TENNESSEE VALLEY AUTHORITY

DIVISION OF ENGINEERING DESIGN

THERMAL POWER ENGINEERING BRANCHES

CIVIL ENGINEERING BRANCH

BREAK EXCLUSION POSITION

FOR COMPLYING WITH

APCSB 3-1 AND MEB 3-1

BELLEFONTE NUCLEAR PLANT UNITS 1 AND 2

JUNE 8, 1976

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JUNE 8, 1976

CEB-76-13

Sponsor Engineer

Reviewed by

Recommended

Approved

TVA 10567 (DED-6-74)

COORDINATION LOG

Plant: BELLEFONTE NUCLEAR PLANT UNITS 1 AND 2
BREAK EXCLUSION POSITION FOR COMPLYING WITH APCSB 3-1 AND MEB 3-1

CEB-76-13

Revision:

R – Denotes review

A – Denotes approval

Thermal Power Engineering Branches						Thermal Power Design Project						Architectural, Hydro, & Special Projects Engineering & Design Branches							
MEB		EEB		CEB		Project Manager				R	A	AD		ME&D		CE&D		EE&D	
											[signature]								
R	A	R	A	R	A	MD		ED		CD		R	A	R	A	R	A	R	A
GWC	GWC			DWGR	DWGR	R	A	R	A	R	A								
TCP	TCP			DCP	DCP	BCS	BCS			FDS	FDS								
HGO	HGO			KLM	KLM	JSB	JSB/m			RDH	RDH								
	CM (for HGO)			DMW	DMW					CDD	CDD								
EGB	EGB			BBN	BBN														
[signature]	[signature]																		

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FOREWORD

On March 3, 1976, TVA representatives met with the Nuclear Regulatory Commission's Mechanical and Containment Systems Branches and presented the TVA plan for implementing the portion of Branch Technical Positions APCSB 3-1 and MEB 3-1 which deals with postulated pipe break exclusions. NRC generally agreed with the TVA approach and asked that the position be submitted for formal consideration. This submittal is in response to that request.

1.0 PURPOSE

The purpose of this submittal is to present for formal review the TVA plan for implementing APCSB 3-1, paragraph B.2.c, and MEB 3-1, paragraphs B.1.b(1)(e) and (f).

2.0 INTRODUCTION

Companion Branch Technical Positions APCSB 3-1 and MEB 3-1 acknowledge the practical necessity for allowing relief in the postulation of pipe breaks in certain main steam and feedwater piping. These positions also establish controls in the form of stress limits and other protective measures to assure an increased confidence level in this particular piping and in the operational integrity of the associated isolation valves.

3.0 SCOPE

The piping addressed by this submittal is the main steam and feedwater piping for the Bellefonte Nuclear Plant beginning at the flued head anchors in the primary containment wall and extending through the annulus to the main steam valve rooms (protected by guard pipe in this region), continuing through the valve rooms and isolation valves, to the flued head anchors in the outer valve room walls (figures 1 through 4).

4.0 PIPING LAYOUT INSIDE MAIN STEAM VALVE ROOMS

Figures 1 through 4 show the main steam and feedwater piping layouts including approximate locations of isolation valves. Figures 5 through 8 are isometrics of the main steam and feedwater lines showing the anchors, supports, and other prominent elements of the piping models. Also shown in figures 5 through 8 are the locations at which breaks would normally be postulated in the main runs and the corresponding stresses associated with the upset plant condition. Stresses at all other points are less than those shown.

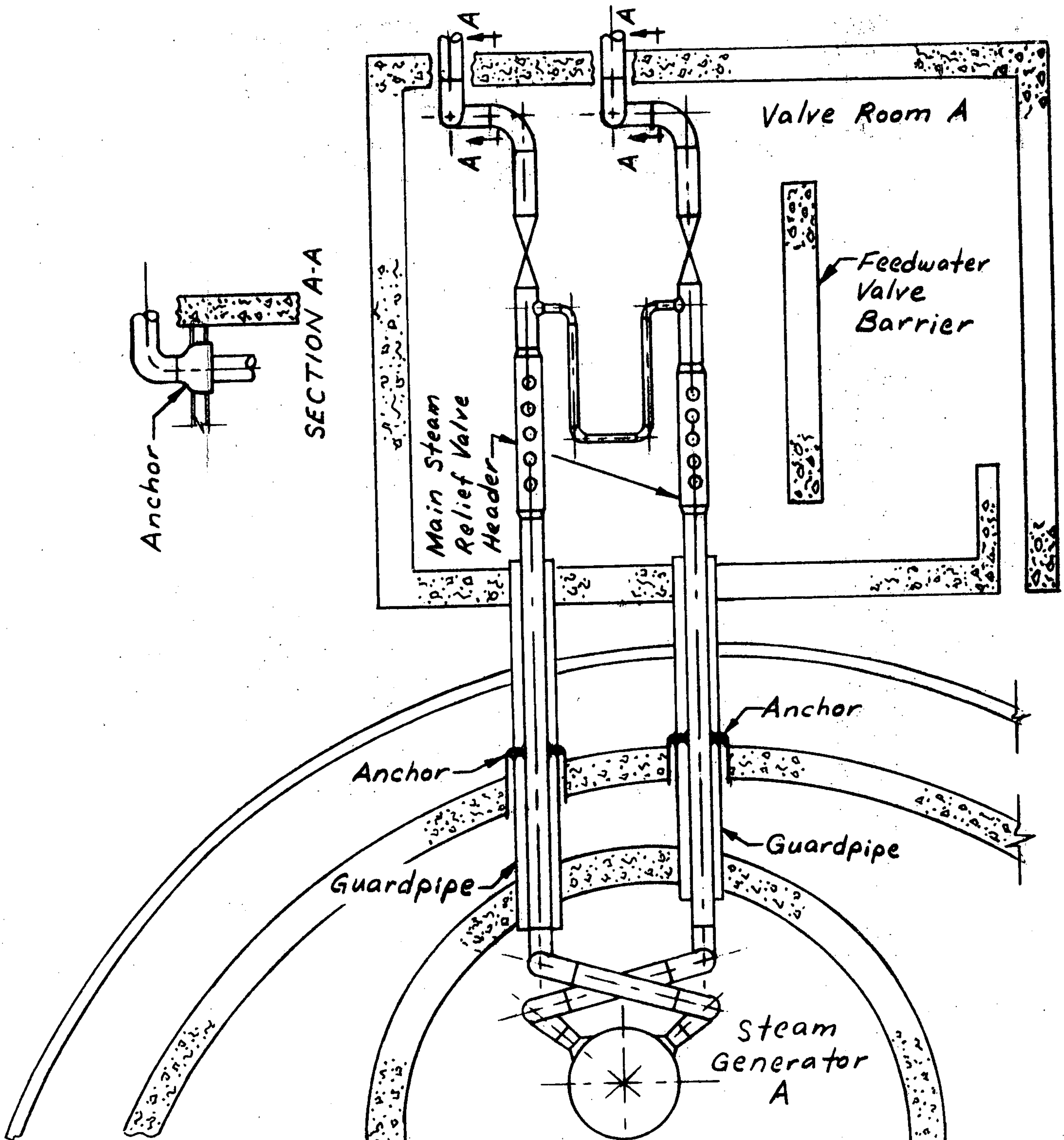


FIGURE 1
MAIN STEAM PIPING
STEAM GENERATOR A

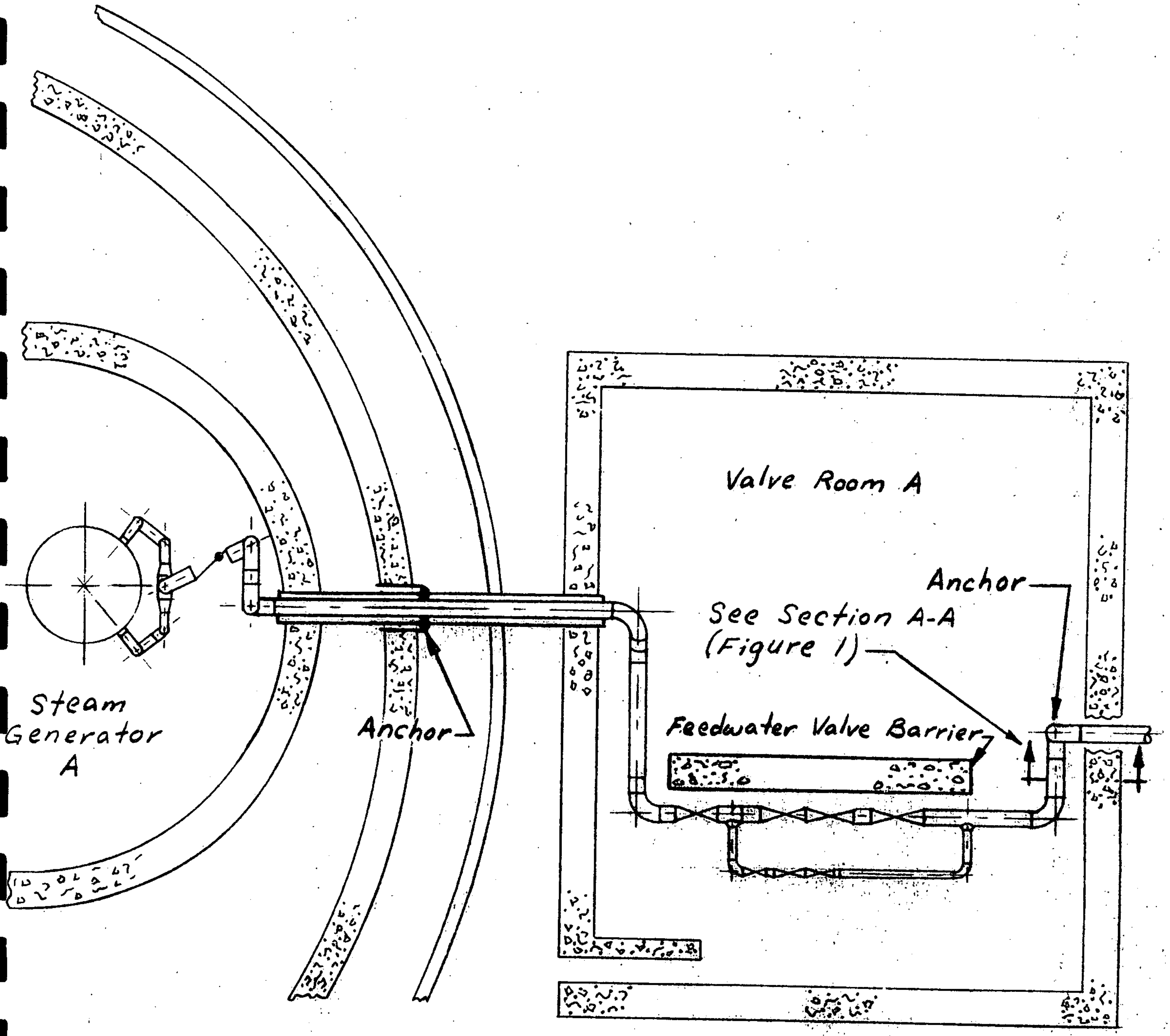


FIGURE 2
FEEDWATER PIPING
STEAM GENERATOR A

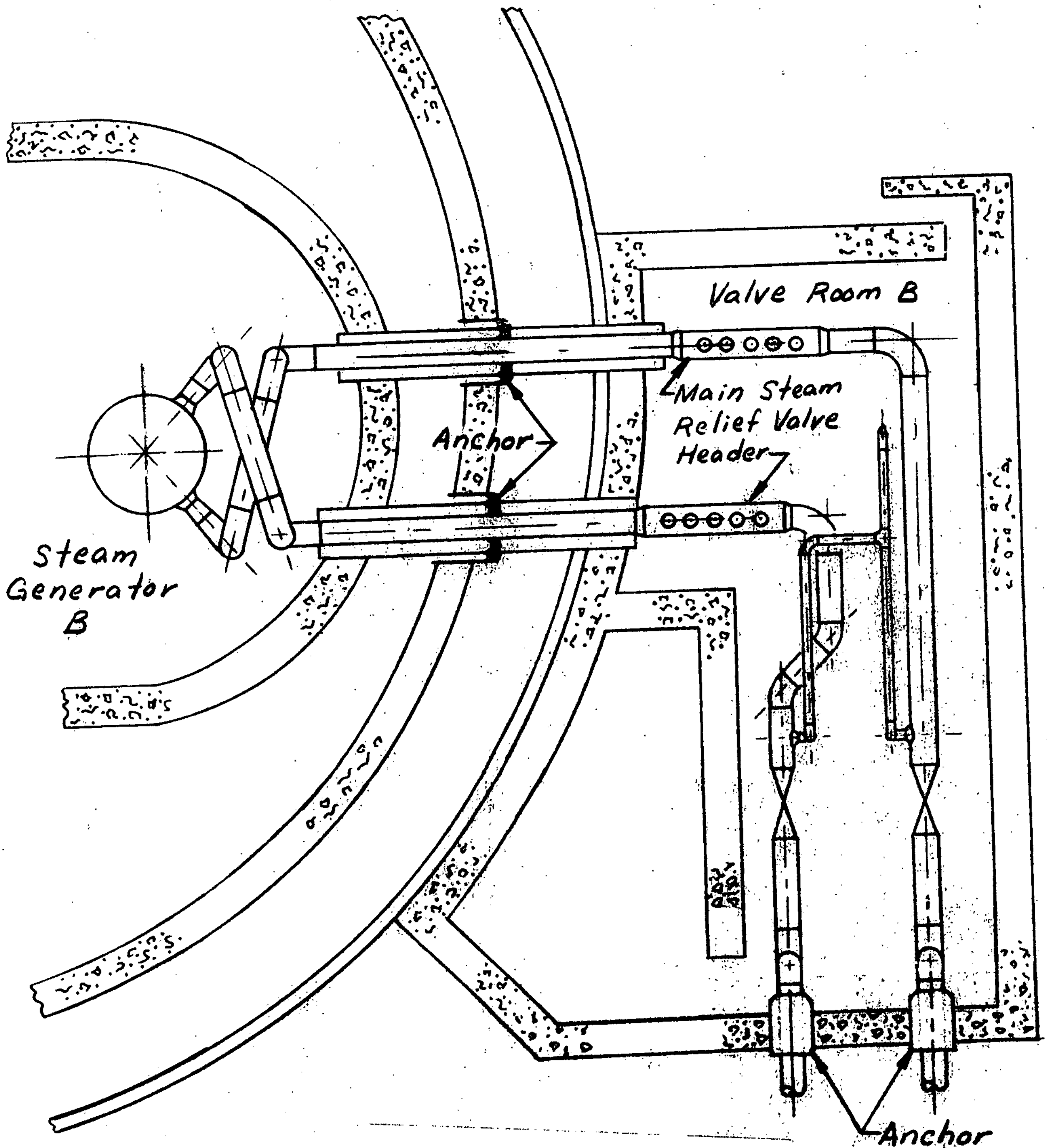


FIGURE 3
MAIN STEAM PIPING
STEAM GENERATOR B

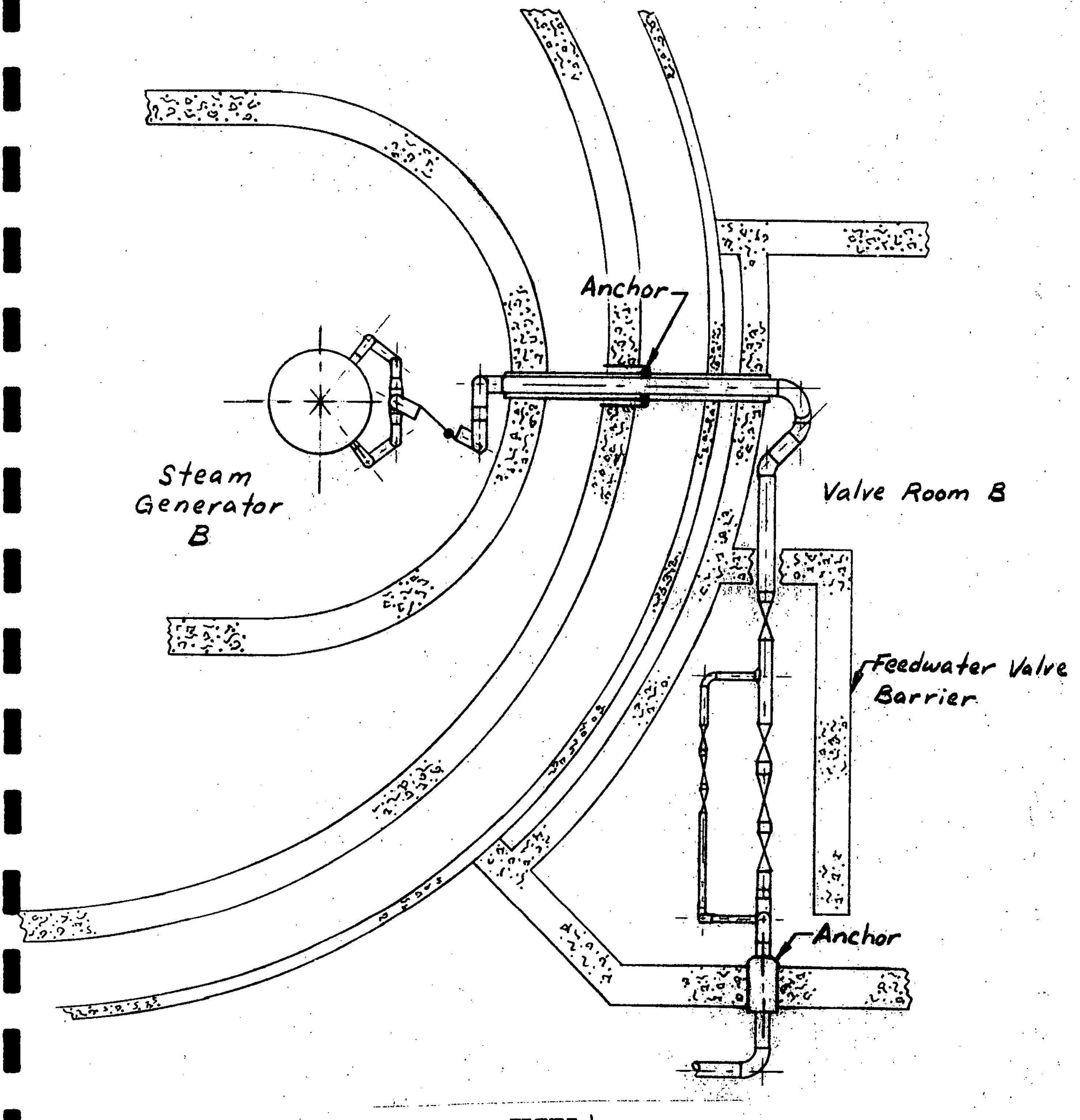


FIGURE 4
FEEDWATER PIPING
STEAM GENERATOR B

NODE POINT	STRESS (KSI) (PLANT UPSET)
1.	26.6
2.	26.0
3.	26.9
4.	19.2
5.	27.3
6.	26.1
7.	26.5
8.	20.4

$$0.8\left(1.2\, S_h + S_A\right) = 37.8 \text{ KSI}$$

For Legend See Figure 7.

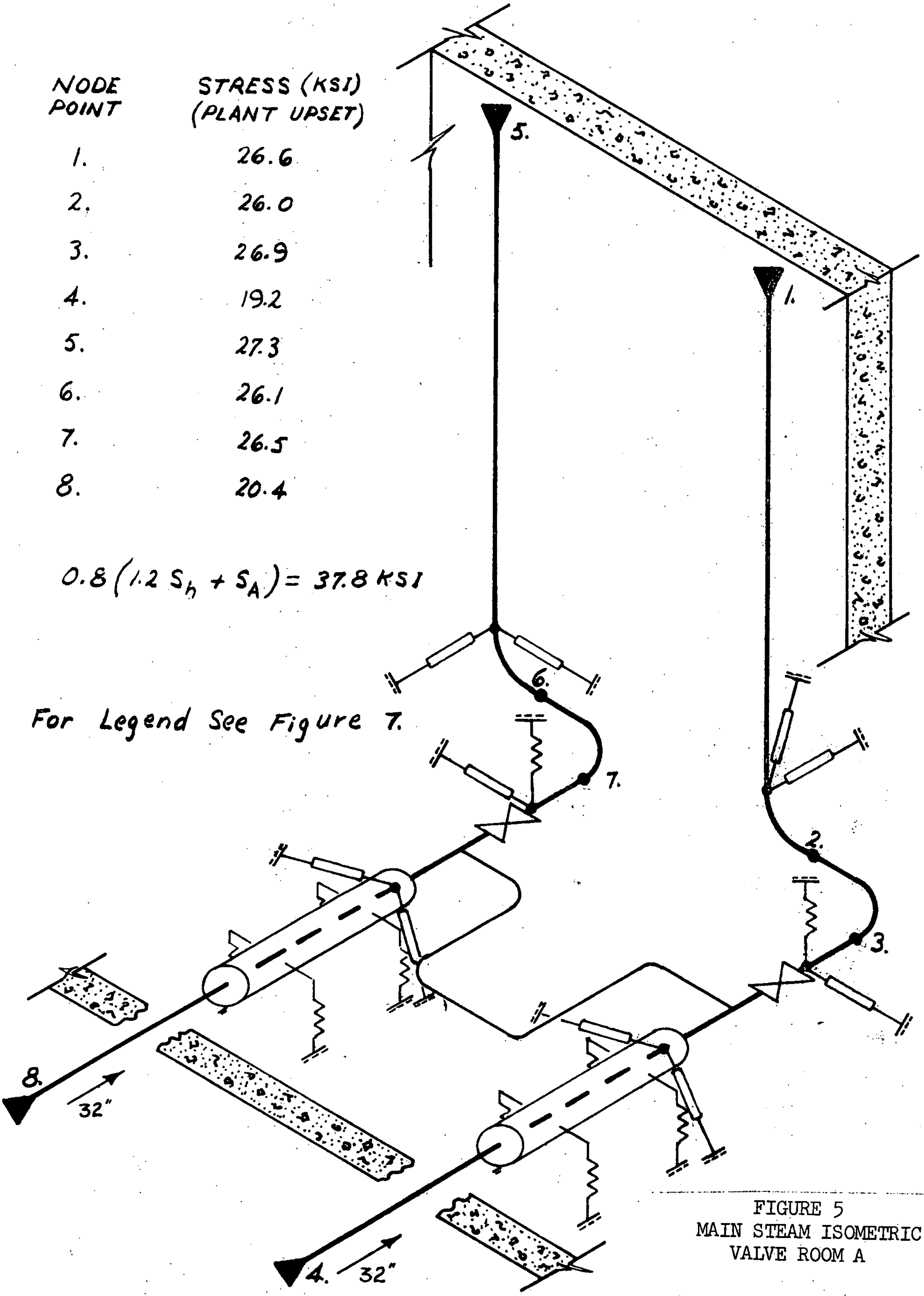


FIGURE 5
MAIN STEAM ISOMETRIC
VALVE ROOM A

NODE POINT	STRESS (KSI) (PLANT UPSET)
1.	17.3
2.	18.4
3.	16.8
4.	18.6

$0.8(1.2S_h + S_A) = 32.4$ KSI

For Legend See Figure 7.

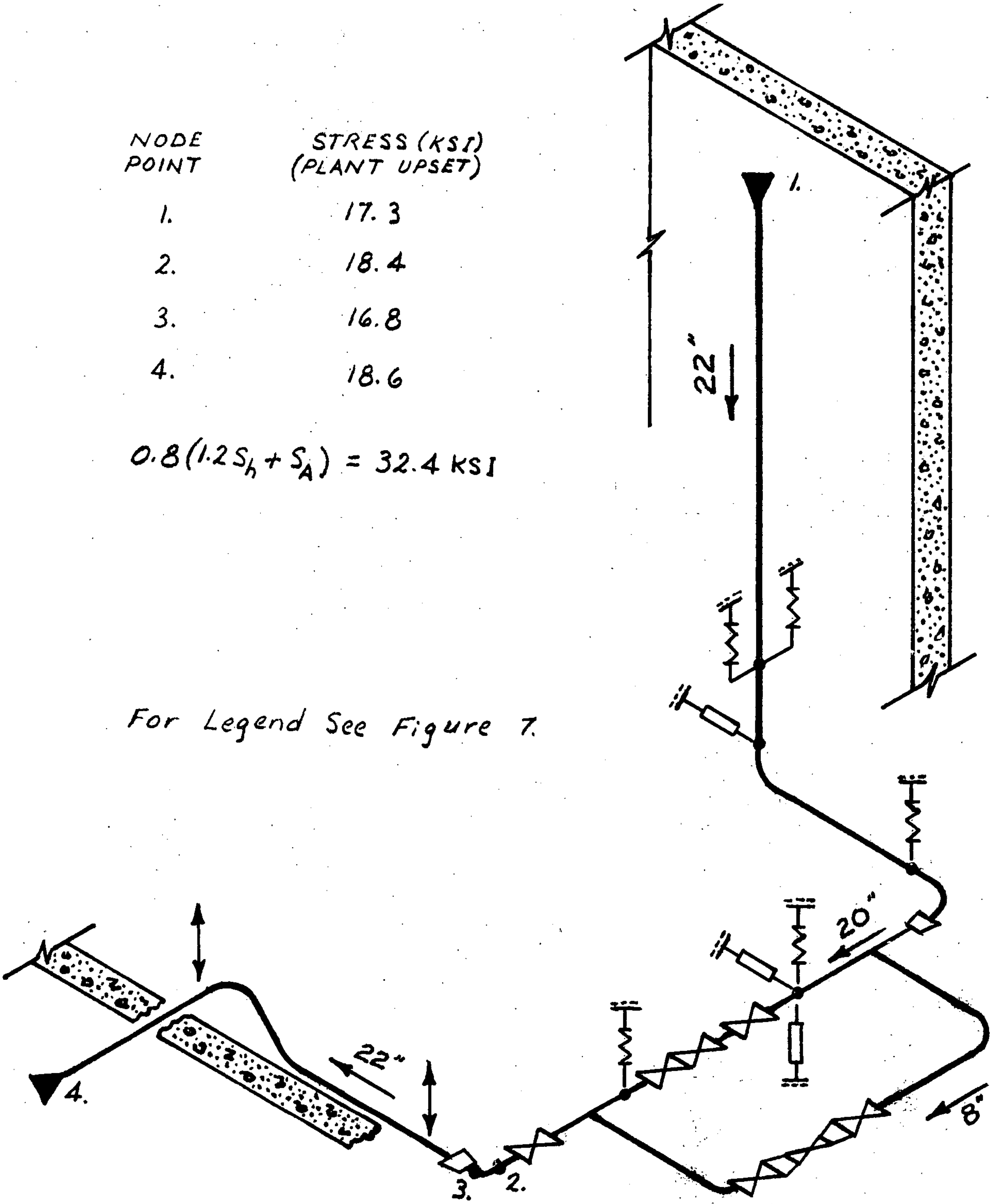


FIGURE 6
FEEDWATER ISOMETRIC
VALVE ROOM A

NODE POINT	STRESS (KSI) (PLANT UPSET)
1.	31.1
2.	28.8
3.	25.9
4.	15.8
5.	27.5
6.	26.8
7.	24.0
8.	15.5

$$0.8\,(1.2\,S_h + S_A) = 37.8\ KSI$$

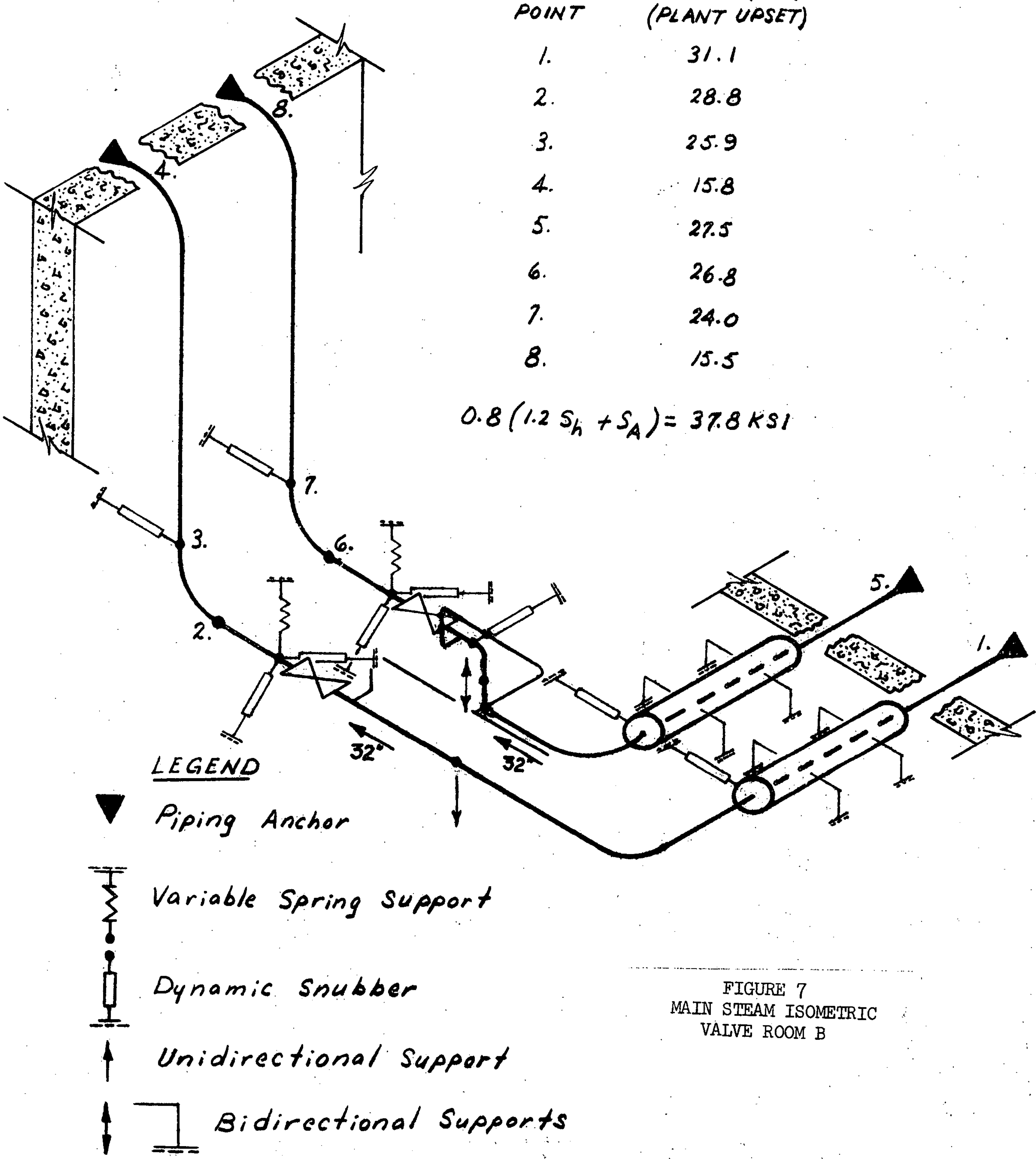
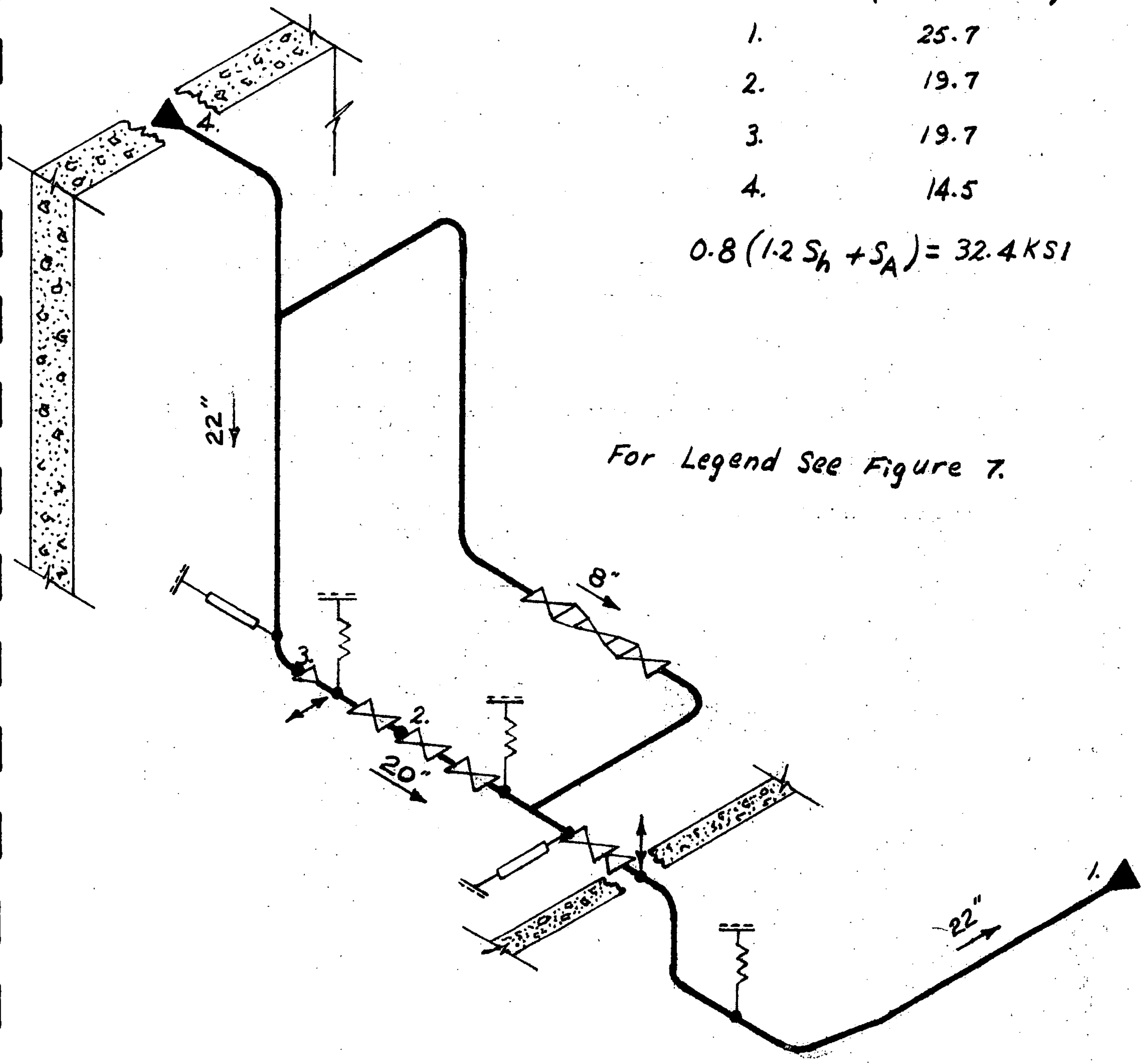


FIGURE 7
MAIN STEAM ISOMETRIC
VALVE ROOM B

NODE POINT	STRESS (KSI) (PLANT UPSET)
1.	25.7
2.	19.7
3.	19.7
4.	14.5

$$0.8(1.2 S_h + S_A) = 32.4 \text{ KSI}$$



For Legend See Figure 7.

FIGURE 8
FEEDWATER ISOMETRIC
VALVE ROOM B

5.0 BACKGROUND

Prior to the break exclusions offered by NRC Branch Technical Positions APCSB 3-1 and MEB 3-1, breaks inside valve rooms were postulated on a highest stress, minimum number basis. Mitigation measures normally consist of additions of large amounts of structural restraints, sleeves, barriers, etc. Many tons of pipe rupture mitigative steel are usually required inside valve rooms to meet the pipe rupture requirements. In addition to the costs and schedule constraints, these mitigative devices complicate other necessary activities such as inservice and maintenance inspections or component servicing, removal, and repair. Other alternatives (such as completely sleeving these lines) have been considered. Many of the same disadvantages exist, however, for sleeving as do for restraining with the additional problems of protecting the valves which cannot readily be sleeved.

It is TVA's position that Branch Technical Positions APCSB 3-1 offer a very rational and meaningful approach to the PWR main steam and feedwater valve room pipe rupture problem. MEB 3-1 acknowledges the decreased probability of breaks occurring in piping systems where the stresses are kept within specified limits and requires physical isolation of the no-break region through use of structural restraining devices. Through use of these restraints, events outside this region are prevented from stressing this piping and interfering with valve operability.

6.0 DESIGN BASES

In the design of the main steam valve rooms and the contained main steam and feedwater piping, several controlling criteria have been set to assure safe shutdown capability is preserved for all postulated pipe ruptures.

a. No arbitrarily located pipe rupture within the valve rooms shall result in a class 9 accident.

b. No pipe rupture in a steam line shall be allowed to jeopardize the isolation capability of the feedwater valves.

c. No pipe rupture event outside the valve rooms shall prevent closure of either the main steam or feedwater valves.

d. No arbitrarily located postulated pipe rupture shall pressurize the annulus region of the reactor building.

e. One complete train of steam supply to the turbine-driven auxiliary feedwater pump shall be protected and located within seismic Category I enclosures.

f. Piping in the no-break region shall be rigorously analyzed to ASME Section III, Class 2 requirements.

g. Stresses for the lines in the no-break region shall not exceed 0.8 $(1.2 S_h + S_A)$ where the terms are as defined in MEB 3-1 for class 2 piping for loading associated with the upset plant condition including the effects of the 1/2 SSE.

7.0 ALTERNATIVE APPROACHES CONSIDERED

Three alternative approaches to the valve room problem were considered in arriving at the selected scheme as presented herein. The alternatives considered and principal considerations are the following:

a. Design without the relief intended by APCSB 3-1/MEB 3-1 break exclusion allowances. The disadvantages of this approach are discussed in 5.0.

b. Design through literal interpretation of APCSB 3-1 and MEB 3-1.

The major problem of this approach may be attributable to a definition of terms. MEB 3-1 allows the use of "restraints" to confine consequences of an unlikely pipe break to the no-break region and to prevent external loading effects from affecting the no-break piping and valves. By the usual connotation of "restraints," these devices are inactive and out of contact with the process piping during all normal (and perhaps upset and emergency) plant conditions. For restraints to provide this protection would require a series of devices placed such as to remove all six components of loading. These would have to be spaced along the piping in such a manner as to resist all shears, moments, and torsion. For this series of restraints to work effectively, the no-break region would have to include the piping throughout the system of restraints. Otherwise, a postulated break within the system of restraints could invalidate the intent of restraints.

c. TVA recognizes that APCSB 3-1 and MEB 3-1 were developed for the general case which could not contain sufficient specifics for all possible cases. The approach taken for the Bellefonte Nuclear Plant differs from that given in b. above in that "anchors" instead of "restraints" are used to perform the function of a series of "restraints" indicated by a literal interpretation of MEB 3-1. Anchors, one at each end of the no-break piping runs, are designed to resist all six degrees of motion.

8.0 IMPLEMENTATION OF APCSB 3-1 AND MEB 3-1 FOR THE BELLEFONTE NUCLEAR PLANT

TVA is using the provisions offered in MEB 3-1 for each main steam and feedwater valve room at the Bellefonte Nuclear Plant. Even though MEB 3-1 was issued late in the design phase of this plant, sufficient advantages were recognized that considerable redesign was performed to allow its implementation. Some of the changes that were made are the following:

a. Flued head type anchors were added at the valve room piping penetrations to the yard and roof areas.

b. Piping was upgraded from B31.1S (from the isolation valves to the anchors in the exterior valve room walls) to ASME Section III, Class 2.

c. The feedwater flow control valves located upstream of the isolation valves were upgraded from ASME Section III, Class 3, to Class 2.

d. Feedwater maintenance valves were upgraded from B31.1S to ASME Section III, Class 2. (All 32-inch main steam and 20-inch feedwater piping and valves are now ASME Section III, Class 2, throughout the no-break region.

e. Inservice inspection requirements were invoked for the upgraded piping.

f. Valve room walls were extended to provide the required flexibility between the terminals (anchors) of each no-break piping run.

g. Piping was completely reanalyzed and requalified both inside the no-break region and outside the valve rooms.

h. As an additional precaution, separation of the main steam and feedwater systems has been maintained through the use of reinforced concrete barrier walls.

i. Guard pipes have been maintained through the containment annulus region for additional protection.

j. The flued head anchor at the primary containment wall was redesigned to eliminate the process pipe circumferential weld on valve room side of the anchor. This provides a greater confidence level for this terminal for which inservice inspection would have otherwise been very difficult to perform. The new design is shown in figure 9.

The break exclusion criteria have only been applied to the 32-inch main steam and the 20- and 22-inch feedwater piping. The next largest lines inside the valve rooms are the 12-inch cross-connectors to the main steam lines. Provisions have been made to accept postulated breaks in these 12-inch and any lesser lines inside the valve rooms.

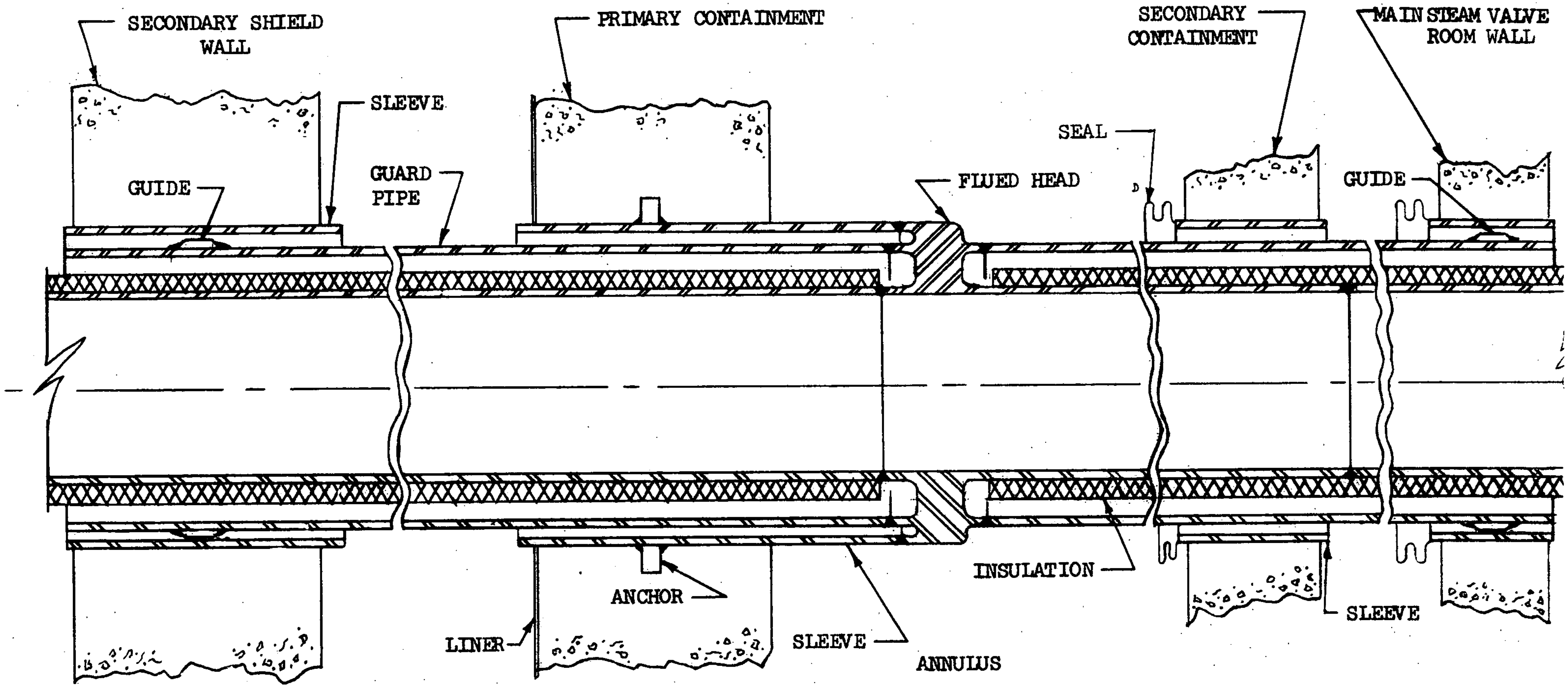


FIGURE 9

TYPICAL PENETRATION WITH GUARD PIPE, BELLEFONTE NUCLEAR PLANT

9.0 SUMMARY

TVA believes that the Branch Technical Position MEB 3-1 and its companion APCSB 3-1 offer a technically sound and safe approach to the problems involving postulated pipe breaks inside the main steam and feedwater valve rooms of pressurized water reactors. As the result of this confidence in the MEB 3-1, TVA has expended considerable effort in its implementation. The following is a summary of the implementing actions taken.

a. Anchors are provided at each end of each run of no-break piping. Isolation valve operability is protected from all events outside of the valve rooms whether in the yard or inside containment.

b. Venting relief paths are provided for all possible postulated breaks inside the valve rooms except the main steam and feedwater main runs. Measures required by MEB 3-1 and described herein have been taken to preclude the postulation of breaks in the main steam and feedwater main runs.

c. All piping and valves included under the no-break criteria have been upgraded to ASME Section III, Class 2, including the inherent inservice inspection requirements.

d. One complete train of steam supply to the turbine-driven auxiliary feedwater pump shall be protected and located within seismic Category I enclosures.

e. All no-break piping has been rigorously analyzed to ASME Section III, Class 2 requirements and the stresses are less than 0.8 $(1.2\ S_h + S_A)$ in accordance with MEB 3-1.

As a result of this implementation, the piping and piping components inside the valve rooms are essentially free from obstruction. There should be no pipe rupture restraints, sleeves, or local barriers to complicate inservice and maintenance inspections or component servicing, removal, and repair. TVA believes that this approach results in not only a cleaner and more economical arrangement but also a more functional, maintainable, and safer plant.