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| Ownership matrix | RPP-27195 |
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1.0 PURPOSE AND SCOPE

(7.1.1, 7.1.2, 7.1.3)

Use of this procedure is initiated by first following procedure TFC-ENG-DESIGN-C-52. This procedure does not stand alone, therefore it is performed in accordance with the requirements of TFC-ENG-DESIGN-C-52.

The objective of design verification is to confirm that designs conform to all design requirements and criteria.

Prior to using this procedure, the extent of design verification is determined by following TFC-ENG-DESIGN-C-52. This determination supports the graded approach by selecting design verification based on aspects of the design, such as cost, complexity, and important to safety.

If the extent of design verification is determined to be checking, this is performed in a different procedure as directed by TFC-ENG-DESIGN-C-52.

If the extent of design verification was determined to be more than checking, then design verification is conducted in accordance with this procedure.

The acceptable methods of Design Verification in accordance with this procedure are:

- [Design Verification Review](#)
- [Qualification testing](#)
- [Alternate calculations.](#)

The design verification methods invoked by this procedure ensure that:

- Proposed new designs or modifications adequately meet design criteria
- A design is technically adequate
- The design inputs have been evaluated and verified for their impact on the design
- The design meets the applicable requirements for environmental, quality, health, safety, and performance.

2.0 IMPLEMENTATION

This procedure is effective on the date shown in the header. Design verification documents that have been prepared or are in process may continue according to the previous revision. Refer to TFC-ENG-DESIGN-C-25 for other implementation considerations such as document numbers, reviews, approvals and document release.

3.0 RESPONSIBILITIES

(7.1.2)

Design verifications, with the possible exception of testing, are performed by the Design Agent. There are several individuals within the design agency that may be involved in design verification. Each of these individual roles is described in the following sections.

3.1 Engineering Manager

The manager of the Design Originator(s) is responsible for:

- Selecting the design verifier in accordance with this procedure.
- Confirming the design verification method selected by the design originator is appropriate.

3.2 Design Originator

The Design Originator (also considered the Design Agent) is responsible for:

- Determining the method of design verification
- Ensuring design verification occurs only at the appropriate design and project phases.
- Preparing, assembling, and submitting the design verification packages to the design verifier.
- If qualification testing is to be performed, verifying that a formal test plan has been established in accordance with TFC-PRJ-SUT-C-01 (or TFC-ENG-DESIGN-C-18 for technology development)

3.3 Design Verifier

(7.1.2)

The design verifier is responsible for:

- Maintaining their independence by not providing input to the design that they are verifying
- Reviewing/verifying the design submitted by the Design Originator
- Providing comments on the Review Comment Record or in SmartPlant Foundation
- Submitting the completed verification package back to the Design Originator
- Filling out the Design Verification Record form (SPF-023), available on the SmartPlant Form website
- Ensuring unverified designs, or unverified portions of the design are identified and controlled with a TBD/HOLD in accordance with TFC-ENG-DESIGN-C-25.

The Design Verifier shall:

Be technically competent to perform the review.

A technically competent individual should have experience in the design or application of comparable systems. Engineers from other projects or the engineering discipline leads should be considered for assignment as design verifier or design verification team lead.

- Not have immediate supervisory responsibility for the individual performing the design (design originator).

If the immediate supervisor is the only technically competent individual available to perform the design verification, approval shall be obtained from the next higher level of management prior to performing the design verification.
- Not have performed the original design development, including supporting calculations completed, in conjunction with the activity being verified.
- Not have specified a singular design approach or ruled out certain design approaches for the design being verified.
- Not have established the design input for the particular design being verified.

The Design Authority may perform the verification provided the Design Authority meets the requirements of the items above.

4.0 PROCEDURE

This section continues from the point where TFC-ENG-DESIGN-C-52 directs that this procedure be used to perform, or document Design Verification.

To perform design verification, continue to Section 4.1.

To document that vendor provided designs have been design verified by the vendor, proceed to Section 4.7.

4.1 General Requirements

Design Verification is a verification of an engineered design that is defined, analyzed, and implemented by engineering documents; not verification of a document. Therefore it must be performed with the document, or set of documents that represent the final design, or a portion of the final design.

4.1.1 When to Perform Design Verification

(7.1.2, 7.1.4)

Design Verification must be performed prior to releasing the final design, or a portion of the final design for:

- Procurement
- Manufacture
- Construction
- Use by another design organization
- Turnover to Operations (Final Design).

Except where this timing cannot be met, such as when insufficient data exist, in which case design verification will be performed at a later date.

In all cases, the design verification must be completed prior to relying upon the component, system, structure to perform its function.

4.1.2 Incomplete/Unfinished Design Verification

(7.1.2)

Although it is not preferable, the need may arise to release the design, or a portion of the design before design verification can be performed.

In these cases the TBD/HOLD process in accordance with TFC-ENG-DESIGN-C-25 may be used to release the design without completing design verification.

The TBD/HOLD process ensures design verification is completed before it is required to be performed. With the exception of turnover to operations to rely upon the component, system, structure to perform its function, this allows subsequent project activities to continue.

Any item or equipment procured, manufactured, constructed without completed design verification must utilize conditional accept tags in accordance with TFC-ESHQ-Q_INSP-C-04 to prevent use/operation until the TBD/HOLDS are removed by completing design verification.

4.1.3 Design Requirements Compliance Matrix

When available, a Design Requirements Compliance Matrix (DRCM) developed in accordance with TFC-ENG-DESIGN-C-42 shall be used as a tool in the design verification process.

If the DRCM contains project related (non-design) requirements, only design requirements shall be considered for design verification.

4.1.4 The Design Verification Package

Design verification is performed in the context of all engineering documents that represent or support the final design, or the portion of the final design being verified. These must be available to the design verifier. The design verifier may be provided the documents as hard copies, or a list of the documents if they are easily retrievable (e.g. SmartPlant® Foundation) by the design verifier.

For designs where portions of the design have previously been verified, the design verifier must have access to both the previously verified design documents, and the design verification package used for the previous verification.

For evaluation of new technologies for suitability of deployment, the only design information available may be performance and functional criteria (TFC-PLN-90 and TFC-ENG-DESIGN-C-34).

The design verification package includes, but is not limited to:

- All documents that establish or flow down design requirements, inputs, or criteria, such as:
 - Modification Travelers
 - Specifications

- All documents that describe, depict, or implement the design, such as:
 - Engineering Change Notices (ECNs)
 - Drawing Change Notices (DCNs)
 - Drawings
 - Specifications
- All supporting documents that analyze, assess, or qualify or otherwise support the design, such as:
 - Calculations
 - Technical Evaluations
 - Reports
- Previously verified design documents, and the associated design verification package.
- DRCM in accordance with TFC-ENG-DESIGN-C-42 where available.

4.1.5 Design Verification Methods

(7.1.2)

The acceptable methods of design verification used to satisfy the requirements of this procedure are:

- Design verification review
- Qualification testing
- Alternate calculations.

Section 5.0 provides definitions of these different types of design verification. Attachment A provides guidance on selection of the design verification method.

In some cases, it may be appropriate to combine more than one design verification method to ensure all aspects of a design are adequately verified.

Qualification testing is most frequently used when an aspect of the design cannot be verified analytically. However, in some cases analytical verification is possible, qualification testing may be the preferable method for verification. This is especially true when aspects of a design are extremely difficult or time consuming to verify analytically.

Cursory supervisory reviews do not satisfy the intent of design verification.

4.1.6 Design Verification Comments

Reviewer comments should only identify inadequate or missing design inputs (requirements), or identify requirements or criteria not met. The reviewer's comments may explain why requirements are not met when necessary for clarification. However, the comments shall NOT provide proposed solutions or resolutions other than "meet requirement." The comment should indicate how the requirement is not met (e.g., the load stress is higher than the allowable stress for the material)

Otherwise, documenting and resolving comments for all Design Verification methods is performed in accordance with the Review Comment Record process in TFC-ENG-DESIGN-C-52.

4.2 Selecting the Design Verification Method and Verifier

- | | |
|---------------------|--|
| Design Originator | <ol style="list-style-type: none">1. Using Attachment A and the DRCM (if available), identify the method, or methods of design verification to be performed.2. Assemble the design verification package per Section 4.1.4.3. If the supporting documents are released, proceed to step 5, otherwise continue to the next step.4. If the supporting documents are NOT released, do one of the following:<ol style="list-style-type: none">a. Wait until the supporting documents are released, then proceed to the next step.b. If a portion of the design can be verified, identify the portion that will not be verified on the document per Section 4.1.2, and proceed to the next step.c. If the design CANNOT be verified, identify the entire design as unverified on the document per Section 4.1.2, and return to TFC-ENG-DESIGN-C-52.5. Begin filling out a Design Verification Record (DVR) form (SPF form SPF-023).6. Ensure the supporting documents required to perform design verification are identified as supporting documents on the DVR.7. Identify the scope of the design verification; the document, portion of the document, or documents being verified, AND the method or methods for design verification. |
| Engineering Manager | <ol style="list-style-type: none">8. Identify the individual responsible for the design verification. |
| Design Originator | <ol style="list-style-type: none">9. Provide the design verification package to the design verifier. |
| Design Verifier | <ol style="list-style-type: none">10. Continue to the appropriate section of the procedure to perform design verification using the method(s) identified on the DVR. |

4.3 Design Verification Review

- | | |
|-----------------|---|
| Design Verifier | <ol style="list-style-type: none">1. Using the design package, and the checklist in Figure 1, perform design verification review against the scope identified on the DVR. |
|-----------------|---|

- Document any comments per Section 4.1.6 and provide to the originator.
- Design Originator
2. Resolve comments with the Design Verifier per Section 4.1.6.
 3. Where required to close out comments:
 - a. Incorporate changes into the design package.
 - b. Perform Alternate Calculations per Section 4.4
 - c. Identify Qualification Testing per Section 4.5
- Design Verifier
4. Verify design changes, or additional design verification activities required to address comments are completed.
 5. Document completion of Design verification review per Section 4.6.

4.4 Alternate Calculations

The Design Verifier may use an alternative calculation to verify the results of a calculation produced in accordance with TFC-ENG-DESIGN-C-10.

Alternate calculations, themselves, do not require checking or additional verification.

NOTE: Unqualified software CANNOT be used to perform an Alternate Calculations as a means to verify a calculation that uses UNQUALIFIED software.

Unqualified software CAN be used to perform an Alternate Calculations as a means to verify a calculation that uses QUALIFIED software itself.

- Design Verifier
1. Ensure a Design verification review has been performed. If not, proceed to Section 4.3.
 2. Review the calculation against the Figure 2 checklist.
 3. Document any comments per Section 4.1.6 and provide to the originator.

NOTE 1: The alternate calculation must use the same inputs and assumptions used in the original calculation. However, the alternate calculation must use a different analytical methodology than the original calculation.

NOTE 2: This alternate calculation does NOT need to be performed in accordance with TFC-ENG-DESIGN-C-10.

4. Perform an alternate calculation.
- Design Originator
5. Resolve comments with the Design Verifier per Section 4.1.6.

6. If the original calculation cannot be verified;
 - a. Provide comments to the calculation originator, and request a revised calculation in accordance with TFC-ENG-DESIGN-C-10 to address the comments, then return to step 1.
 - b. If the original calculation cannot be revised, and/or subsequently cannot be verified, develop and release a new calculation in accordance with TFC-ENG-DESIGN-C-10.

Design Verifier

7. Ensure the original calculation is verified.
8. Document completion of Design verification review per Section 4.6.

4.5 Qualification Testing

Reviews in this section identify the features, characteristics, and functions that must be verified by testing.

Design Verifier

1. Ensure a Design verification review has been performed. If not, proceed to Section 4.3.
2. Identify the requirements of the design that need to, or are planned to be verified by Qualification Testing. Document these on the Design Verification Record (DVR).
3. Provide the DVR to the Design Originator.

Design Originator

- NOTE: Formal test plans are developed in accordance with TFC-PRJ-SUT-C-01, or TFC-ENG-DESIGN-C-18 for technology development.
4. Verifying that a formal test plan has been established, and that will verify the list of requirements identified on the DVR by the Design Verifier to be verified by Qualification Testing.
 5. If a test plan has not been developed, or existing test plans do not adequately verify the requirements, exit this procedure and develop a test plan, or revise existing test plans in accordance with the applicable test plan procedure.
 6. If qualification testing is completed successfully, provide the Design Verifier with final test reports, and proceed to the next step.
 7. If qualification testing is not successful, and leads to design changes, return to step 1 after redesign has been completed.

Design Verifier

8. Verify that qualification testing successfully verified the requirements listed on the DVR.
9. Where tests were performed on models or mockups, ensure scaling laws were established and verified.

10. Where applicable, ensure error analysis of results have been performed.
11. Finish filling out the DVR by referencing the test reports that document verification of the requirements.
12. Document completion of Design verification review per Section 4.6.

4.6 Documenting Completed Design Verification

- | | |
|-------------------|--|
| Design Verifier | <ol style="list-style-type: none"> 1. Complete the remaining portions of the DVR form. Attach completed checklists used for each verification method to the DVR, and approve the DVR. 2. Provide the DVR and attached checklists to the Design Originator. |
| Design Originator | <ol style="list-style-type: none"> 3. Attach the approved DVR and any additional documentation to the document. Ensure the Design Verifier is an approver on the document. 4. Return to TFC-ENG-DESIGN-C-52. |

4.7 Vendor Design Verification

This section is used to ensure that designs produced by vendors have been design verified by the vendor.

- | | |
|------------------|---|
| Project Engineer | <ol style="list-style-type: none"> 1. Fill out the Design Verification Record (DVR) form (SPF form SPF-023) for the sections applicable to vendor produced designs. 2. Attach the DVR to the associated MT and return to TFC-ENG-DESIGN-C-52. |
|------------------|---|

5.0 DEFINITIONS

Alternate calculation. A method of verifying the correctness of original calculations or analyses by using alternate methods to perform an equivalent calculation. In performing an alternate calculation, the appropriateness of assumptions, input data, and computer hardware/software, if used, are also evaluated.

Design Document. See TFC-ENG-DESIGN-C-52.

Design Requirements Compliance Matrix (DRCM). A single point of reference for applicable design requirements and design assumptions/Documented Safety Analysis (DSA) assumptions (if applicable)/project technical assumptions (if applicable) that would impact design or deployment associated with a project, and documentation of requirement compliance and technical assumptions reasonableness and re-verification, where necessary.

Design verification review. An evaluation of a design, performed by an individual, or individuals, to verify that the design is correct and satisfactory. This evaluation is performed by reviewing not just a single design documents, but the entire set of design documents that

represent the entire design. This evaluation verifies the adequacy of design inputs, technical assumptions, design methods, interfaces, and outputs.

Engineering Document. See TFC-ENG-DESIGN-C-52.

Previously Verified Design. A design, as evidenced by documentation or approvals that has undergone design verification at an earlier date.

Qualification Testing. Testing (including prototype testing and proof testing) that verifies adequacy of design under conditions that simulate the most adverse design conditions, operating modes, and environmental conditions.

6.0 RECORDS

(7.1.5)

The following records are generated by the performance of this procedure:

- Design Verification Record (SPF form SPF-023).

The record custodian identified in the Company Level Records Inventory and Disposition Schedules (RIDS) is responsible for record retention in accordance with TFC-BSM-IRM_DC-C-02.

7.0 SOURCES

7.1 Requirements

7.1.1 DOE O 430.1B Chg 1, "Life Cycle Asset Management."

7.1.2 TFC-PLN-02, "Quality Assurance Program Description."

7.1.3 TFC-PLN-112, "Graded Approach to Quality."

7.1.4 TFC-PLN-136, "Engineering Design Program."

7.1.5 TFC-BSM-IRM_DC-C-02, "Records Management."

7.2 References

7.2.1 TFC-ENG-DESIGN-C-10, "Engineering Calculations."

7.2.2 TFC-ENG-DESIGN-C-18, "Testing Practices."

7.2.3 TFC-ENG-DESIGN-C-25, "Technical Document Control."

7.2.4 TFC-ENG-DESIGN-C-34, "Technical Requirements for Procurement."

7.2.5 TFC-ENG-DESIGN-C-42, "Design Requirements Compliance Matrix."

7.2.6 TFC-ENG-STD-01, "Human Factors in Design."

7.2.7 TFC-ESHQ-Q_INSP-C-04, "Inspection and Test Status Indicators."

7.2.8 TFC-PLN-90, "Technology Maturation Management Plan."

7.2.9 TFC-PRJ-SUT-C-01, "Test Plan Preparation."

Figure 1. Design Verification Checklist

| Item | Issue | Results |
|-----------------------------|--|---|
| 1 | Were the design inputs correctly selected and identified? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 2 | Have design assumptions, DSA assumptions (if applicable), and project technical assumptions (if applicable) that would impact design or deployment associated with the project been adequately described and are they reasonable? Where necessary, have assumptions been identified for re-verification when the design task has been completed (e.g., design assumptions included in design calculations, DSA assumptions included in applicable DSA, project technical assumptions (where applicable) that would impact design or deployment included in the Project Execution Plan risks and assumptions lists (if applicable), and project specific risk management plan (if applicable))? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 3 | Were appropriate design or analytical methods and computer programs used? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 4 | Were the design or analytical inputs correctly incorporated into the design, analysis or evaluation? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 5 | Does the design meet the functional and performance requirements? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 6 | Are the necessary design inputs for interfacing organizations specified in the design documents or in supporting procedures or instructions? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 7 | Have suitable materials, parts, processes, and inspection and testing criteria been specified? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 8 | Have engineering standards (including national consensus codes and standards) and criteria been specified properly in the design? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 9 | Is the design in compliance with applicable regulatory requirements and/or regulatory commitments? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 10 | Have Human Factors in accordance with TFC-ENG-STD-01 been incorporated into the design? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| Additional Comments/Issues: | | |

Figure 2. Calculation Review Checklist.

| Item | Issue | Results |
|-----------------------------|---|---|
| 1 | Are the assumptions used in the original calculation appropriate and reasonable? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 2 | Is the input data used in the original calculation appropriate/correct? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 3 | Was the original calculation method appropriate and properly applied? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 4 | Was the original calculation performed and documented in accordance with the procedure TFC-ENG-DESIGN-C-10? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 5 | Do the results of the alternate calculation agree with and verify the results of the original calculation? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| Additional Comments/Issues: | | |

**ATTACHMENT A – GUIDANCE FOR SELECTING APPROPRIATE TYPE OF DESIGN
VERIFICATION**

| Design verification review | Alternate Calculation | Qualification Testing |
|--|--|--|
| Designs involving single, or multiple disciplines, and judged to be verifiable via document review against requirements. | Where correctness of a calculation cannot be verified by review. Any or all calculations generated in a design may be selected for verification by alternate calculations. | Where performance or functional requirements cannot be verified by other means. Any or all portions of the design may be selected for qualification testing. |