# EXPRO National Manual for Projects Management

# Volume 6, chapter 3

# Calculations Procedure

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## Table of Contents

# 1.0 PURPOSE

The purpose of this procedure is to define the work process and templates to be used by the Engineering in the development of design calculations for Entity's infrastructure projects.

# 2.0 SCOPE

This procedure defines the minimum requirements. It applies to the creation and revisions of all engineering calculations performed for the design of government infrastructure projects.

# 3.0 DEFINITIONS

| Term | Definitions |
|---|---|
| A/E Consultant | Architectural/Engineer Consultant appointed by the EPMO to undertake the design of the project. |
| ECMS | An information management and collaboration platform for managing and controlling program documents and records. |
| Entity | A Saudi Government organization which is responsible for the delivery of government funded infrastructure construction projects. |

# 4.0 REFERENCES

1. Document No. EPM-KE0-GL-000011 – Definitions and References
2. Document No. EPM-KE0-GL-000010 – Engineering Introduction
3. Document No. EPM-KE0-GL-000015 – Project Submission Standards and Requirements
4. Document No. EPM-KE0-GL-000016 – General Design Guideline
5. Document No. EPM-KE0-PR-000011 - Verification and Validation of Computer Programs

# 5.0 RESPONSIBILITIES

Entity shall be responsible for the implementation of the requirements of this procedure by Architect & Engineer (A/E). Any deviation from the intent and purpose of this procedure will be discussed and agreed by the Entity with EXPRO before implementation.

# 6.0 PROCESS

## 6.1 Meanings of the Terms Used in this Procedure:

### 6.1.1 Assumption

An engineering assumption is a design criterion, input, or judgment made based upon an engineer's experience, empirical data, hypothesis, probable inference, or literature that although not based on a confirmed reference, is not expected to change over the life of the calculation (even in a confirmed calculation). An assumption is often made to simplify the calculation methodology. All assumptions must be documented in the calculation and must have sufficient rationale provided to justify that their use is appropriate in the calculation.

### 6.1.2 Preliminary Information

Information required for the calculation that is not yet confirmed and may change as the design evolves or more detailed information becomes available.

### 6.1.3 Preliminary Calculations

Preliminary calculations are calculations that contain preliminary information. Preliminary calculations are identified with letter revision designators (00A, 00B, etc.). When practical, the preliminary information should be listed as such and clearly identified in a conspicuous location in the calculation (for later confirmation).

### 6.1.4 Design Input

Factual information, such as design criteria, performance requirements, vendor data, codes and standards, design bases, regulatory requirements, or other design requirements upon which detailed final design is based. Design inputs can be directly tied to an appropriate reference document, are not expected to change, and as such, are considered confirmed or approved data.

### 6.1.5 Confirmed Calculations

Confirmed calculations only contain confirmed information (with firm references) that is not expected to change and are identified with number revision designators (000, 001, 002, etc.). Confirmed calculations may form the basis of drawings, Contract Documents, specification packages, submittals to regulatory agencies (e.g., licensing and permitting documents), or other design documents that are used to purchase equipment and/or services, construct or operate the facility, or provide the design requirement for change to an operating plant (i.e., Issued for Purchase, Issued for Construction, Issued for Use, etc.).

## 6.2 Verification and Validation of Computer Programs

Computer programs used for engineering design and analysis shall be verified and validated before use according to the procedure: EPM-KE0-PR-000011 - Verification and Validation of Computer Programs

## 6.3 Work Process for Creation of Calculation

### 6.3.1 Responsibility of Discipline Lead Engineer

- Determine what all calculations are to be performed by his/her group
- Assigns the calculation Originator and Checker. Ensures that both are sufficiently qualified to originate the calculation. Ensures the Checker is independent.
- Informs the Originator if the calculation is intended to be turned over to the other external entity.
- If multiple Originators or Checkers are used to prepare a calculation, the specific sections or pages originated and checked by each party shall be clearly identified on the Cover Sheet of the calculation.
- Ensures that the Originator is a trained and experienced user of the software to be used in the calculation and that any software to be used complies with the discipline's List of Approved Computer Software
- Approve the calculation and submit the completed calculation package to Enterprise Content Management System (ECMS).

### 6.3.2 Responsibility of Calculation Originator

- Shall be a proficient user of the software used for calculation and be aware of how to address any error notices (if they could impact the calculation).
- Shall prepare a Calculation Cover Sheet, Computer Program Information Sheet and Calculation Sheet. Refer to **Attachments 1, 2 and 3** of this procedure for samples.
- Use the calculation checklist **(Attachment 4)** to ensure it is orderly and complete.
- Sign on the checklist and calculation Cover Sheet before submitting for checking.

### 6.3.3 Responsibility of Calculation Checker

- Checker shall be capable of producing the calculations independently.
- Remain sufficiently independent to be able to perform check of the calculation
- Check the calculation using calculation checklist (**Attachment 4**)
- Verify the completeness of the entire calculation package
- Provide any comments to the Originator for resolution

- Sign or initial the checklist and calculation cover sheet after all comments are satisfactorily resolved.

## 6.4 Work Process for Revising a Calculation

### 6.4.1 Responsibility of Discipline Lead Engineer

- Ensure any necessary coordination with other disciplines/functions occurred, comments have been resolved and reflected on calculations appropriately.
- Ensure checking has been completed and any comments have been resolved
- Ensure calculation is complete, conforms to design and procedural requirements.
- Meets applicable Codes and Standards identified for the project
- Approve calculations performed on project.
- Sign and enter the date on the Cover Sheet
- Submit the completed calculation package to ECMS for input into the record management system (e.g. ECMS).

### 6.4.2 Responsibility of Calculation Originator

- Ensures that a copy of the current revision is stored in the Electric Content Management System before making any changes
- Clearly identifies the reason for revision
- Identifies any added or deleted sheets or sections of calculation.
- Clearly identifies the appropriate revision designator on each sheet.
- Clearly identifies all revised portions of the calculation, preferably using revision bars in the left margin where possible (after removing any change markings from the previous revision). Where use of revision bars is not practical (including computer printouts in appendices), it is acceptable to provide a comprehensive listing of the revised sections or pages and appendices on the Cover Sheet in the Reason for Revision block (or elsewhere on the Cover Sheet). If it is too lengthy to include on the Cover Sheet, a description of changes can be included in another area of the calculation in lieu of using revisions bars.

- Performs applicable actions identified above for the originator

### 6.4.3 Responsibility of Calculation Checker

- Shall take responsibility for checking the revised portions of calculation, which includes reviewing the entire calculation to determine if any other portions were affected (that now need to be changed to fully incorporate the new information) and to further ensure that no other portions were inadvertently changed by mistake. (This is especially important when software tools were used to create any portion of the calculation.)
- Performs applicable actions as identified above for the checker

## 6.5 General Notes on Calculations Preparation

- Alternate forms may be used for a calculation as long as each sheet includes the entire document number (including the revision), page numbers (e.g., 1 of 10, 2 of 10, etc.) and the appropriate Intellectual Property (IP) statement. All sheets in an appendix shall similarly include the entire Document Number (including the revision), page numbers (e.g., A1 of 2, A2, of 2, B1 of 3, etc.). Care must be taken to ensure that no copyrights are violated when including documents prepared by others in an appendix.
- Use of any computer program, version, or operating system that is not approved for use on a project shall require Entity's approval.
- When computer calculations are completed, computer printouts may be discarded provided pertinent results and sufficient input information to rerun the program are retained. Input and output files used in computer programs should be included as an appendix.
- Although the Checker does not need to be well experienced in the use of the software used in the calculation, the Checker must be sufficiently familiar with the software to assure its appropriate application and use.
- When a calculation changes status from a letter revision to Rev. 000, all sheets in the calculation (including appendices) shall be converted to Rev. 000 (even if there are no other changes on some pages), and all

revision bars associated with any letter revisions shall be removed. No revision bars shall appear on the Rev. 000 calculation.

- Calculations that are revised to be superseded or voided should also carry appropriate wording in the Reason for Revision block (e.g., “Calculation superseded by Calculation XXX” or “Calculation Voided”).

### 6.6 Document Management

Issued copies of all completed calculations shall be retained in the applicable project record management system (ECMS) along with native files if possible. Native files of calculations shall be retained in the appropriate project share drive.

## 7.0 ATTACHMENTS

1. EPM-KE0-TP-000027 - Calculation Cover Sheet Template
2. EPM-KE0-TP-000028 - Computer Program Information Sheet Template
3. EPM-KE0-TP-000029 - Calculation Sheet Template
4. EPM-KE0-TP-000003 - Calculation Checklist

## Attachment 1: EPM-KE0-TP-000027 - Calculation Cover Sheet Template

| Calculation Cover Sheet | Project Name: (1) |
|---|---|
| | Job/Sub div. No. (2) |
| Subject: (6) | Calc. No. (3) |
| Discipline: (7) | Sheet No. (4) of (5) |

**Calculation Status Designation** (8)

☐ Preliminary ☐ Confirmed ☐ Superseded ☐ Voided

**Computer Program Information - Refer to Computer Program Information Sheet**

(9)



| (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) |
|---|---|---|---|---|---|---|---|
| Rev. No. | Reason for Revision | Total # of Sheets | Last sheet No. | By | Checked By | Approved By | Date Approved |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**Record of Revisions**

## INSTRUCTIONS FOR COMPLETING THE CALCULATION COVER SHEET

1. Project name
2. Project job number and subdivision number, if used
3. The unique identifier assigned to the calculation
4. The sheet number (i.e., always "1" for the Cover Sheet) - Appendices should be paginated separately from the main body of the calculation (e.g., A1 of 2, A2 of 2, B1 of 3, B2 of 3, etc.).
5. The total number of sheets in the main body of the calculation (not counting any appendices) - If sheets have been added or deleted without repaginating the remaining sheets that were not affected by the latest calculation revision, use the sheet number corresponding to the last sheet in the main body of the calculation. (This means that the last sheet number could be different from the total number of sheets in the main body when the entire main body was not repaginated.)
6. The title or objective of the calculation
7. Discipline name
8. A check mark or "X" to indicate the calculation status designation - Note the number of the superseding calculation on the Cover Sheet when entering "Superseded."
9. Space to add or provide any appropriate comments - Appropriate comments to include the following:
    a. May be used for the Table of Contents or to list appendices when a Table of Contents is not prepared – The total number of sheets in each appendix shall be listed (either on the Cover Sheet or in the Table of Contents).
    b. Reference to inclusion of Checker's alternate calculation (as an appendix), if used
    c. Explanation of what sections or sheets were originated and checked by the various parties when multiple Originators and/or Checkers are used
    d. This section may also be used to extend any other Cover Sheet entry when so noted.
10. The unique revision designator - Letter designators, starting with "00A," are sequentially assigned to Preliminary calculations, and number designators, starting with "000," are sequentially assigned to Confirmed and Confirmed with Preliminary Information calculations.
11. The purpose for issuing or revising the calculation - Identify any revised, deleted, or added sections/sheets (unless the revised portion is clearly marked or otherwise explained). General phrases are acceptable (e.g., "Issued for Use" at Rev. 000 and "Revised and Re-Issued for Use") as long as revisions are otherwise clearly identified in calculations issued after Rev. 000.
12. The total number of sheets in the hard copy calculation package including appendices (with the Cover Sheet being number 1) - If any of the appendices are in an electronic format (e.g., memory stick or CD), indicate the total number of hard copy pages printed plus the number of electronic files (e.g., 76 + 3 electronic files).
13. The number of the last sheet in the calculation package including all appendices (e.g., App. C, Sh. C4)
14. The signature(s) or initials of the Originator(s) of the calculation
15. The signature(s) or initials of the Checker(s) of the calculation
16. The initials of the Discipline Lead who approves the calculation
17. The date the Discipline Lead approves the calculation.

## Attachment 2: EPM-KE0-TP-000028 - Calculation Computer Program Information Sheet Template

| Computer Program Information Sheet | Project Name & Units: | |
|---|---|---|
| | Job/Sub div. No.<br>XXXXX-XXX | |
| Subject: | Calc. No.<br>XXX-XXXX-XXXXX | |
| | Sheet No.<br>x of y | Sheet Rev. |

Complete the following table regarding all computer programs used to produce the calculation. For revisions to the calculation, clearly indicate any changes affecting information provided regarding computer programs. Add rows as necessary.

**Computational/Analytical Computer Programs**

**List all computational/analytical computer programs used to produce the calculation.**

Note: If the program is not an approved software on the project, then the verification package must be included (or referenced) in the calculation or the results must be completely checked by an alternate means (e.g., hand calculation, etc.).

| Name of Program(s) | Approved for use on Project | Version/ Release |
|---|---|---|
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## Attachment 3: EPM-KE0-TP-000029 - Calculation Sheet Template

| Calculation Sheet | Project Name & Units: | |
|---|---|---|
| | Job/Sub div. No.<br>XXXXX-XXX | |
| Subject: | Calc. No.<br>XXX-XXXX-XXXXX | |
| | Sheet No.<br>x of y | Sheet Rev. |

## Attachment 4: EPM-KE0-TP-000003 - Calculation Checklist

| PROJECT NAME: | | CALCULATION NO. | | | REV. | | | |
|---|---|---|---|---|---|---|---|---|
| No. | QUESTIONS | ORIGINATOR | | | CHECKER | | | |
| | | N/A | YES | NO | N/A | YES | NO |
| **A.** | **General** | | | | | | | |
| 1 | Is the calculation legible, logical and orderly fashion and uses standard calculation template in the procedure EPM-KE0-PR-000003 | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 | Table of Contents, if used, consistent with the calculation including page numbers? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 | Is the purpose of the calculation and intended use of the output clearly stated? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 | Is the coversheet properly completed, including title, calculation number (in accordance with the Entity's Document Numbering System), Discipline and Calculation Status Designator? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 | Are the calculation revisions clearly identified? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 | Do all pages of attachments and appendices include job number, calculation number, revision number, attachment/appendix number, page number (with each attachment/appendix independently paginated), and the source for the attachment and/or appendix? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 | Is the total number of sheets in the main body of the calculation (without any attachments or appendices) listed correctly on the calculation coversheet? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8 | If preliminary information was used in the calculation, the calculation must state this. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9 | If calculation is being used for Licensing or Permitting, has it been converted to "Confirmed"? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10 | Have the initials of the originator, and checker been properly entered in the "BY" and "CHECKED" boxes on the coversheet? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11 | When revising a calculation, have all the changes been properly indicated by use of revision bars in the right hand margin? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **B.** | **Input Data & Assumptions** | | | | | | | |
| 12 | Does it list all the codes/ standards the calculation is based on and are these codes specified in the Project Design Basis or specifications? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 | Are the data input sources correctly used and clearly identified and retrievable (if not retrievable, to be included in the calculation)? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14 | Are all Design Inputs "Issued for Use" or vendor document "Status "3", if not, is the calculation issued for "Preliminary Information" which will need be Confirmed in the future. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15 | Is there a complete list of valid and reasonable assumptions and engineering judgments stated along with supporting technical rationale? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **C.** | **Method of Analysis** | | | | | | | |
| 16 | Does the calculation use an accepted methodology that represents a "Standard or Practice" used in similar applications? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17 | Is the methodology readily understood, and is it appropriate for the type of calculation, in accordance with applicable codes, standards, and local regulations? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18 | Are the equations correct, appropriate for use, source identified, and derivation/justification provided for major equations not of common usage? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19 | Are input and outputs in SI units? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **D.** | **Use of Analysis Software** | | | | | | | |
| 20 | If analysis software used, has it been identified (name and version) in the body of the calculations and approved for use by the Entity and Design Contractor's organization | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 21 | Has the analysis software been verified and validated by the Design Contractor or other organization performing the analysis? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 22 | Does the computer model that has been created, adequately reflect actual (or to be modified) plant conditions (e.g., dimensional accuracy, type of model/code options used, time steps, etc.)? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 23 | If the calculation contains a large amount of input/output data that would make the checking/verification process data laborious, has a simplified means been | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| PROJECT NAME: | | CALCULATION NO. | | | | REV. | |
|---|---|---|---|---|---|---|---|
| **E.** | **Output/Conclusions** | | | | | | |
| 1 | Are the outputs reasonable and as expected? If not, has sufficient justification been presented for the deviations? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 | Are the stated conclusions justifiable and consistent with the calculation results? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 | Is the calculation presentation complete and understandable without any need to refer back to the Originator for clarification or explanations? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **F.** | **Overall Review** | | | | | | |
| 4 | Does the calculation meet its purpose/objective, and is it acceptable for use? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 | You are the only person that will be held responsible for this calculation. Are you willing to take full responsibility for this calculation? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| No. | Checker's Comments | Resolution |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

| Originator's Name / Signature and Date: | Checker's Name / Signature and Date: |
|---|---|
| | |