

# Lockheed Martin Energy Research Corporation Oak Ridge National Laboratory

## STANDARD OPERATING PROCEDURE

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**NUMBER: SOP-ENG-04**

**REVISION: 0**

**DATE: March 26, 2002**

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### DESIGN VERIFICATION

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#### I. PURPOSE

To define the process used at Oak Ridge National Laboratory (ORNL) to ensure that engineering design is technically adequate, addresses the hazards identified, and that the resulting system, structure, or component will be fit for its intended use. Design verification is also commonly referred to as checking. Design verification methods include, but are not limited to:

- 1) document design check, or
- 2) alternate calculation, or
- 3) qualification testing.

#### II. DEFINITIONS

- A. Alternate Calculation: A separate calculation used to verify that the results of the original calculation are correct.
- B. Designer: The designer is the person responsible for generating the design documents for an engineering project. The designer is responsible for resolving and incorporating all design review comments into the design documents. Typically, the designer is ultimately responsible for the design documents and their technical content.

- C. Document Design Check: A document design check is a detailed discipline verification within that particular engineering discipline performed by the discipline verifier/checker to ensure that the design documents mitigates the project hazards, and meets system requirements and the established design criteria. Documents design checks can include a combination of the following: calculations signed by the verifier/checker, drawings signed by the same verifier/checker as verified the calculations, design review comment forms, and redlined design documents (drawings, calculations, specifications, etc.).
- D. Qualification Testing: Implementation of a detailed set of test conditions and criteria to verify the adequacy of performance of a design under the established conditions. Qualification testing is usually performed on a prototype design.
- E. Verifier/checker: The verifier/checker checks the design documents to confirm it is technically adequate and the resulting system, structure, or component will be fit for the intended use, mitigate the hazards and that the proper standards have been used in mitigation of the hazards. The verifier/checker must be someone different from the designer. Verifying/checking is a technical verification of design documents, not simply a drafting check. Depending on the management of a project, the verifier/checker can be ultimately responsible for the design documents. Verifier/checker responsibilities must be determined at the beginning of the project.

### III. REQUIREMENTS

#### A. Verification

Individuals or groups other than those who performed the work shall perform the verification. The verifiers shall have sufficient technical skills and competence to have originated the work being verified (References A, B, and C). Verification may commence prior to the completion of the design and the verified document may include assumptions. The verification may range from a detailed check of an entire design package or analysis to a limited check of the design approach and the results obtained.

1. For nuclear facilities - All documents require verification. Verification shall be performed using a graded approach (see Section III.B, Graded Approach, below). The design documents shall be verified and approved prior to implementation of the design (References A and B). Revisions and temporary modifications are to be verified and approved to the same verification criteria as the original issue (References B and C).
  - a) Nuclear Facility: A facility at ORNL that has been categorized as Category 1, 2, or 3 by the DOE-STD-1027-92 Change 1, Hazard Categorization and Accident Analysis Techniques for compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports, criteria
2. For non-nuclear facilities - All documents shall be verified based on the graded approach. The verifier's approval of the design document confirms concurrence of the approach and the level of detail of the verification performed is appropriate for the project and its safety significance. Design verification shall be completed before design output is used by other organizations or to support other work such as procurement, manufacture, and construction. Revisions and temporary modifications shall be verified according to their project and safety significance.

3. Design Work Performed By Outside Organizations - Design verification for all documents generated by an architect-engineer (AE) or vendor is responsibility of the AE or vendor organization. AE's and vendor's design management shall approve all design documents.
  - a) ORNL shall review AE design documents per SOP-D-.07, AE Milestone Design Reviews.

B. Graded Approach

1. A graded approach should be utilized when performing verification work.
2. A graded approach is a process by which the level of analysis, documentation, and actions are commensurate with some or all of the following factors:
  - a) The relative importance to safety, safeguards, and security;
  - b) The magnitude of any hazard involved;
  - c) The life cycle stage of a facility;
  - d) The programmatic mission of a facility;
  - e) The particular characteristics of a facility;
  - f) The economic impact; and
  - g) Any other relevant factors.
3. The intent of the graded approach is to permit the flexibility to implement activities and processes, as appropriate, to comply with the requirements (including safety) for the individual facilities, in a cost-effective manner.
4. The graded approach, when used for a nuclear facility, does not eliminate any nuclear safety requirements. Whenever a graded approach is applied in meeting a nuclear safety requirement, the bases for selecting an action pursuant to the graded approach shall be documented (references A and B) and the nuclear facility's Design Authority shall approve the selected graded approach.

IV. PROCESS

A. The designer:

1. Develops the design documents in accordance with the appropriate procedures, system requirements and design criteria.
2. Along with project management and the appropriate facility design authority, determines and coordinates the design reviews, interface reviews and approval signatures and stamping.
3. Resolves comments by the verifier/checker, other reviewers, and supervision/design management and incorporates agreed upon comments into the design documents.
4. Obtains approval signatures.
4. Forwards the approved original design documents to the Project Manager for issue and distribution and for transmittal to Records Management.

B. The verifier/checker:

1. Receives the design documents from the designer.
2. Checks the design documents to confirm it is technically adequate and the resulting system, structure, or component will be fit for the intended use and mitigates hazards. The verification effort typically includes confirming the design documents comply with the requirements of the project Design Criteria, and/or the Systems Requirements Document. Attachment A is a list of general items to be considered during the verification process.
3. The verifier/checker communicates comments to the designer by using any of the following: design review comment forms (Attachment B or C), email, redline mark-ups, or other means depending on the project.
  - a) Alternate calculation method, the verifier/checker:
    - i. Reviews the original calculation to assess the appropriateness of assumptions, input data, and the calculation method;
    - ii. May perform a simplified or less rigorous approach, such as a hand calculation, to check computer analysis/software or utilize a different computer software.
    - iii. Attaches the alternate calculation to the original design package upon completion of the verification and summarizes the results.
4. The design and verifier/checker resolve all comments.
5. The verifier/checker approvals on drawings are documented by the verifier/checker's signature/initials in drawing title block and/or revision block.
6. The verifier/checker approvals on calculations are denoted by verifier/checker's initials on calculation sheets and/or signature on a Design Analysis Calculation (DAC) cover sheet (see reference C).
7. For Qualification testing, the verifier/checker:
  - a) Defines and documents the systems to be tested, the specific testing sequence, and the test procedures. Test requirements and acceptance criteria, unless otherwise designated, shall be specified and approved by the organization/discipline responsible for the design of the item to be tested.
    - i) When tests are to be performed on models or mockups, scaling laws shall be established and verified. The results of model test work shall be subject to error analysis, where applicable, prior to use in final design work.
    - ii) Tests required to verify conformance of a prototype to specified requirements and to demonstrate satisfactory performance shall be specified in the Engineering Specification, Test Plan, Purchase Requisition, other documents, or a combination of documents.
  - b) Verifies the test results to confirm the adequacy of the design documents to perform its intended function.

C. Supervisor/Design management:

1. Assures the level of verification is appropriate for the design documents based on the type of facility and the graded approach selected,
2. Assures the design documents are verified by the appropriately qualified engineers, or designers,
3. Assures the design documents meet the intent of the system requirements, are consistent with standard practices, have clarity of presentation, and have had the appropriate safety reviews.

D. Project Engineer:

1. Issues the design documents certified for construction (CFC) when assured the design documents meet project scope, cost, and schedule,
2. Transmits copies of the approved design documents to the entire design team and sends the originals to Records Management.

V. REFERENCES

- A. ORNL-QA-P02, ORNL Nuclear Quality Assurance Plan
- B. 10CFR Part 830 Final Rule
- C. SOP-ENG-D.03, Design Analysis And Calculations

VI. ATTACHMENTS

- A. Attachment A, Design Verification Considerations
- B. Attachment B, Design Review Comments (Word Format)
- C. Attachment C, Design Review Comments (Excel Format)

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Approved by:

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Director, Engineering

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**ATTACHMENT A**

**DESIGN VERIFICATION CONSIDERATIONS**

## DESIGN VERIFICATION CONSIDERATIONS

1. Were hazards identified and engineering controls utilized to the maximum extent practical?

Primary types of hazards:

- A. Industrial and construction safety hazards
- B. Chemical safety hazards
- C. Ionizing radiation safety hazards
- D. Non-ionizing radiation safety hazards;
- E. Toxic materials/hazardous materials/ hazardous wastes;
- F. Discharges to air, water and land;
- G. Energy source hazards;
- H. Biological hazards;
- I. Fire Protection; and
- J. Natural Phenomena

2. Are the applicable Work Smart Standards (WSS), other codes, standards and regulatory requirements properly identified and are their requirements for design met?
3. Were inputs correctly selected and incorporated into design?
4. Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verification when the detailed design activities are completed?
5. Are the appropriate quality and quality assurance requirements specified?
6. Have applicable construction and operating experiences been considered?
7. Have the design interface requirements been satisfied?
8. Was an appropriate design method used?
9. Is the output reasonable compared to input?
10. Are the specified parts, equipment, and processes suitable for the required application?
11. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
12. Have adequate maintenance features and requirements been specified?
13. Are accessibility and other design provisions adequate for performance of needed maintenance and inspections?
14. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?
15. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?

16. Are adequate handling, storage, cleaning and shipping requirements specified?
17. Are adequate identification requirements specified?
18. Have design calculations and software been verified adequately?
19. Has technical design information provided by other disciplines or programs been verified by that discipline or program?
20. Has technical design information provided by an external engineering organization or vendor been confirmed and accepted by verifier?
21. Have Lessons Learned been researched and appropriately incorporated?
22. If standardized or previously proven design is used in the project, have all pertinent design inputs been verified for each application of the project?
23. Has appropriate Design Authority been included in review and comment of design and their approval forthcoming?
24. Has the design identified the need for changes to other configuration management documents? If so, have the changes been issued?



# **ATTACHMENT B**

## **Design Review Comment Form (Word Format)**

SITE ORNL	ISSUE DATE
A-E	
PROJECT NO.	ACCOUNT NO.
BLDG. NO.	STATUS REVIEW

**ENGINEERING DESIGN REVIEW RECORD**

PROJECT TITLE
JOB TITLE

ITEM NO.	DRAWING OR SPC. NO. & PARAGRAPH	COMMENTS	A-E ACTION

REVIEWED BY	DATE	PRINCIPAL ENGR.	DATE
A-E	DATE	PROJECT ENGR.	DATE

# **ATTACHMENT C**

## **Design Review Comment Form (Excel Format)**



Item#	Drawing # or Specification & Section #	Comments/Description	Comment By	AE Response	AE Response By