



PERFORMANCE DOCUMENT COVER PAGE

NOTE: If the following document is printed, this cover page must be attached to the front and the required information filled in below.

Date Printed: _____ Dates Rev. No. Checked: _____

Document Number: _____ Revision Number: _____

Title: _____

Person Checking Revision Number: _____

The attached document was printed from the online Performance Document System. The user must check that the hard copy revision number matches the revision number of the controlled document in the online Performance Document System. For future use, confirm the revision number's accuracy online and record dates that the revision number was checked.

Section Below Completed by the Performance Document Group Only

Document Type: [] Administrative [] Technical [] Standard Practice [] Alarm Response Emergency

Required Review Date: _____ Date Required Review Completed: _____

Document Status: [] Maintain As Is [] Revise [] Delete

If "Maintain As Is," Next Required Review Date: _____

If "Revise" or "Delete," Due Date: _____



United Cleanup Oak Ridge LLC

OWNER: Engineering	PROC-DE-0704	REVISION: 7
SUBJECT MATTER AREA: Calculations	PREPARER: Alex Stinnett / Charles Curtis	Page 1 of 23
PROCEDURE TYPE: Administrative <input checked="" type="checkbox"/> Emergency <input type="checkbox"/> Alarm Response <input type="checkbox"/>	CONCURRENCE/DATE: A. J. Reed 10/19/23 [Approval Signature on File]	
TITLE: PROJECT CALCULATIONS	APPROVED BY/DATE: Charles Curtis 10/18/23 [Approval Signature on File]	
USQD <input checked="" type="checkbox"/> UCD <input type="checkbox"/> CAT X <input type="checkbox"/> EXEMPT <input type="checkbox"/>	EFFECTIVE DATE: 11/13/23	
USQD/UCD/CAT X No: PSW-MS-PROCDE0704-2314 R1	REQUIRED REVIEW DATE: 11/13/26	
Exhibit L Mandatory Contractor Procedure: No <input type="checkbox"/> Yes <input checked="" type="checkbox"/>	If an Interim Procedure, Expiration Date:	

PURPOSE 3

SCOPE..... 3

OTHER DOCUMENTS NEEDED 3

WHAT TO DO 3

 A. Simple Calculations 3

 B. Embedded Calculations 5

 C. Formal Calculation Preparation by UCOR Personnel 6

 D. Calculation Checking..... 7

 E. Calculation Verification..... 8

 F. Formal Calculation Approval 9

 G. Issuing Formal Calculations 10

 H. Calculation Preparation by Subcontractor 11

 I. Revisions..... 12

 J. Computer Use in Calculations 13

RECORDS..... 14

SOURCE DOCUMENTS 14

Attachment A Definitions/Acronyms 15

Attachment B Guidance on Computer Use..... 17

Attachment C Calculation Format and Content..... 18

Attachment D Flow Charts 21

This document is approved for public release per review by:

David Hamrin 10/10/23

ETTP Classification & Date
Information Control Office

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 2 of 23

REVISION LOG			
Revision	Effective Date	Description of Changes	Pages Affected
7	11/13/23	Intent change. Addresses IF-2023-0305, CA-3. Supersedes TWPC procedure CM-P-EG-06, Preparation of Calculations. Removed references to PROC-DE-1008 and PROC-DE-1018. Incorporated new Form-4210, Calculation Cover Page, to replace use of Form-136 as a cover page. Added description and general use statement for each type of calculation. Changed performance steps that were previously "Project Engineer" to "Project Engineer or Organizational Manager or Lead" to align with current and intended responsibilities. Organized steps to align with actual process. Clarified when Form-3473 is required. Added steps to Verification section and clarified which type of verification is required. Added steps related to ERB, of required. Added new definitions. Clarified Attachment B, Guidance for Computer Use. Added new Attachment C, Calculation Format and Content. Added new Attachment D, Flow Charts.	All
6	12/13/22	Non-intent change. Updated company name and logo. Updated to terminology in DIR-UCOR-600 as necessary.	All
5	7/12/21	Intent change. Updated Appendix B to remove outdated software examples (IF-2021-0477).	16
4	2/20/20	Intent change. Total re-write. Includes new form, Form-3473, Calculation Checking and Verification Checklist.	All
3	6/20/16	Intent change. Revised Section B on alternate calculations and section G on computer calculations to align with NQA-1 requirements. This revision addresses corrective action PD-P2-01 from issue IF-2016-0416 and corrective actions 1 and 2 from management assessment MA-EN-16-003. Added clarifications to assumptions in Section A.	4, 5, 9, 11
2	11/9/15	Intent change. Added Nuclear Safety Review prior to calculation approval.	4, 5
1	3/2/15	Intent change due to triennial review. Updated procedure references, organization changes, clarified other details.	All
0	12/5/11	Initial release of this document number. This document replaces BJC-DE-0704 (Rev. 0), <i>Project Calculations</i> , and resolves I/CATS Action 36417.	All

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 3 of 23

PURPOSE This procedure provides the method and format for preparing, checking, approving, revising, filing, and retaining manual and computer-generated project calculations.

SCOPE This procedure applies to the generation of calculations by United Cleanup Oak Ridge LLC (UCOR) and subcontractors for use by UCOR when so requested in the subcontract requirements. This procedure does not apply to calculations performed per other approved procedures (e.g., lift plans).

A calculation in this procedure is any type of technically required mathematical computation in which the results are used in a design, study, report, evaluation, specification, or work activity that is performed or used by personnel working on UCOR projects.

Projects or specific subject matter areas may have alternate or additional instructions on specific tasks contained in or implied by this procedure (e.g., PROC-NS-1005, *Nuclear Criticality Safety Evaluations and Calculations*, for calculations and/or validation of Nuclear Criticality Safety software).

Subcontractors should contact their Subcontract Coordinator/Subcontract Technical Representative for assistance in understanding or complying with this procedure.

OTHER DOCUMENTS NEEDED

- PROC-IT-6008, *Application Lifecycle Management*
- PROC-OS-1004, *Document Numbering and Issuance*
- Form-3473, Calculation Checking & Verification Checklist
- Form-4210, Calculation Cover Page

WHAT TO DO **NOTE:** There are three types of calculations: Simple, Embedded, and Formal. Each calculation type is covered in Sections A, B, and C, respectively.

A. Simple Calculations

A Simple Calculation includes finite, observable inputs and produces simple results of fact (e.g., area, volume, flow, distance, unit conversion). It requires routine arithmetical operations and does not utilize complex relationships. It is normally used to support operations or to provide estimates. Calculation correspondence including checking, approval, and results are provided via email or other agreed upon method. Simple Calculations do not have a document number and do not have a Calculation Cover Page. Use of a Simple Calculation as the appropriate method is agreed upon by the requester/project requiring the calculation, and the Project Engineer (PE) or Organizational Manager (OM) or Lead for the group performing the calculation.

Originator

1. Simple calculation shall **NOT** be utilized for the following:

- In support of design.
- To determine the operability of Safety Class (SC)/Safety System (SS) structures, systems, and components (SSCs).
- When potential release to the environment is possible.
- To meet regulatory requirement(s).
- In situations where a formal record needs to be maintained.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 4 of 23

- Originator
2. Prepare the calculation in a manner that produces a legible, reproducible document of sufficient contrast.
 3. Ensure calculations are orderly, complete, and are sufficiently detailed to support review and checking.
 4. Ensure the calculation includes, at a minimum, the following:
 - A concise statement of the purpose for the calculation.
 - All input data including source and source revision number/effective date, as applicable.
 - Individually listed assumptions.
 - Clearly stated equations.
 - Identification of the units used.
 - Clear results and conclusions.
 5. Transmit the calculation to a checker who has sufficient qualifications to have originated the calculation.

NOTE: Form-3473, Calculation Checking & Verification Checklist, is not required for Simple Calculations.

- Checker
6. Review the calculation for appropriate assumptions, inputs, method, completeness, and accuracy.
 7. Return the calculation to the Originator with any comments.

- Originator
8. Resolve any comments with the Checker.

NOTE: Additional review and approval is at the discretion of the PE or OM or Lead.

- PE or OM or Lead
9. If required, review the calculation for completeness and ensure the criteria for a Simple Calculation are met.
 10. If required, resolve any comments with the Originator and Checker.
 11. If required, indicate approval of the calculation, and return to the Originator.

NOTE: Simple Calculations are informal and not required to be transmitted to the Document Management Center (DMC) as an official record.

- Originator
12. Transmit the calculation to the requester/project.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 5 of 23

B. Embedded Calculations

An Embedded Calculation is a Committed Calculation (verified inputs and assumptions) that is embedded within another document (e.g., Design Change Notice [DCN], Engineering Instruction [EI], Documented Safety Analysis [DSA], Fire Hazard Analysis [FHA], Specification, Report). It is checked, reviewed, approved, and issued as part of the document in which it is embedded, hereafter referred to as a mother document. Embedded Calculations should not be used in situations where the calculation will need to be independently or directly referenced by another current or future document. Embedded Calculations do not have a separate document number and do not have a Calculation Cover Page. Use of an Embedded Calculation as the appropriate method is agreed upon by the requester/project requiring the calculation, and by the PE or OM or Lead from the organization performing the calculation.

Originator

1. Calculations may be embedded if the following criteria are met:
 - Does **NOT** produce an effect on or change to a SSC designated as safety class or safety significant or defense-in-depth.
 - Is **NOT** being used to support a credited Administrative Control (AC), specific Administrative Control (SAC) or Programmatic Administrative Control (PAC).
 - Is **NOT** used to meet regulatory requirement(s).
 - Does **NOT** contain unverified assumptions.
2. Prepare the calculation in a manner that produces a legible, reproducible document of sufficient contrast.
3. Ensure calculations are orderly, complete, and are sufficiently detailed to permit verification if necessary.
4. Ensure any computer programs/software meet the requirements of Section J, Computer Use in Calculations.
5. Ensure the calculation includes, at a minimum, the following:
 - A concise statement of the purpose for the calculation.
 - All input data including source and source revision number/effective date, as applicable.
 - Assumptions individually listed and clearly stated with a basis.
 - Equations individually listed and clearly stated.
 - Numerical calculations including identification of the units used.
 - Concise statements addressing the calculation results, recommendations, limitations, and conclusions.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 6 of 23

NOTE: After checking the calculation, approval of the mother document also approves the calculation. The calculation does not require separate approval.

Originator

6. **GO TO** Section D, Calculation Checking.

C. Formal Calculation Preparation by UCOR Personnel

A Formal Calculation is a standalone document that contains sufficient detail, including basis and references, such that a person technically qualified in the subject can review and understand the analyses and verify the adequacy of the results without requiring help or clarification from the originator. A Formal Calculation can be either Preliminary or Committed. A Preliminary Calculation contains open items such as unverified assumptions and is used for preliminary design, procurement, or other activities. A Preliminary Calculation is issued and revised using an alpha revision identifier (e.g., A, B, C) until all the open items are addressed. It is then revised to a Committed Calculation, Rev 0. A Committed Calculation is used to support development of drawings, specifications, reports, design documents, Safety Basis documents, and other engineering products used to construct, modify, or operate a facility. A Committed Calculation has verified inputs and assumptions and no remaining open items.

PE or OM or Lead

1. Assign an originator competent in the subject matter of the calculation.

Originator

2. Obtain a calculation number using the Document Number Request System.

3. Determine if the calculation is Preliminary or Committed.

- For Preliminary Calculations, the revision identifier shall be an alpha character, with the initial issue being “Revision A.”
- For Committed Calculations, the revision identifier shall be a numeric character, with the initial issue being “Revision 0.”

4. Prepare the calculation(s) using Form-4210, Calculation Cover Page, and in accordance with Attachment C, Calculation Format and Content.

- a. Prepare the calculation in a manner that produces a legible, reproducible document of sufficient contrast.
- b. Designate each page (including intentionally left blank pages) with the calculation number, revision number, and page number. In addition, attachments and addendums may be numbered separately.

5. Ensure calculations are orderly, complete, and are sufficiently detailed to permit verification if necessary.

Originator

6. **GO TO** Section D, Calculation Checking.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 7 of 23

D. Calculation Checking

NOTE: This section is not applicable to Simple Calculations. Checking Simple Calculations is addressed in Section A.

PE or OM or Lead 1. Assign an individual (someone besides the originator) to be the checker for the calculation who has sufficient qualifications to have originated the calculation.

NOTE 1: Form-3473, Part 1, is required for checking all Formal Calculations (Preliminary or Committed) and for checking all Embedded Calculations that affect or support the Safety Basis OR that are associated with SC or SS SSCs.

NOTE 2: Form-3473, Part 1 is recommended for Embedded Calculations that do **NOT** affect the safety basis and may be used as determined by the PE, OM, Lead, or the originator.

NOTE 3: If more than one checker is used, then a separate Form-3473 for each checker is recommended.

Checker 2. Perform a line-by-line check of the calculation and review the following:

- a. Technical accuracy, completeness, and procedural compliance, including logic of the calculation, adequate explanation of assumptions, and clarity of the conclusion. This includes:
 - Performing mathematical checks.
 - Reviewing correct use of technical inputs and quality requirements.
 - Checking for appropriate methodology, computer programs, etc.
 - Reviewing the reasonableness of the output with regards to the approach and methodology used.
 - Performing an administrative check of the calculation, including page numbers, required content, etc.
- b. **IF** the results from a referenced calculation are used as an input to a Committed Calculation, **THEN:**
 - Ensure the referenced calculation is Committed, **OR**
 - The Open Items from the referenced Preliminary Calculation do **NOT** affect the Committed Calculation being prepared.

3. **IF** multiple checkers are used on a calculation, **THEN**

the checkers shall identify which portions of the calculation they checked on Form-3473 or other agreed upon method.

4. Check computer calculations to ensure the computer programs meet the requirements of Section J, Computer Use in Calculations.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 8 of 23

NOTE: For Embedded Calculations developed as part of a mother document, checker signatures are included with the mother document review and approval process AND/OR, if used, Form-3473.

Checker **5.** Provide comments to the Originator on Form-3473, if used. If Form-3473 was not used, then provide written comments via alternate agreed on method (e.g., email).

Originator **6.** Resolve any comments with the Checker.

E. Calculation Verification

Verification is the process of assuring the calculation was performed correctly and produced the correct result. At least one of the three methods of verifying a calculation is used when verification is required. The methods of verification are Verification by Review, Verification by Alternate Calculation, and Verification by Testing. Verification by Review (Form-3473) is always performed when verification is required. Either of the other two methods may be used in combination with Verification by Review.

NOTE 1: Calculation Verification is required for all Formal Calculations.

NOTE 2: Calculation Verification may be requested by the PE, OM, Lead, or the originator for any calculation.

NOTE 3: Calculation Verification is normally performed by the checker. However, the PE, OM, or Lead may assign a verifier independent of the checker if necessary.

Verifier **1.** Perform a verification of the calculation using at least one of the three methods described below.

a. Verification by Review:

i. Complete the verifications listed, and document results on Form-3473, Part 2.

ii. Resolve any issues or discrepancies with the originator.

iii. Provide the completed, signed Form-3473 to the originator

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 9 of 23

NOTE: An Alternate Calculation does **NOT** require a Form-4210 and does **NOT** require a document number. Title the calculation “Alternate Calculation to Verify XXX-XXXX-XXX” or similar and, when finished, include with original calculation with the checking and verification package.

Verifier

- b.** Verification by Alternate Calculation:
- i.** Review the appropriateness of method, assumptions, input data used, and any computer hardware/software used for the original calculation as part of the verification.
 - ii.** **IF** computer software is used for the Alternate Calculation, **THEN** follow the guidance in Attachment B, Guidance on Computer Use.
 - iii.** Complete the Alternate Calculation and ensure the results verify correctness of the original calculation.
 - iv.** Request the Alternate Calculation be checked in accordance with Section D, Calculation Checking.
 - v.** Resolve any issues or discrepancies with the originator.
 - vi.** Provide a copy of the Alternate Calculation, signed by the verifier and checker, to the originator.

NOTE: Verification by Testing is rarely used to verify a calculation. The test method and results will be documented and approved in a separate engineering document.

Verifier

- c.** Verification by Testing:
- i.** Develop an appropriate test of all or part of the calculation.
 - ii.** Execute the test and evaluate the results to verify the calculation.
 - iii.** Document the test and results as documentation of acceptable verification.

F. Formal Calculation Approval

This section is applicable to Formal Calculations. Embedded Calculations are approved with the mother document in which they are embedded. Simple calculations do **NOT** require formal approval.

NOTE: Nuclear Safety review and approval of a Formal Calculation is **NOT** required with written waiver from the Chief Engineer.

Originator

- 1.** Submit the checked and, if required, verified calculation(s) to PE or OM or Lead AND to Nuclear Safety for approval.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 10 of 23

- | | |
|---|---|
| Nuclear Safety Manager (or designee) or USQD preparer/ reviewer | <ol style="list-style-type: none"> 2. Review Formal Calculation(s) for impact on the applicable facility Safety Basis documents. 3. Return any calculation review comments to the originator for disposition. |
| Originator / Subcontractor | <ol style="list-style-type: none"> 4. Resolve the comments and return the calculation back through the checker and review cycle, as required. |
| Nuclear Safety Manager (or designee) or USQD preparer/ reviewer | <ol style="list-style-type: none"> 5. Sign the “Nuclear Safety Review” block on Form-4210. |
| PE or OM or Lead | <ol style="list-style-type: none"> 6. Consult with Engineering Management and Nuclear Safety to determine if the calculation needs to be presented to the Engineering Review Board (ERB) either alone or together with associated documents (reference CHT-UCOR-238, Engineering Review Board (ERB) Charter). 7. IF calculation needs approval through ERB, THEN complete presentation and approval by ERB. 8. If required, return to the originator to resolve any comments and return the calculation back through the checker, review and approval cycle, as required. 9. Ensure the final calculation package is complete, conforms to procedural requirements, and includes all required supporting documentation and required signatures. 10. Approve the calculation by signing and dating the “Approver” block on Form-4210. |
| | <p>G. Issuing Formal Calculations</p> |
| PE or Lead or Originator or designee | <ol style="list-style-type: none"> 1. Have the calculation package issued through the Vault program. The .pdf signed package, word version, and any supporting information will be maintained in Vault. When the calculation is issued in Vault, an automatic notification will be sent to the DMC. The .pdf package will then be extracted from Vault to be maintained as a record. |

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 11 of 23

H. Calculation Preparation by Subcontractor

This procedure is listed as an Exhibit L – Mandatory Contractor Procedures document and is flowed down to subcontractors. Calculations performed by a subcontractor for UCOR should be performed using this procedure when possible. However, calculations may be performed using the subcontractor procedure, or alternate procedure, if they meet the intent of this procedure and are approved by UCOR and/or specified in the specific contract documents. Which calculation procedure is used depends on several factors including the subcontract scope, contractual requirements, impact to worker safety and health and environmental compliance, and relation to the Safety Basis, SC/SS SSCs. The preferred method is to use this procedure with at least one qualified UCOR person as a checker or reviewer signing the cover page, then issuing the calculation with a UCOR document number.

NOTE 1: The subcontractor should obtain the calculation number through UCOR in accordance with PROC-OS-1004, *Document Numbering and Issuance*, unless an alternate method has been approved by UCOR in writing.

NOTE 2: Typed or printed name of originator and checker is acceptable on Form-4210 if signature or initials are included on the subcontractor's calculation cover page.

UCOR PE or
Originating
Manager or Lead

1. Ensure the appropriate method for calculation preparation, approval, issue, and revision have been communicated to the subcontractor and is reflected in the appropriate contract documents.
 - a. **IF** the calculation supports or impacts the Safety Basis, is related to SC or SS SSCs, supports a Level 1 Procurement, or is used to support the Commercial Grade Dedication process, **THEN EITHER** use of this procedure is required **OR** submittal and approval of the calculation procedure to be used is required.

Subcontractor

2. Assign an originator and checker qualified to perform the calculation.
3. Prepare calculation following either the subcontractor's calculation procedure or this procedure.
4. Place the calculation number, revision, and page number on each page of the calculation.
5. Place approval signatures and printed name for the originator and checker on either Form-4210 or a subcontractor cover page.

Subcontractor
Approver

6. Approve calculation attesting to calculation completeness, accuracy, and conformance with design practice and procedure requirements, and the calculation is adequate for submittal to UCOR.
7. Submit the calculation to UCOR for approval and/or issue.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 12 of 23

UCOR PE or
Originating
Manager or Lead

8. **IF** the calculation was submitted with the subcontractor numbering syntax and cover sheet, **THEN** obtain a calculation number in accordance with PROC-OS-1004 and attach Form-4210 on top of the calculation as a new cover sheet. Note the purpose of the calculation, limitation of the UCOR review, and additional information on Form-4210.
9. Assign additional review, checking, and validation as required in accordance with this procedure.
10. Complete approval in accordance with Section F, Formal Calculation Approval.

I. Revisions

NOTE 1: Revisions are prepared, checked, reviewed, and approved in the same manner as a new calculation with the addition of the steps included in this section of the procedure.

NOTE 2: The revision must be identified in one of the following ways:

- Revision bars or other graphical indication of changes in the calculation.
- A summary and a description of changed content listed on Form-4210.
- The numbers of the pages that changed, a description of what changed, and replacement pages, to be included in the total package, for the pages that changed listed on Form-4210.

NOTE 3: This section is not applicable to Simple Calculations. Simple Calculations are not formally issued or revised.

Originator

1. Request the latest revision of the original calculation from the DMC.
2. Identify revisions to completed calculations as follows:
 - a. Preliminary Calculations shall be given an alpha character revision designator. Committed Calculations shall be given a “numeric” revision designator. When a Preliminary Calculation is converted to a Committed Calculation, the revision alpha character shall be changed to a number, starting with “0”.
 - b. When graphically indicating changes, the change indicators from previous revisions shall be removed. Revisions shall be identified (e.g., revision bars for text) adjacent to the revised portions. The letter or number designator for this revision shall be noted adjacent to the calculation number provided on each calculation page.
 - c. All calculation pages affected by the revision shall be identified in the Summary of Revision section of the Calculation Cover Page.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 13 of 23

Originator

- d. Minor changes may be made on the original calculation pages by lining out, initialing, and dating the portion being revised (“pen and ink” revision). The revision bars (see Step I.2.b) shall be used. The use of white-out or correction tape is not permitted. The information from preceding revisions, except the revision bars, shall **NOT** be erased.
- e. **WHEN** a revision is made, **THEN**
the originator, checker, reviewer(s), and approver are required to follow all the steps in this procedure for the revised portions of the calculation.

J. Computer Use in Calculations

NOTE 1: Software verification and validation is performed in accordance with PROC-IT-6008, *Application Lifecycle Management*.

NOTE 2: This section does **NOT** apply to software that serves only as a data repository and does **NOT** perform calculations.

NOTE 3: This section does not apply to Simple Calculations

Originator

1. **IF** using computer software for the calculation, **THEN**
include the following in the calculation package:
 - Inputs and outputs.
 - Algorithms and code revealing functions/formulae created by the originator or checker.
 - Identification of software packages by name.
 - Documentation as to whether each software package used is either registered in the Server Asset Management and Official Applications System (SAMOA) or has been determined to be exempt based on the criteria given in PROC-IT-6008, Attachment B, and Attachment B of this procedure.
 - Version/release for all software packages employed.
 - DOE serial number, type of computer, and operating system used.
 - Options used if the program permits multiple options. If default options are used, then a justification should be stated.
 - Basis supporting application of the computer program to the specific physical problem.
2. **WHEN** a front-end validation program is used, **THEN**
include a statement confirming this method was employed and was successful.
3. **WHEN** test problems are used, **THEN**
include a description of the problems, the results obtained, and a statement regarding their acceptability.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 14 of 23

Originator

4. **WHEN** a spreadsheet is used to perform calculations, **THEN** check the equations for computations performed within the spreadsheet.

RECORDS

Records generated by this procedure and listed below shall be dispositioned in accordance with PROC-OS-1001, *Records Management, Including Document Control*.

- Form-3473, Calculation Checking & Verification Checklist
- Form-4210, Calculation Cover Page, with approved Formal Calculation

SOURCE DOCUMENTS

- UCOR-4141, *UCOR Quality Assurance Program Plan, Oak Ridge, Tennessee*.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 15 of 23

Attachment A
Definitions/Acronyms
Page 1 of 2

Alternate Calculation – A calculation prepared independent of the original calculation by alternate methods to verify correctness of the original calculation. An alternate calculation is prepared during the checking process, typically by the checker of the original.

Approver – Reviews the calculation to determine calculation completeness, accuracy, and conformance with design practices and procedure requirements. Once satisfied with the calculation, approves it for the company. Typically, the approver is the Project Engineer, Organizational Manager or Lead.

Checker/Verifier – An individual different from the originator who is qualified to have originated the calculation who performs a check of the calculation for technical accuracy. This may be performed by a review of the original calculation or by performing an alternate calculation.

Committed Calculations – Calculations that form the basis of drawings, specifications, or other design documents used to procure, construct, or operate a facility, or provide the design basis for change to an existing facility. Committed Calculations have verifiable assumptions and inputs.

DCN – Design Change Notice

DMC – Document Management Center

DSA – Documented Safety Analysis

EI – Engineering Instruction

Embedded Calculations – Committed calculations embedded within a mother document (e.g., Design Change Notice, Engineering Instruction, Documented Safety Analysis, or Fire Hazards Analysis).

FHA – Fire Hazard Analysis

Formal Calculation – Standalone document that contains sufficient detail, including basis and references, such that a person technically qualified in the subject can review and understand the analyses and verify adequacy of the result without requiring help or clarification from the originator.

Inputs – Information fed into a formula, data processing system, or computer.

Lead – Person assigned by management to oversee completion of the calculation.

Mother Document – The host document for an Embedded Calculation.

Open Items – Are those items that affect the results of a calculation and require resolution prior to the calculation becoming Committed. Open Items are only pertinent to inputs and assumptions. Programmatic activities that are required to complete a task that a calculation is supporting do **NOT** constitute an open item.

Organizational Manager (OM) – The manager of the organization responsible for providing the calculation.

Originator – An individual qualified based on education, training, and/or experience within a particular discipline to perform original analysis, computations, and draw conclusions concerning an engineering problem.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 16 of 23

Attachment A
Definitions/Acronyms
Page 2 of 2

Preliminary Calculations – Calculations which contain inputs and/or assumptions that are not verifiable at the time of calculation preparation (open items). A Preliminary Calculation undergoes revision as open items are closed. A Preliminary Calculation eventually becomes a Committed Calculation prior to use.

Project Engineer (PE) – A person appointed by the UCOR Engineering Manager to be responsible for the technical aspects of a project or operations and for providing review and approval authority for their project or operations. The UCOR Engineering Manager and/or Project Engineer Designee (for example, a subject matter expert or other technically qualified person) may serve the Project Engineer role for approval of calculations. For operating systems, this role is often filled by a System Engineer/Cognizant System Engineer.

SC/SS SSC – Safety Class/Safety Significant Structures, Systems, and Components

Simple Calculation – A Simple Calculation includes finite, observable inputs and produces simple results of fact (e.g., area, volume, flow, distance, unit conversion). It requires routine arithmetical operations and does **NOT** utilize complex relationships. It is normally used to support operations or to provide estimates.

UCOR – United Cleanup Oak Ridge LLC

Unverified Assumption – An assumption that has not been confirmed, substantiated, or proven to be true that affects the results of a calculation and requires verification prior to the calculation becoming Committed.

Verification – The process of assuring a calculation was performed correctly and produces the correct results.

Verified Assumption – An assumption that has been confirmed, substantiated, or proven to be true.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 17 of 23

Attachment B
Guidance on Computer Use
Page 1 of 1

All software used for Engineering Calculations must be approved through the Software Quality Assurance (SQA) process. If the software has not been previously approved and listed in the Server Asset Management and Official Applications System (SAMOA), then complete the approval process in accordance with PROC-IT-6008, *Application Lifecycle Management*. Ensure the software has been properly categorized to the level required, or higher, for the calculation it will be used for OR complete the Software Quality Assurance (SQA) process to categorize to the required level. Software used to support Safety Management Programs (SMPs) as described in DSA-MS-SMP-0017, *Safety Management Program Description*, must be category B-C, B-B, or B-A as appropriate.

As listed in PROC-IT-6008, spreadsheets used to create software application products must be categorized and require the same SQA work as custom developed software applications. Spreadsheets developed for one-time-use for calculations are exempt from PROC-IT-6008. Refer to PROC-IT-6008 for additional information.

Users of software should adhere to the principles of numerical analysis and be especially wary of:

- a. round-off errors that arise because it is impossible to represent exactly all base-10 real numbers;
- b. numbers that closely approach zero, infinity, or use very large absolute value of an exponent;
- c. truncation errors that are committed when an iterative method is terminated or a mathematical procedure is approximated, and the approximate solution differs from the exact solution;
- d. discretization error that arises because the solution of the discrete problem does not coincide with the solution of the continuous problem;
- e. boundary condition input error that results in large output error;
- f. inappropriate method for elimination of singularities created in Finite Element Method models;
- g. ill-conditioning error so that a small error in the data will grow to be a large error in results due to numeric instability;
- h. sampling error for describing systems whose outputs are inherently stochastic. A stochastic variable is a variable that varies randomly to some extent, and whose behavior can be analyzed and described statistically but not predicted precisely;
- i. insufficient sampling (number of model runs) for Monte-Carlo based simulations to support the level of statistical confidence stated for the results;
- j. finite element mesh is too coarse (increasing piecewise approximation error) or too fine (resulting in excessive execution time to be of practical use);
- k. mesh refinement technique results in excess time to convergence;
- l. iterative solver errors arise from permitting iteration with binary repeaters (such as iteration by decimal number 0.1) or choice of iterative quantity resulting in instability that might not be detected because proprietary methods do not provide iteration stopping criteria;
- m. using weight for mass and other units confusion;
- n. using constant values or means for variable parameters;
- o. noisy data errors arise from exceedance of the maximum rate through the channel that collected the electronic data;
- p. wrong definition of material or unrealistic assumption of material homogeneity;
- q. inadequate constraints lead to singularity;
- r. misapplication of algorithms or dividing by very small quantities;
- s. storage precision size is inadequate for mesh refinement resolution near boundaries;
- t. stack overflow or underflow resulting from lack of arbitrary precision storage capability of the software employed.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 18 of 23

Attachment C
Calculation Format and Content
Page 1 of 3

Include the following section in the body of the calculation that are marked “required”. Other sections may be added as needed and the exact order of the sections is optional.

1. Objective/Purpose (required)

Describe the objectives (including the required end products) of the analysis including a problem statement. Describe the analysis performed in the calculation. For design calculations, identify the calculation’s design requirements and applicable National Codes and Standards. When preparing a new or revised calculation that is to be used to implement the safety basis, this element must be included in the scope of the calculation.

2. Summary of Results and Conclusions (optional depending on calculation length or complexity)

For lengthy or complex calculations, summarize the results and conclusions contained in later sections, highlighting the key points.

3. Introduction/Background (optional)

Provide any background information needed to understand the calculation purpose.

4. Input Data (required)

Information that serves as input to the calculation must be referenced to the source.

Information used to produce a hand calculation or used as input for a computer code or spreadsheet must be explicitly stated or be included in an attachment that will be part of the calculation. (It is not intended that impractical attachments, such as voluminous databases, be included.) Extensive compilations of input data used in more complex calculations may be better contained in separate appendixes.

Data files used in computer codes, with associated release numbers or dates, shall be listed. Enough information shall be included in the report to allow a complete reconstruction of all the input cases. This may include publishing all input files used to reach the conclusion(s) in the calculation.

Copies of reference information should be made available to the checker and organizational manager to simplify the review and approval process. Results of literature searches or other applicable background data shall be identified.

Information or data used to produce a hand calculation or used as input to a computer code or spreadsheet shall be included in an attachment.

Boundary and initial conditions (including those used in finite element analyses) shall be clearly defined and justified. This includes effects with interfacing systems, structures, and components (SSCs) and physical phenomena (e.g., structural loads, temperatures, flow rates, pressures, chemical contents, voltages, and currents).

In documenting input data, preference should be given to providing the information in a numbered list format with a description of the type of input data used and the reference that it was taken from.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 19 of 23

Attachment C
Calculation Format and Content
Page 2 of 3

5. Assumptions (required)

Explicitly state or reference assumptions used in the analysis along with supporting data or information. Assumptions that are stated must be used within the calculation. At a minimum, list key assumptions that must be verified prior to relying on the calculation for operation.

Clearly highlight any unverified assumptions to ensure they are addressed before the calculation is committed. The suggested method is to include the text “UNVERIFIED ASSUMPTION”.

The use of testing as a checking method for calculations produced using software that is not pre-verified (i.e., one-time-use spreadsheets) is to be listed as an assumption requiring verification. Test results that validate the calculation are to be provided to verify the assumption.

If no assumptions are made, then state that and no other information is required for this section.

6. Method of Analysis (required)

The method needs to “stand alone” in quality and completeness so a reasonably knowledgeable person would not have to seek the originator’s input on the methodology used in order to arrive at the same conclusions. Provide a brief description of the method of solution, numerical computations, and identification of the source or derivation of all equations that are not common usage. The method should use recognized national standards wherever possible with clear derivation of or reference to equations and any limitations on their use. Provide diagrams, sketches, photographs, or drawings to clarify the extent of the calculation and provide visual association with the actual configuration. Structural calculations, as a minimum, require a free body diagram that should include dimensions, forces, moments, and reactions; the free body diagram should be legible and should clearly represent the actual configuration.

If the calculation uses computer software, then ensure the bases (of reference thereto) supporting application of the computer program to the specific physical problem is described in this section. If a formulation has been taken from an unpublished reference (such as an internal memo) or was developed by the engineer/analyst, then the validity of the model or correlation must be demonstrated. The engineer/analyst must ensure the uncertainties thus introduced will not impact the conclusions of the document. The actual numerical calculations may be included in this section where practical. Complex calculations or spreadsheets not readily contained within the body of the calculation are better contained in separate appendices.

Information necessary to reconstruct the analysis, including hand calculations, must be included.

Where one-time-use spreadsheets are used, their method should be described in this section or in a separate appendix, using one of the following methods.

- Explode and print equations (e.g., cell formulae contents), macros, scripts, or strings of multiple functions. If a formula is applied to a series of cells, then only one instance of the formula is necessary to be shown in this section.
- Sufficiently document equations, external links, and code use in each cell so as to allow independent recreation via hand calculation.
- Provide a description of the electronic spreadsheet file and how it is used to perform the calculation.

OWNER: Engineering	PROC-DE-0704
PROJECT CALCULATIONS	REVISION: 7
	Page 20 of 23

Attachment C
Calculation Formal and Content
Page 3 of 3

7. Use of Computer Software (required if software is used)

See the “Computer Use in Calculations” section of this procedure.

8. Results (required)

Describe the results obtained. The number of significant figures reported shall be consistent with the quality of the data and with its purpose.

All information illustrated in the printed version shall be explicitly reproducible from the values shown in the printed version. For example, if the calculation presents a tabular array of intermediate results, and subsequently presents another array of results calculated from the former, then subsequent results generated shall be explicitly reproducible from the values as presented. In other words, those subsequent results should not reflect numerical adjustments from “hidden” digits (e.g., as might be present in an Excel workbook).

9. Conclusions (required)

Describe the degree to which the objectives and purpose have been met along with information on the appropriateness and completeness of the results for the intended purpose. Do not present new information in the conclusions; only draw on information previously presented in the body of the calculation.

10. Recommendations (optional)

List recommendation(s) including basis information.

11. References (required)

Examples of references include drawings, reports, change notices, manuals, publications, codes, and standards. Provide the title, author (or company), and revision number or publication date, if available. References that may not be retrievable in the future shall be added to the document as attachments. The engineer/analyst must be able to supply the reviewer with a copy of any document cited in the analysis.

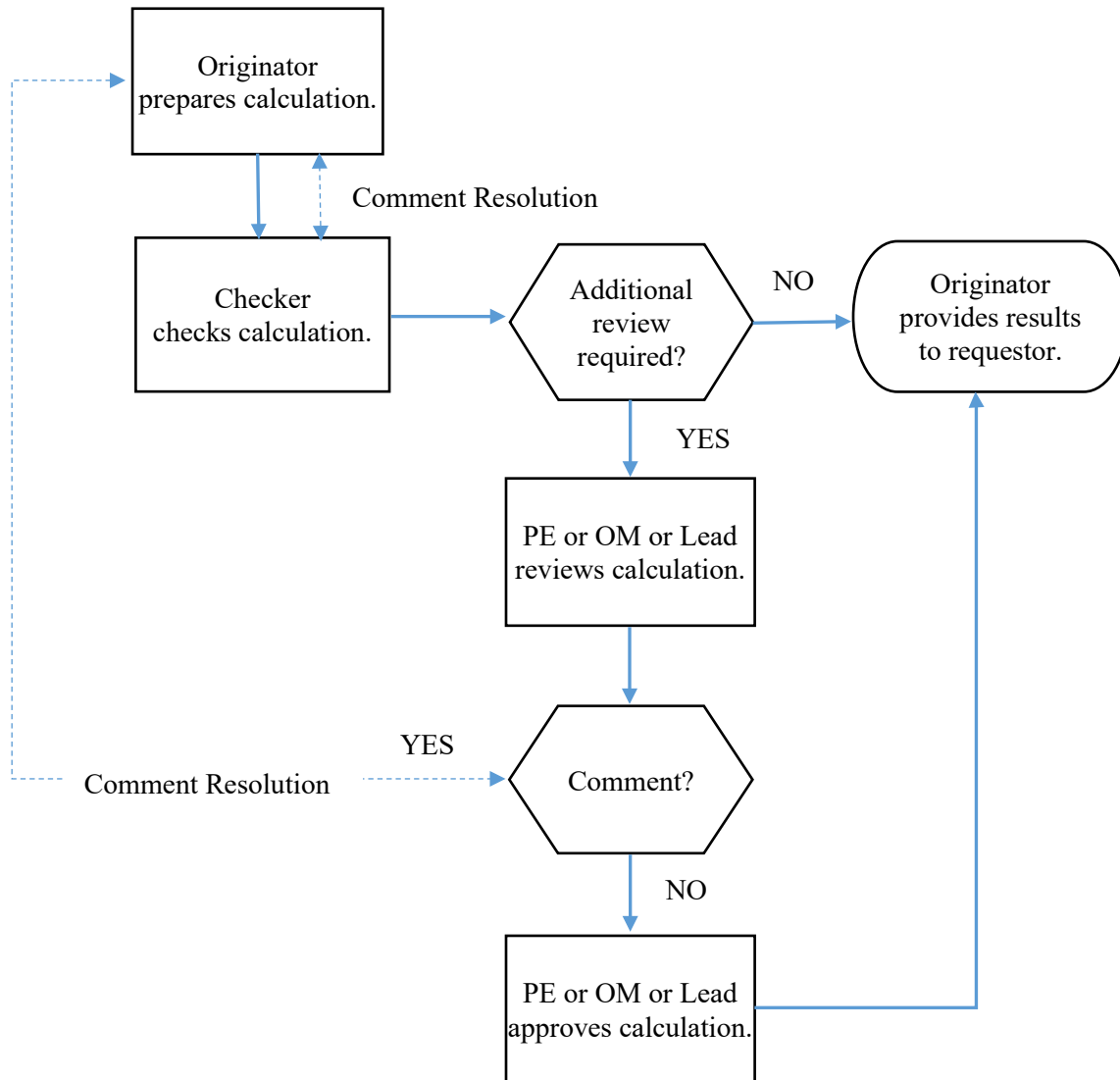
12. Attachments and Appendices (optional)

Include additional information such as computer software documentation (including spreadsheet printouts where practical), calculation review checklist(s), alternate calculation(s), detailed calculations not readily contained in the main body, extensive compilations of input data, inspection reports, correspondence about the calculation, verification results, and copies of references, memos, or pages of manuals that are not otherwise readily retrievable from document control or records systems.

**Attachment D
Flow Charts
Page 1 of 3**

SIMPLE CALCULATIONS

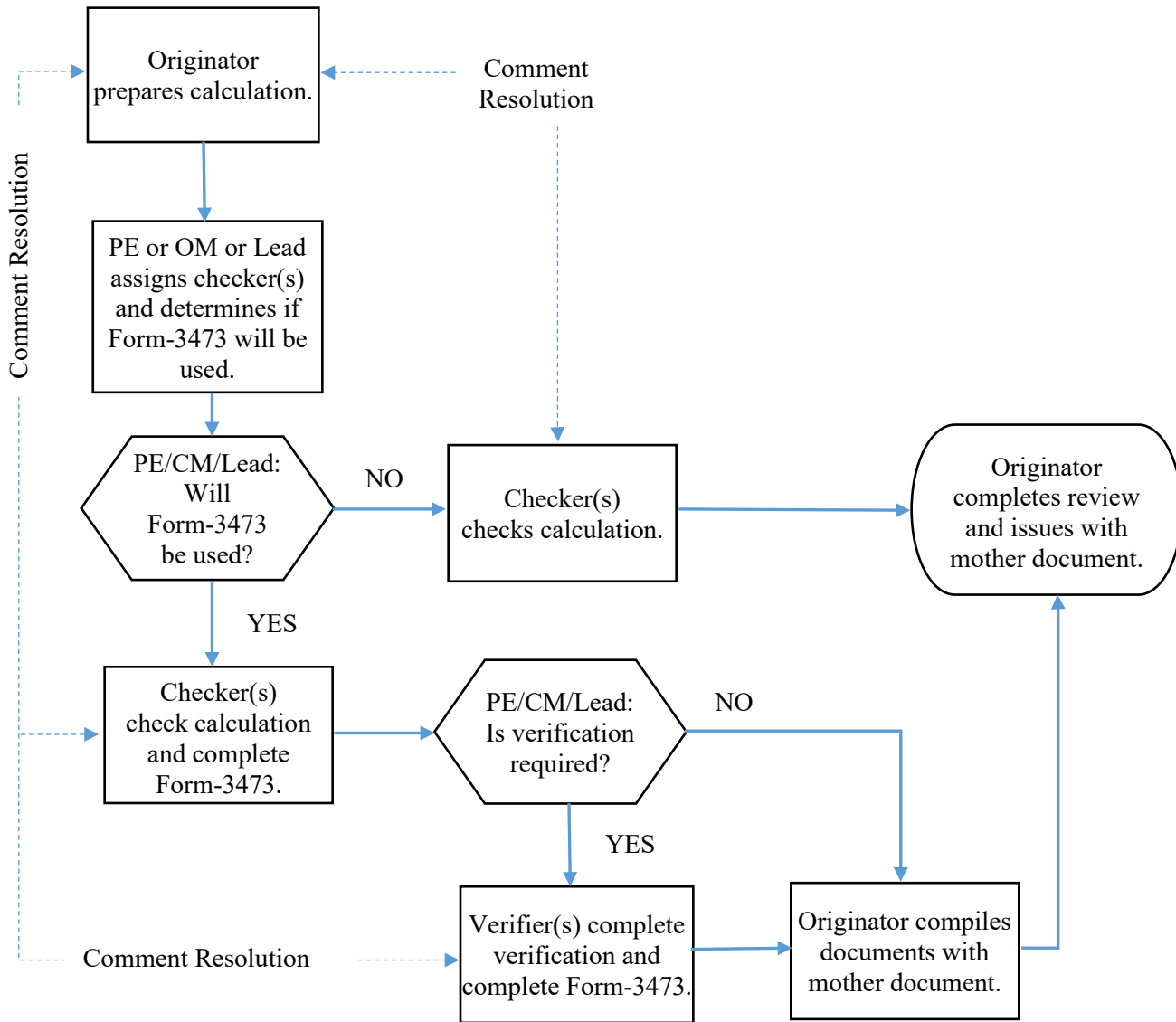
A Simple Calculation includes finite, observable inputs and produces simple results of fact (e.g., area, volume, flow, distance, unit conversion). It requires routine arithmetical operations and does not utilize complex relationships. It is normally used to support operations or to provide estimates. Calculation correspondence including checking, approval, and results are provided via email or other agreed upon method. Simple Calculations do not have a document number and do not have a Calculation Cover Page. Use of a Simple Calculation as the appropriate method is agreed upon by the requester/project requiring the calculation, and the Project Engineer (PE) or Organizational Manager (OM) or Lead for the group performing the calculation.



**Attachment D
Flow Charts
Page 2 of 3**

EMBEDDED CALCULATIONS

An Embedded Calculation is a Committed Calculation (verified inputs and assumptions) that is embedded within another document (e.g., Design Change Notice, Engineering Instruction, Documented Safety Analysis, Fire Hazard Analysis, Specification, Report). It is checked, reviewed, approved, and issued as part of the document in which it is embedded, hereafter referred to as a mother document. Embedded Calculations should not be used in situations where the calculation will need to be independently or directly referenced by another current or future document. Embedded Calculations do not have a separate document number and do not have a Calculation Cover Page. Use of an Embedded Calculation as the appropriate method is agreed upon by the requester/project requiring the calculation, and by the PE or OM or Lead from the organization performing the calculation.



**Attachment D
Flow Charts
Page 3 of 3**

FORMAL CALCULATIONS

A Formal Calculation is a standalone document that contains sufficient detail, including basis and references, such that a person technically qualified in the subject can review and understand the analyses and verify the adequacy of the results without requiring help or clarification from the originator. A Formal Calculation can be either Preliminary or Committed. A Preliminary Calculation contains open items such as unverified assumptions and is used for preliminary design, procurement, or other activities. A Preliminary Calculation is issued and revised using an alpha revision identifier (e.g., A, B, C) until all the open items are addressed. It is then revised to a Committed Calculation, Rev 0. A Committed Calculation is used to support development of drawings, specifications, reports, design documents, Safety Basis documents, and other engineering products used to construct, modify, or operate a facility. A Committed Calculation has verified inputs and assumptions and no remaining open items.

