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TVA Tennessee Valley Authority

TENNESSEE VALLEY AUTHORITY

Division of Nuclear Engineering

NE NUCLEAR ENGINEERING

CIVIL ENGINEERING BRANCH INSTRUCTION

CEB-CI 21.97

TITLE: OPERABILITY CRITERIA FOR PIPE AND PIPE SUPPORTS ON TVA CLASS I SEISMIC PIPING - BROWNS FERRY

THIS DOCUMENT CONSISTS OF 4 PAGES.

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PREPARED	S.E. Affolt					
REVIEWED	Von R Thompson					
APPROVED	W.E. Pennell/KH					

cc: RIMS, SL26 C-K

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Revision: 0

R—Denotes review

A—Denotes approval

ENGINEERING AND TECHNICAL SERVICES (E&TS)

CEB		EEB		MEB		NEB		ECB							
R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A

PROJECT ENGINEERING (PR ENG)

BFEP		BLEP		IRP		SQEP		WBEP		WP		DSN			
R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A

ENGINEERING ASSURANCE (EA)

R	A	R	A	R	A

OPERATIONS ENGINEERING SERVICES (OES)

EI&CB		MSB			
R	A	R	A	R	A

STAFFS

BACS		IMS		HR	
R	A	R	A	R	A

OTHER ORGANIZATIONS

R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A

TVA

Title: OPERABILITY CRITERIA FOR PIPE AND PIPE SUPPORTS ON TVA CLASS I SEISMIC PIPING - BROWNS FERRY

REVISION LOG

CEB-CI 21.97

Revision No.	DESCRIPTION OF REVISION	Date Approved
0	Original Issue	

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1.0 PURPOSE

The purpose of this instruction is to provide engineering guidelines for implementing Browns Ferry operability criteria as applicable to non-torus attached pipe and pipe support modifications for TVA Class I seismic piping.

2.0 SCOPE

These guidelines shall apply to all piping and supports on TVA Class I seismic piping, for which pipe or pipe support modifications are required; i.e., any physical modification of pipe or pipe support required as a result of the inability to qualify according to Design Criteria BFN-50-C-7103 and BFN-50-C-7104 (Reference 1 & 2). Modifications will be prioritized into two groups; those that require implementation for operability and those that require implementation for design criteria. Operability modifications are those piping and pipe support modifications that do not comply with the criteria in this document. Design criteria modifications are those piping and pipe supports modifications that comply with the requirements of this document but are necessary for design criteria compliance.

3.0 PIPE STRESS EVALUATION CRITERIA

For piping systems that do not meet the design criteria BFN-50-C-7103 a case by case piping system operability review maybe performed as follows.

For the emergency loading combinations and stress intensification factors as defined in BFN-50-C-7103, evaluate the piping to ensure that the primary stress in the piping is less than 2 S_y and the secondary stress in the piping is less than S_y or ASME Section III Equation 10 and 11 allowables of reference 5.

In cases where piping secondary exceeds the secondary stress allowables of reference 5 they may be shown to meet an augmented Class 2 and 3 fatigue evaluation (Reference 7).

Alternatively, the piping strains shall not exceed the limits of Code Case N-47, Appendix T.

The adjacent pipe supports shall meet allowables given in this criteria document.

4.0 PIPE SUPPORT EVALUATION CRITERIA

4.1 Load Combinations and Piping Movements

For prioritization the proposed pipe support modifications shall be evaluated only for the emergency loading condition in accordance with BFN-50-C-7103.

4.2 Allowable Limits

The following limits shall be used to establish priorities for pipe support modifications.

4.2.1 Linear Supports:

The support member stresses shall not exceed the lessor of 1.2 S_y and 0.7 Su for tensile and flexural stresses, and 90 percent of the critical buckling stress as defined in AISC specification (Reference 3) for compressive loads. Shear stresses shall not exceed 60 percent of allowable stress for tensile and flexure stresses.

4.2.2 Standard Support Components:

These shall meet the emergency allowables of BFN-50-C-7103.

4.2.3 Bolting:

The stress allowables for bolting shall be the greater of 70 percent of the minimum specified tensile strength or the minimum specified yield stress of the bolt material.

4.2.4 Concrete Expansion Anchors:

The minimum factors of safety for concrete expansion anchors (wedge & shell types) shall be 2.0. (Reference 6).

4.2.5 Pipe to Pipe Support Gap:

Supports with pipe to pipe support total gap which exceeds 1/2" shall be modified unless acceptable in accordance with the evaluation in 4.2.6. In addition, the first support adjacent to equipment nozzles, anchors, penetrations, and active valves and body or stem supported valves shall be modified if the total gap exceeds the installation requirement of 5/32 inch maximum total gap. (Reference 4)

4.2.6 Load Sharing Between Supports:

For supports that do not meet the interim allowable stress criteria presented herein and are not adjacent to an equipment nozzle, an anchor, a penetration, an active valve, or a body/stem-supported valve, a case-by-case evaluation may be performed that considers redistribution of load to adjacent supports. The effect of load redistribution on piping stress shall be considered in accordance with section 3.0.

The adjacent pipe supports shall meet the allowables contained in this criteria document.

4.2.7 Constant and Variable Spring Supports:

Shall be evaluated to accommodate the "maximum pipe movement" without bottoming out.

4.2.8 Subsystem Evaluations

Portions of a stress analysis math model may be decoupled and a local analysis may be performed, to assess the need for the modification, provided appropriate overlap on model boundaries is considered. Hand calculations, new subsystem models, and scaling techniques may be utilized in addition to computer calculations.

The following section provide guidance for the evaluation of modifications required due to thermal loading.

4.2.8.1 Modifications Due to Thermal Loading:

Support flexibility for specific supports may be utilized in the subsystem evaluations in lieu of conservative computer code default values to more realistically predict thermal loading.

The effects of gaps may be considered where large thermal loads result from the constraint of small thermal growths due to opposing supports.

4.2.9 Thermal Monitoring

Modifications identified due to exceeding the swing angle, binding, or other potential thermal interferences on snubber, strut, and spring supports need not be a design constraint and may be deferred, if visual monitoring shows no thermal binding or restraint in the support assembly. Additionally, supports requiring modification due to unrealistic thermal loads will be monitored with instrumentation to determine the actual thermal loads.

5.0 DOCUMENTATION

Engineering evaluations performed to determine the priority of modifications shall be documented in calculations performed in accordance with the applicable QA requirements.

6.0 REFERENCE

1. Design Criteria for Structural Analysis and Qualification of Mechanical and Electrical Equipment BFN-50-C-7103.

2. Design Criteria for Design of Supports BFN-50-C-7104.

3. Specification for the Design, Fabrication, and Erection of Structural Steel Buildings, AISC 7TH and 8TH Editions.

4. Letter from R. L. Cloud Associates to TVA "Position Paper on Pipe to Support Gap Limit, "Letter No. P154-3 L-020, August 25, 1987.

5. ASME Section III, Subsection NC, 1983.

6. IE Bulletin No. 79-02, Revision 1, Supplement 1 dated August 20, 1079, Pipe Support Base Plate Designs Using Concrete Anchor Bolts.

7. NUREG/CR-2343, DATED June 1983, Comparisons of ASME Code Fatigue Evaluation Methods for Nuclear Class 1 Piping with Class 2 or 3 Piping.

USE OF ARTIFICIAL TIME HISTORY

- BACKGROUND
- SUBMITTAL TO NRC ON 5/26/87
- IMPORTANCE OF TIMELY APPROVAL
  - 79-14/02
  - SMALL BORE

BROWNS FERRY SEISMIC DESIGN BASES

		ORIGINAL	FOR PIPING ANALYSIS
1. PEAK GROUND ACCELERATION			
	OBE	0.1g	0.1g
	DBE(SSE)	0.2g	0.2g
	VERT.	2/3 Horiz.	2/3 Horiz.
2. EARTHQUAKE COMPONENT		2-D	2-D
3. SITE DESIGN SPECTRUM		"HOUSNER" BASED ON AVERAGE OF 4 EARTHQUAKES	"HOUSNER" BASED ON AVERAGE OF 4 EARTHQUAKES
4. TIME HISTORY INPUT MOTION FOR SEISMIC SYSTEM ANALYSIS		1940 EL CENTRO EARTHQUAKE TIME HISTORY (N-S COMPONENT) ENVELOPING HOUSNER SPECTRUM	ARTIFICIAL TIME HISTORY ENVELOPING HOUSNER SPECTRUM

BROWNS FERRY UNIT 2
79-14/79-02 PROGRAM

PROGRAM OVERVIEW
- o SCOPE
- o PROGRAM SUMMARY

STATUS

COMPLETION PLAN
- o SCHEDULE
- o MODIFICATION PRIORITIZATION

CRITERIA
- o SYSTEM OPERABILITY CRITERIA
- o SEISMIC DESIGN BASIS
- o PIPING AND SUPPORT DESIGN CRITERIA

REVIEW SUBMITTALS

SUMMARY

BROWNS FERRY UNIT 2
79-14/79-02 PROGRAM

SCOPE

- NRC BULLETIN 79-02
- NRC BULLETIN 79-14
- APPROXIMATE QUANTITIES

  30 SYSTEMS
  240 STRESS PROBLEMS
  4000 SUPPORTS

- COMPLETED TORUS AND CRD

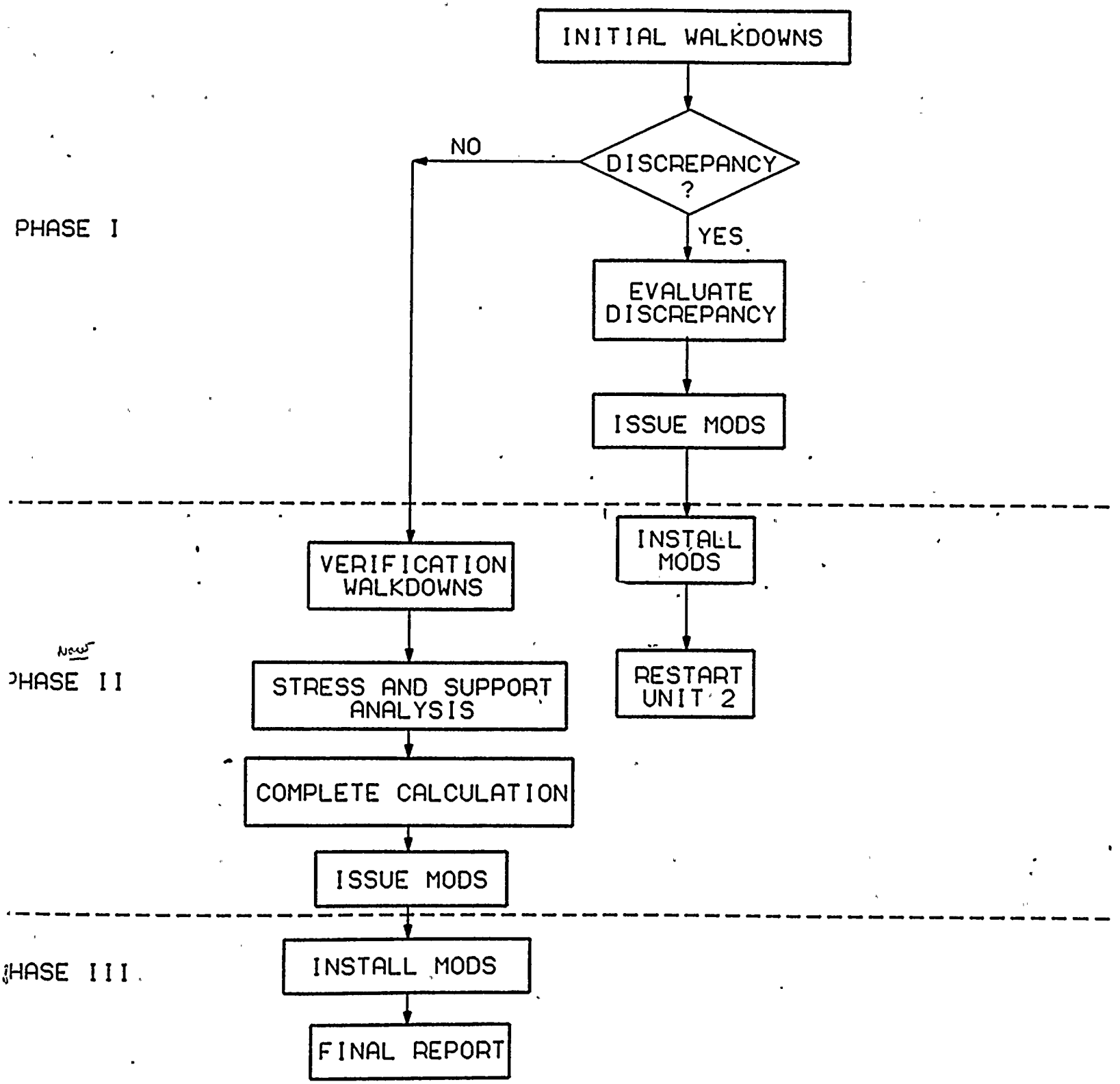
  20 STRESS PROBLEMS
  500 SUPPORTS

- REMAINING 79-14 PROGRAM

  220 STRESS PROBLEMS
  3500 SUPPORTS

BROWNS FERRY UNIT 2
79-14/79-02 PROGRAM

PROGRAM SUMMARY



BROWNS FERRY UNIT 2
79-14/79-02 PROGRAM

STATUS

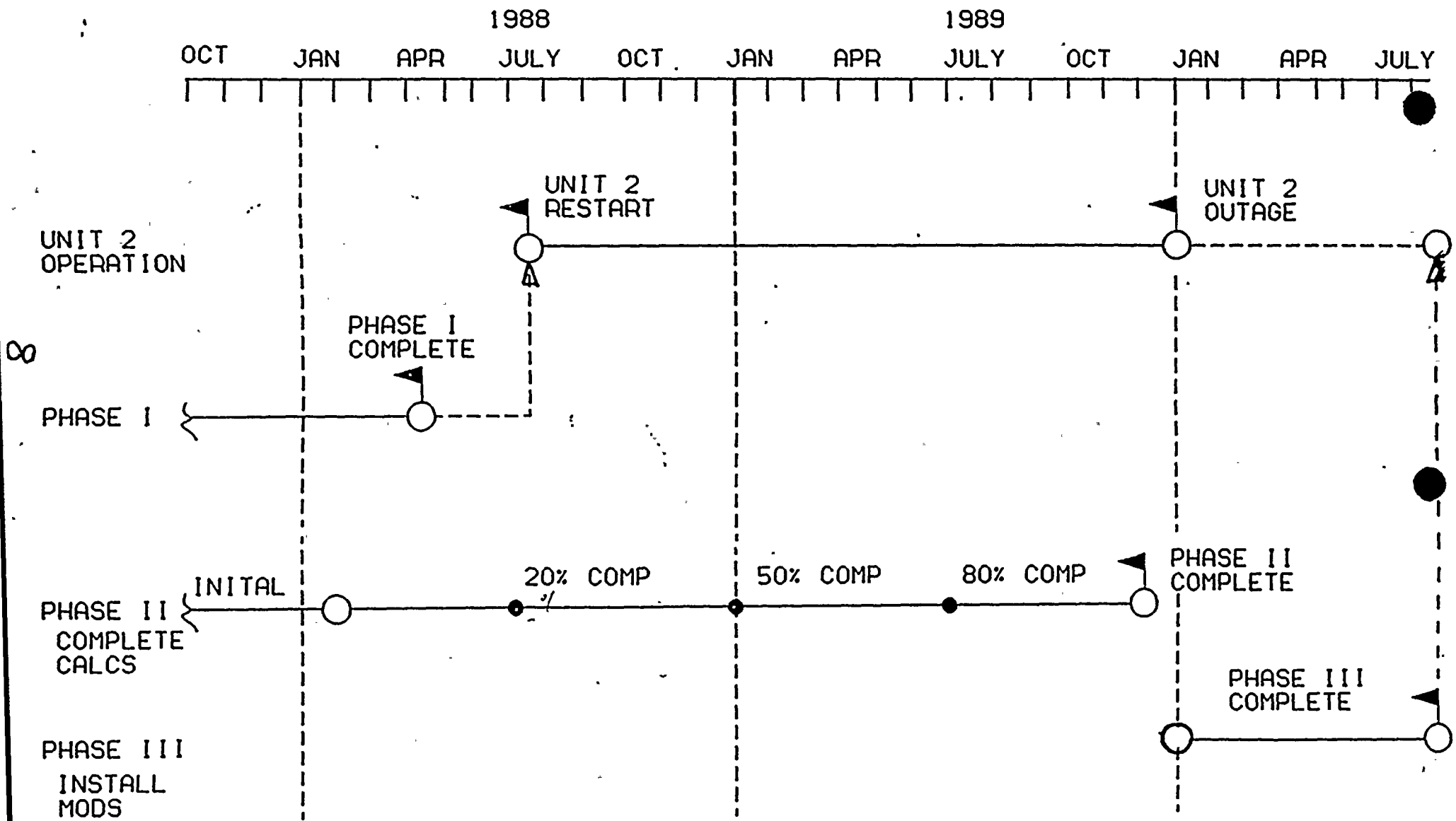
PHASE I

- COMPLETED WALKDOWNS
- DEVELOPED DATA BASE OF SUPPORTS
- ASSEMBLED DATA PACKAGES
- IDENTIFIED APPROX 600 DISCREPANCIES (3 UNITS)
  - 510 ACCEPTABLE OR MINOR
  - 90 MODIFICATIONS
- RESOLVING AUDIT FINDINGS

PHASE II

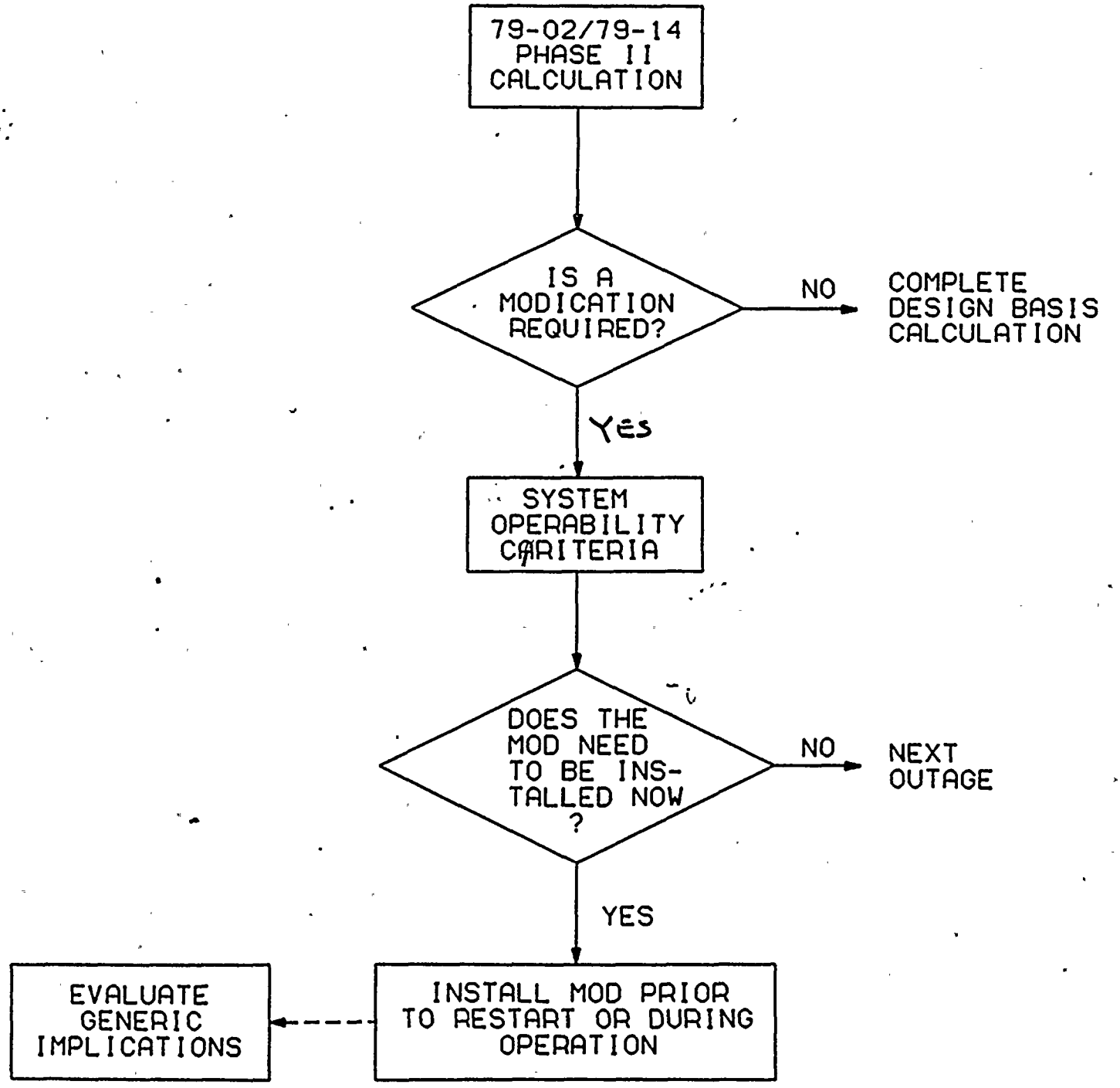
- INITIATED VERIFICATION WALKDOWNS
- INITIATED ANALYSIS
- CONTINUING DATA BASE ACTIVITIES

BROWNS FERRY UNIT 2
79-14/79-02 PROGRAM



BROWNS FERRY UNIT 2
79-14/79-02 PROGRAM

MODIFICATION PRIORITIZATION



BROWNS FERRY UNIT 2
79-14/79-02 PROGRAM

SUMMARY
SYSTEM OPERABILITY CRITERIA

LOAD COMBINATIONS:

PIPE AND PIPE SUPPORT MODIFICATIONS TO BE EVALUATED FOR EMERGENCY LOAD CONDITION ONLY.

LINEAR SUPPORTS:

MEMBER STRESS IS THE LESSER OF 1.2 SY & 0.7 SU FOR TENSION & FLEXURE AND 0.9 PCR FOR MEMBERS IN COMPRESSION.

STANDARD COMPONENTS:

MEET EMERGENCY ALLOWABLES IN DESIGN CRITERIA.

NON-STANDARD COMPONENT SUPPORT BOLTING:

ALLOWABLE STRESS IS MINIMUM SPECIFICED YIELD STRESS OR $0.7S_U$

CONCRETE EXPANSION ANCHORS:

SAFETY FACTOR MUST BE EQUAL TO OR GREATER THAN 2.0.

BROWNS FERRY UNIT 2
79-14/79-02 PROGRAM

SUMMARY
SYSTEM OPERABILITY CRITERIA
(CONTINUED)

SPRINGS:

MUST NOT EXCEED LIMITS OF TRAVEL

GAP BETWEEN PIPE & SUPPORT:

MAY BE AS MUCH AS 0.50 IN. (EXCEPT WHEN ADJACENT TO EQUIPMENT).

*LOAD SHARING:

LOAD MAY BE REDISTRIBUTED TO ADJACENT SUPPORTS: EFFECT ON PIPING STRESS MUST BE CONSIDERED.

*PIPING SYSTEM OPERABILITY (JUSTIFICATION FOR CONTINUED OPERATION):

- -ASSUME PIPE SUPPORT FAILS
- -PRIMARY STRESS IN PIPING NOT TO EXCEED 2 SY
- -ADJACENT PIPE SUPPORTS MEET OPERABILITY CRITERIA

*THESE CASES WILL BE USED ON A LIMITED BASIS.

BROWNS FERRY UNIT 2
79-14/79-02 PROGRAM

PIPING
SEISMIC DESIGN BASIS

	ORIGINAL DESIGN BASIS (EL CENTRO)	79-14/02 CRITERIA (ARTIFICIAL TIME HISTORY)
1. PIPING DAMPING		
OBE	0.5% (SECT C.3.2.1)	0.5%
DBE	1%	1%
2. DIRECTIONAL COMBINATIONS	SRSS (SECT C.3.2.1)	SRSS
3. MODAL COMBINATIONS	SRSS (SECT C.3.2.1)	SRSS
4. RIGID RESPONSE	20HZ (SECT C.2.1)	20HZ
5. VERTICAL RESPONSE SPECTRA (ALL ELEVATIONS)	0.07g-OBE 0.13g-DBE	2/3 HORIZIONAL GROUND RESPONSE SPECTRA
6. HORIZONTAL RESPONSE SPECTRA	DETERMINE BY DYNAMIC ANALYSIS FROM GROUND RESPONSE SPECTRA	DETERMINE BY DYNAMIC ANALYSIS FROM GROUND RESPONSE SPECTRA

DESIGN CRITERIA USED AT BROWNS FERRY

79-02/79-14 PHASE I PIPING & SUPPORT LOADING COMBINATIONS AND STRESS LIMITS

LOADING COMPINATIONS		PIPING (1)	SUPPORTS/ANCHOR BOLTS
NORMAL			
PRIMARY	DW+ P	1.0 S_H OR YIELD	1.0 AISC/FS≥2
SECONDARY	T_H	S_A OR YIELD	—
PRIMARY + SECONDARY	DW+P + T_H	(S_A+S_H) OR YIELD	1.5 AISC/FS≥2
UPSET			
PRIMARY	DW+P+OBE	1.2S_H OR YIELD	1.0 AISC/FS≥2
PRIMARY + SECONDARY	DW+P+DBE +T_H	—	1.6 AISC/FS≥2
EMERGENCY			
PRIMARY	DW+P+OBE	1.8S_H OR YIELD	1.33 AISC/FS≥2
PRIMARY+ SECONDARY	DW+P+DBE +T_H	—	1.6 AISC/FS≥2

S_H - BASIC MATERIAL ALLOWABLE ~~STESS~~ STRESS AT DESIGN TEMPERATURE

S_A - ALLOWABLE EXPANSION STRESS

(1) USE LARGER OF CODE ALLOWABLE OR YIELD

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DESIGN CRITERIA USED AT BROWNS FERRY
PIPING AND SUPPORT LOADING COMPINATIONS AND STRESS LIMITS

LOADING COMPINATIONS		79-14/79-02 PROGRAM	
		PIPE	SUPPORTS (3)
NORMAL			
PRIMARY	DWG+ P	S_H	
PRIMARY + SECONDARY	DWG+P + T_H	S_A+S_H	1.0 AISC
UPSET		(1) (2)	
PRIMARY	DW+P+OBE	$1.2S_H/1.5S_H$	1.33 AISC
PRIMARY + SECONDARY	DW+P+DBE +T_H	$1.2\ (S_A+S_H)$	
EMERGENCY		(1) (2)	
PRIMARY	DW+P+OBE	$1.8S_H/2.0S_H$	1.5 AISC OR .9 FY
PRIMARY+ SECONDARY	DW+P+DBE +T_H	—	

(1) OPERATING PRESSURE

(2) MAXIMUM PRESSURE

(3) ANCHOR BOLT F.S $\geq$ 4,5

S_H - BASIC MATERIAL ALLOWABLE STRESS AT DESIGN TEMPERATURE

S_A - ALLOWABLE EXPANSION STRESS

BROWNS FERRY UNIT 2
79-14/79-02 PROGRAM

S U B M I T T A L S

DATE	DESCRIPTION
o JUNE 81	DESCRIPTION FOR 3-PHASE PROGRAM
o AUG 86	NUCLEAR PERFORMANCE PLAN VOLUME 3. REVISION 0
o APR 87	PROGRAM PROCEDURES
o MAY 87	USE OF ARTIFICIAL TIME HISTORY IN LIEU OF 1940 EL CENTRO
o APR 87	SEISMIC DESIGN ISSUE
o JULY 87	NUCLEAR PERFORMANCE PLAN VOLUME 3. REVISION 1

BROWNS FERRY UNIT 2
79-14/79-02 PROGRAM

SUMMARY

REQUEST NRC APPROVAL:

- USE OF ARTIFICIAL TIME HISTORY FOR PIPING
- 3-PHASE PLAN AND SCHEDULE FOR IMPLEMENTATION OF 79-02 AND 79-14 PROGRAM
- USE OF ENGINEERING JUDGEMENT IN LIEU OF COMPLETE CALCULATION DOCUMENTATION IN PHASE I