

YANKEE NUCLEAR SERVICES DIVISION

FRAMINGHAM, MASSACHUSETTS

Engineering Instruction

TITLE: ENGINEERING CALCULATIONS AND ANALYSES

INSTRUCTION NO: WE-103

REV.	REVIEWS (Initial)				APPROVAL	DATE
	P.E. DEPT.	NE DEPT.	E.E. DEPT.	QA DEPT.		
0	<i>AK</i>	<i>QMG</i>	<i>JNR</i>	<i>DBP</i> 7-7-77	<i>LHH</i>	7/8/77
1	<i>DBP</i>	<i>JCT</i>	<i>JNR</i>	<i>DBP</i> 1-3-78	<i>LHH</i>	1/3/78
2	<i>DBP</i>	<i>JCT</i>	<i>JNR</i>	<i>DBP</i> 4-24-78	<i>LHH</i>	4/24/78
3	<i>JDH</i>	<i>BCS</i>	<i>JNR</i>	<i>DBP</i> 2-13-81	<i>LHH</i>	2/13/81
4	<i>JDH</i>	<i>BCS</i>	<i>JNR</i>	<i>DBP</i> 4-2-81	<i>LHH</i>	4/2/81
5	<i>JDH</i>	<i>BCS</i>	<i>JNR</i>	<i>DBP</i> 9-27-82	<i>LHH</i>	10/4/82
6	<i>DBP</i>	<i>BCS</i>	<i>JNR</i>	<i>DBP</i> 10-6-83	<i>JNH</i>	1/1/85
7	<i>DBP</i>	<i>BCS</i>	<i>JNR</i>	<i>WKP</i>	<i>JNH</i>	12/2/84

## CALCULATIONS AND ANALYSES

WE-103

### 1.0 PURPOSE

- 1.1 To provide guidance for the performance, review, approval, and control of engineering calculations and analyses.

### 2.0 DISCUSSION

#### 2.1 Definitions

2.1.1 Design Analysis Review - To confirm, substantiate, and assure that a calculation or analysis has been performed in conformance with the specified requirements. Acceptable methods include critical second - party reviews, comparison to alternate calculations or analyses, or qualification tests.

2.1.2 Check - To determine the reasonableness or accuracy of a calculation or analysis by investigation, comparison, or examination. A check is usually performed in cases where a calculation or analysis is not related to a specific design or design change, or when a design analysis review has already been performed.

2.2 Use of this Instruction assures that calculations and analyses are performed in a logical manner, so that a competent individual can review the work without recourse to the originator.

2.3 This Instruction is used for the performance of calculations and analyses during engineering design activities, and for the review of calculations and analyses which were performed by engineering or by outside design organizations. It may also be used when it is requested that calculations and analyses be performed (1) to verify that operating plants conform to their technical specifications or

licensing requirements, or (2) in response to a regulatory agency, when the action or response involves a change in the technical specifications or an unreviewed safety question.

- 2.4 Specific calculations and/or analyses occasionally have to be performed in accordance with requirements of codes, standards, design criteria, specifications, procedures, instructions, etc., which differ from those found in this Instruction. In such cases, originators are directed to identify and reference the non-standard requirements and their sources.

### 3.0 INSTRUCTIONS

- 3.1 Calculations and Analyses shall be assigned and identified as follows:

- \* 3.1.1 Originators shall be designated by a person whose title or function is Senior Engineer or above.
- 3.1.2 The originator shall establish and maintain a work file with which the calculation or analysis can be identified. All pertinent documentation accumulated in the work file as part of the work activity shall be included in the calculation documentation. There is no requirement to maintain a work file once a calculation is approved.
- 3.1.3 To assure ready reference and retrieval of work, the calculation or analysis shall be assigned a title which will allow the work to be identified with the plant, project, or request for which the work was initiated. For example, the title may include an EDCR number, Work Order number, a specification number, or similar identification, such as "Pipe Stress Calculation for VY EDCR 83-2".
- 3.1.4 An identifying number shall be obtained from the Document Control Center (DCC).

3.2 The format and content of a calculation or analysis shall conform to the following requirements:

3.2.1 The title page (Figure 1) shall contain the work activity title; the name of the applicable project or plant; calculation number; signatures and dates indicating performance (or revision), review, and approval of the work.

3.2.2 Successive pages including attachments shall contain the calculation number, page number, and date; and shall encompass the following, as applicable: (see Figure 2)

- 1) A problem description which includes the objective of the analysis or calculation
- 2) The intended method of solution.
- 3) Any references (such as drawings, specifications, or instructions) required to accomplish the activity.
- 4) Sources of equations and the units of parameters shall be identified, except where the equations and units are common engineering knowledge and are thus not taken from a specific reference.
- 5) Any design inputs used in the calculation or analysis, including specific references and sources.
- 6) Assumptions used to perform the calculations and their sources must be clearly stated or referenced in enough detail to allow competent, independent review.
- 7) The actual calculation or analysis. If a computer code is used, the originator shall provide a statement as to the status of code verification (code Level II or method of verification) and that the code is

appropriate for the application. See Figure 3 for guidance. Data extracted from computer codes shall be identified and reference shall be made to the computer program used. Whenever it is impractical to include the computer printout in the activity work file, the originator shall include or reference a listing of the input data with a synopsis of the output in the activity work file.

- 8) A summary of the results or conclusions. The originator shall be responsible for stating that the objective of the analysis/calculation was achieved, if appropriate.
- 9) Review form, if required.

3.2.3 Figure 3 provides guidance for the use of computer codes in calculations and analyses. Depending on the status level of the code, the guidance assures that the code has been properly verified and is appropriate for the application. If this assurance is not obtained, the originator is directed to WE-108 for guidance in obtaining, writing, or modifying a code to Level II status.

Unverified codes (or portions of codes) and engineering aids (such as calculators, programmable calculators, handwritten programs, etc.) may be used in calculations and analyses if the design analysis review required by Section 3.3 of WE-103 will provide the proper verification.

3.2.4 As the guidance given in this Instruction must be general enough to apply to many different situations, the suggested format for the calculation or analysis should be followed

to the extent that it can be applied to the specific activity. The content may be changed as necessary to give sufficient information to accomplish the desired objective.

3.3 Calculations and/or analyses shall be reviewed and approved according to the following Instructions:

\* 3.3.1 Reviewers shall be designated by a person whose title or function is Senior Engineer or above.

3.3.2 If a calculation or analysis is related to an initial design or design change, a design analysis review (see Definition) shall be performed by an individual other than the originator or his supervisor. The depth of review shall be determined by the reviewer, considering the safety significance, complexity, degree of standardization, state-of-the-art, and similarity to previous work. When alternate calculations are performed, the appropriateness of assumptions, input data, and code or other calculational method used in the original calculation shall be addressed.

3.3.3 The review of mechanical piping and structural analyses shall be performed using the attached checklist, Table I. The items on this list shall be addressed in the review.

3.3.4 All checks and reviews shall be documented as follows:

- 1) If a critical second-party review was performed in accordance with Section 3.3.2 above, and the reviewer's comments are readily resolved with the originator, the reviewer shall document his review by signing and dating the cover sheet.

2) If extensive or major comments are involved, or if a method other than critical second-party review is involved, the results of the review and the method used shall be documented on Form WE-103-1 or by a Standard Memorandum, WE-005, addressed to the originator and included in the work activity file. After resolution of comments, the reviewer shall sign and date the cover sheet.

3.3.5 If, after consultation with the originator, a reviewer determines that any portion of a calculation or an analysis is unacceptable, he shall issue a Standard Memorandum to the individual who assigned the task, explaining his objections. The issued Standard Memorandum shall be included in the work activity file.

3.3.6 The originator shall incorporate or resolve all comments by reviewers. In the event resolution is not possible, the appropriate Manager(s) shall provide resolution. Resolutions shall be documented on the review form, or by memo, and signed by the involved individuals.

3.3.7 If a calculation or analysis is not related to an initial design or design change (i.e., analysis of plant performance), then the depth of review shall be determined by the reviewer to the degree necessary to address any safety significance, as discussed in Section 3.3.2.

3.3.8 If a calculation or analysis has already had a design analysis review performed (such as work done by an outside design organization), check or review is not required, but may be performed. If the reviewer does perform a check or review, review of his work is not required.



- 3.3.9 Upon completion of the review process, the calculation or analysis shall be approved by the originator's Manager.
- 3.4 Calculations and analyses shall be revised according to the following Instructions:
- 3.4.1 Revisions to approved calculations and analyses shall be reviewed and approved by the same discipline(s) or group(s) that performed the original review and approval, unless otherwise designated by the Project or Department Manager. The designated organization and all reviewing organizations shall have access to pertinent background information, have demonstrated competence in the specific area of interest, and have adequate understanding of the requirements and intent of the original calculation or analysis.
- 3.4.2 Calculations or analyses which have been transferred to DCC as design records may be revised or supplemented, provided the revisions are reviewed and approved in accordance with this EI. The revision shall be transferred to DCC in accordance with DCC transfer requirements of WE-002.
- 3.5 The distribution of approved calculations and analyses shall be as follows:
- 3.5.1 Forward to DCC in accordance with the internal interface and DCC transfer requirements of WE-002.
- \* 3.5.2 Copies of completed work, or where more appropriate, a Standard Memorandum describing the work and results, should be sent to those who:
- 1) contributed to the work content,



- 2) are affected by its results,
- 3) are responsible for any implementation necessitated by the work.

If a memo is written, it shall be included in the work file.

3.5.3 Revisions shall receive the same distribution as the original calculation or analysis.

3.6 Deficiencies with this EI shall be reported according to Instructions found in WE-001.

#### 4.0 RECORDS

4.1 Calculations or analyses which are engineering design records, shall be controlled by DCC.

- \* 4.2 Calculations or analyses which provide technical backup for answers to NRC questions or verify plant operation within licensing requirements are not design records, but shall be forwarded to DCC for retention.

\*Indicates guidelines which are not QA requirements.

IMS NO. \_\_\_\_\_

RECORD TYPE \_\_\_\_\_

W.O./P.O. NO. \_\_\_\_\_

YANKEE ATOMIC ELECTRIC COMPANY

ANALYSIS/CALCULATION FOR

TITLE \_\_\_\_\_

PLANT \_\_\_\_\_ CYCLE \_\_\_\_\_

CALCULATION NUMBER \_\_\_\_\_

	PREPARED BY/DATE	REVIEWED BY/DATE	APPROVED BY/DATE
ORIGINAL			
REVISION 1			
REVISION 2			
REVISION 3			

KEYWORDS \_\_\_\_\_  
 \_\_\_\_\_

FIGURE 1

WE-103-9

## FORMAT FOR CALCULATIONS AND ANALYSES

1. Calculation No. \_\_\_\_\_
2. Structure/System/Component to which calculation applies
3. Problem Description  
Including objective and intended method, results of literature searches and other background data
4. Details of Analysis:  
Design Inputs, including sources  
Assumptions, including sources  
Appropriate figures, sketches, etc.  
Calculation/Analysis  
Identification of computer codes used
5. Results/Conclusion
6. References  
Including original work request, correspondence, texts, pertinent memos, drawings
7. Attachments  
Including (as applicable) review forms, computer output, technical information, associated correspondence, and memos

FIGURE 2

# GUIDANCE FOR THE USE OF COMPUTER CODES IN ANALYSES

WE-103, Section 3.2.3

## STATUS LEVELS OF CODES

- Level I Code: In process of being developed, modified or tested.
- Level II Code: Verified, documented, and scope identified.
- Level III Code: Superseded version of a Level II code, kept as a Level III for historical record and limited controlled usage.
- Level IV Code: Archived because it is obsolete or wrong, kept for historical purposes only.

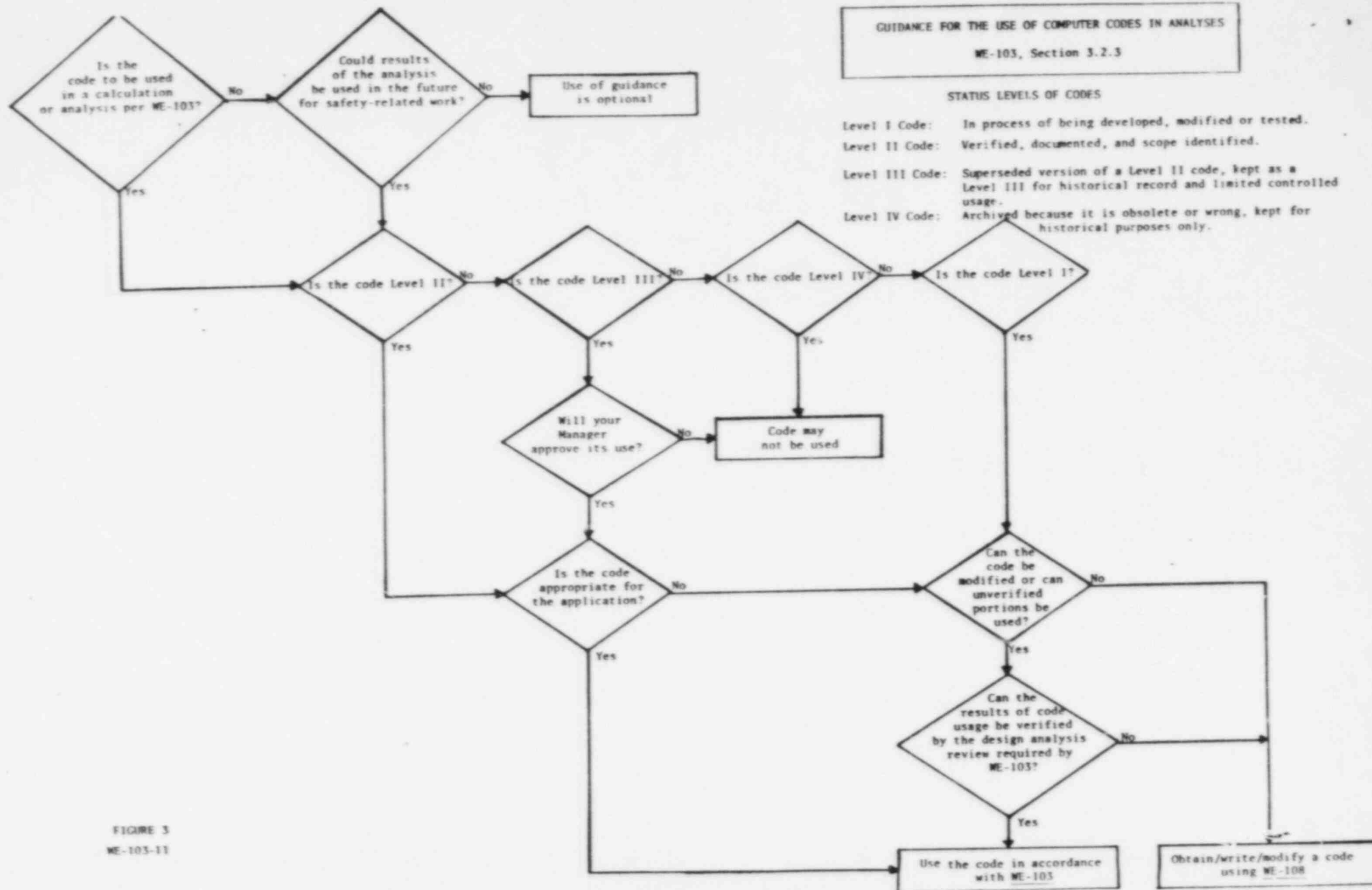


FIGURE 3  
WE-103-11

TABLE I

MECHANICAL ANALYSIS VERIFICATION CHECKLIST

I. MATERIAL PROPERTIES

- a. Are all material properties used in the analysis consistent for the material required and the design temperature?
- b. Are material property sources adequately referenced?

II. MODEL GEOMETRY

- a. Are lengths and coordinates consistent with reference documentation?
- b. Are the elements employed consistent with the structure modeled?
- c. Are eccentricities properly accounted for?
- d. Are boundary conditions or support functions adequately represented?
- e. Are units consistent?
- f. Is mass/weight distribution consistent with the type of analysis performed?

III. ELEMENT PROPERTIES

- a. Is orientation of elements consistent with structure geometry?
- b. Are cross sectional properties consistent with dimensions or pipe schedule?
- c. Are all necessary properties either calculated or referenced?
- d. Is the derivation of "equivalent" substructures clear and done properly? Have "cookbook" formulas been used correctly?
- e. If stress intensification factors are used, have they been properly calculated or referenced and applied?
- f. Have all model calculations been checked for calculational accuracy?
- g. Has transformation of neutral axes been properly done?
- h. Are all assumptions of rigid structures proper?

#### IV. LOADING

- a. Have all required loadings on the system been considered (pressure, accelerations, thermal, dead weight, etc.)? Are loading combinations done properly?
- b. Are anchor motions properly accounted for?
- c. Does the loading used consider adequately:
  - 1. Locations (building, elevation, etc.)
  - 2. Design loads required (FSAR, envelope, etc.)
  - 3. Dynamic amplifications for static analysis (resonance, multimode effect)
  - 4. Damping consistent with FSAR or regulatory guide standards
  - 5. Uncertainties (i.e., peak broadening)
  - 6. Required frequency content
- d. Is the source of all loadings properly referenced?

#### V. DESIGN CALCULATIONS

- a. Are procedures followed suitable to requirements of analysis?
- b. Have all hand calculations been verified?
- c. Are computer codes uniquely written for calculation properly verified?
- d. Are all computer codes employed familiar to the verifier and employed in a proper manner?
- e. Do all calculation results seem consistent with the problem geometry and the input loading?

#### VI. DESIGN CRITERIA

- a. Is the acceptance criteria consistent with required design codes?
- b. Are required design codes consistent with plant FSAR requirements?
- c. If current standards/criteria are to be followed, are up-to-date documents being used?
- d. Have any deviations which could affect acceptance criteria been adequately accounted for (i.e., anchor bolt spacing)?
- e. Are standards followed well documented?

VII. REPORT FORMAT

- a. Does the calculation comply with the current revision of WE-103?
- b. Is the calculation well documented and traceable?
- c. Are all changes to existing design or new designs required documented in one summary location?
- d. Are the major assumptions stated? Does the verifier concur that all assumptions are reasonable for the analysis?



REVIEW FORM

CALCULATION NO. \_\_\_\_\_

TITLE: \_\_\_\_\_  
\_\_\_\_\_

☐ Mechanical Analysis Verification Checklist was used.

COMMENTS

RESOLUTION

\_\_\_\_\_  
Reviewer / Date