acceptance. This process will be used from the start of conceptual design process until the establishment of the CD-2 Design Baseline.

4.2 Design Control During Project Execution**4.2.1 Design Control of CD-2 Design Baseline**

Once the Design Baseline is established at CD-2, subsequent design changes impacting the baseline will occur though the following methodology:

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The CDE will initiate a Design Change Notice (DCN; see Figure 1).

The DCN will be reviewed by all affected organizations to ensure that the design approach is adequate and that the proposed design change is in compliance with applicable calculations, analysis, special tests, and material requirements of the baseline design.

The CDE will ensure the approved DCN and subsequent documents meet the following criteria:

- The DCN clearly documents design change requirements against the baseline design
- Appropriate codes and standards, including the requirements of the baseline design criteria, are properly identified and applied in the design change
- All appropriate drawings, specifications, instructions, sketches, and engineering specification changes are based on the baseline design requirements
- An independent technical review is considered for the design change
- All potentially affected groups have reviewed the design change package
- If applicable, all calculations or analyses performed to substantiate the adequacy of the design change are independently reviewed
- All other effected design documents have been identified and changed.

During implementation of a design change, the CDE will ensure that:

- Complete records are available documenting the design change, changes to the design documents subsequent to the baseline design, and final approval of the design change package.
- Design records include substantiation of intermediate steps in the design process, such as calculations, computer programs, and pertinent testing.

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- If the design change required a change in materials, components, or equipment, like for like or better substitutes were identified, approved, and documented (vendor data traceability).
- If acceptance testing was performed, the testing verified that the design change met the original design requirements.
- All documents that define the SSC configuration have been revised to reflect the design change.
- No other related support systems are affected by the documented DCN.

The DCN will be the governing document to initiate any change to approved design baseline documents. Design documents consist of any document that required peer review and approval, such as specific SSC drawings, piping and instrumentation diagrams, bases for design, electrical one-line drawings, process flow diagrams, and floor plans with typical sections and details. All engineering calculations, analyses, and special tests will be documented as specific design records, such as engineering specifications or special fabrication/construction procedures.

4.2.2 Design Control of CD-3 Design Baseline

Once the Technical Baseline is established at CD-3, subsequent changes to the managed by a design control process in accordance with “10 CFR 50.59”.

4.3 Design Control During Project Transition/Closeout

The Design control methodology employed during the Transition/Closeout phases will be developed by the operations organization.

5. REFERENCES

10 CFR 830.122, 120 [10 CFR 830, Appendix A].

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants*.

DOE O 414.C, *Quality Assurance*

DOE-STD-1073-2003, *Configuration Management*

DOE-STD-1189-2008, *Integration of Safety into the Design Process*

LWP-10200, “Calculations and Analysis”

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LWP-10400, "Design Control"

MCP-13910, "Reviewing and Approving Documents and Records"

NQA-1-2000, *Quality Assurance Program Requirements for Nuclear Facilities*

NQA-1-2000, Requirement 3, *Design Control*

PLN-2021, "Quality Assurance Program Plan (QAPP) for the Next Generation Nuclear Plant Project (NGNP)"

STD-10011, "Drawing Requirements Standard"

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Design Change Notice (DCN)

DCN Initiator: _____ DCN No. _____

WBS SSC Description

Initial WBS SOW Work Plan No. _____

Cognizant Vendor Design Engineer: _____ Date _____

Design Change Quality Level: _____ Determined By: _____ Date: _____

Design Change Request Description (Baseline design change):

Justification:

Design/Document Change effect on other WBS Systems, Schedules, Budgets:

Design Change Quality Level: _____ Determined By: _____ Date: _____

This change will effect:

Facility/System Design Description Analysis, Calculations, on design baseline
 Schedules Budget

Cognizant Owner Engineer:

Changes consistent with SOW requirements. _____ y/n

All sketches, drawings and documents revised logged and documented within the WBS library _____ y/n

Major changes that affect cost and schedule are properly identified and reported to management _____ y/n

Does the change affect contractual agreements _____ y/n

Approvals

Cognizant Design Engineer:----- Date _____

Vendor Engineering Manager:-_____ Date _____

Cognizant Owner Engineering : _____ Date _____

Other: _____ Date _____

CDCN Approved _____ Not Approved _____

Figure 1, Example design change notice