

TENNESSEE VALLEY AUTHORITY  
WATTS BAR NUCLEAR PLANT

PIPE SUPPORT MINIMUM DESIGN LOAD EVALUATION  
FINAL REPORT

PREPARED BY:

*Steve Stanisik*

DATE:

*7/15/91*

REVIEWED BY:

*W. L. Matthews*

DATE:

*7/15/91*

APPROVED BY:

*Ruben O'Hara*

DATE:

*7/15/91*

## EXECUTIVE SUMMARY

PROBLEM DESCRIPTION - Specific requirements were incorporated in the Watts Bar pipe support design criteria (WB-DC-40-31.9, Revision 7) to close an employee concern regarding pipe support stiffness and deflection requirements (specifically Sections 2.3.6 and 3.7.1). Revision 9 to the criteria revised portions of the document which had been added for the employee concern closure. TVA did not coordinate this change with the Employee Concern Program (ECP) Manager. Further, the completed pipe support evaluations for the piping in the large bore 79-14 reanalysis effort used Revision 9 and later revisions of this criteria for design and qualification of new and modified support structures.

RESOLUTION - To resolve this issue with the ECP, TVA has completed a three-phased program to demonstrate that the changes made by Revision 9 (and later) neither impact the closure of the employee concern nor compromise the adequacy of the pipe supports at the Watts Bar Nuclear Plant.

- Phase I: Screening of design load vs. minimum design load (MDL)
- Phase II: Engineering evaluation of supports having a design load less than the MDL; check deflection using MDL
- Phase III: Refined analysis for supports falling out of Phase II; issuance of any modifications

For the Hanger and Analysis Update Program (HAAUP) 8660 pipe supports, as listed in the Hanger Tracking Program (HTP), were qualified using Revision 9 or later of WB-DC-40-31.9. The total number of support evaluations per phase is as follows:

Phase I	.....	8660	supports
Phase II	.....	4939	
Phase III	...	56	

CONCLUSIONS - The results of the MDL program have demonstrated:

- a) Compliance with the minimum design load provisions of WB-DC-40-31.9, Revision 7, has been demonstrated for 99.95% of the HAAUP pipe supports. The four supports listed below would require modification to meet Revision 7 provisions:

47A42708001  
47A42708002  
47A43503006  
701CCR493

- b) Later revisions to the design criteria provide comparable structural designs to those designed using Revision 7, and, therefore, do not invalidate the closure of the employee concern.

CONCLUSIONS - (continued)

- c) Based on the evaluation of 1219 supports for pipe sizes from 1.25" to 2" which demonstrated their acceptability for MDL coupled with the fact that supports for piping 1" and smaller are excluded from the MDL requirements, it is concluded that the Small Bore Program work scope is acceptable.

RECURRENCE CONTROL - Revisions to sections 2.3.6, 3.4.4, 3.5.1, and 3.7.1 of WB-DC-40-31.9 have been identified to clarify MDL and to include "source noting" of the ECP concern to prevent recurrence.

EXTENT OF CONDITION - A review of the design criteria revisions from 1988 to the present did not reveal any other changes that could possibly invalidate corrective actions.

## TABLE OF CONTENTS

<u>Section</u>	<u>Description</u>	<u>Page</u>
	EXECUTIVE SUMMARY .....	2
	TABLE OF CONTENTS .....	4
1.0 ...	BACKGROUND .....	5
2.0 ...	PURPOSE .....	5
3.0 ...	SCOPE .....	5
4.0 ...	REFERENCES / DATA SOURCES .....	6
5.0 ...	METHODOLOGY:	
5.1 ...	Phase I and Phase II.....	7
5.2 ...	Phase III .....	7
6.0 ...	ATTRIBUTE ASSESSMENT:	
6.1 ...	Piping 1" and Smaller .....	8
6.2 ...	Deflections Less Than or Equal to 1/8" ..	8
6.3 ...	+Y Restraints for 36" ERCW Piping on Problem N3-67-09A .....	9
6.4 ...	Y-directional Restraint Without +Y Component .....	9
7.0 ...	RESULTS .....	10
8.0 ...	CONCLUSIONS .....	11

### Attachment

A .....	PHASE III SUMMARY .....	A1
---------	-------------------------	----

## 1.0 BACKGROUND

During the November, 1990 NRC audit of Amendment 64 of the Watts Bar FSAR, the minimum design load requirements for pipe supports were subject to review. Revision 7 of WB-DC-40-31.9, "Criteria for Design of Piping Supports and Supplemental Steel in Category I Structures" specified, in response to an employee concern (Reference 13), a minimum design load (MDL) for pipe supports.

Section 2.3.6 of Revision 7 defined MDL as, "The larger of 150 pounds or the weight of a standard water-filled ANSI B31.1 span". In Revision 9 of the same document, this requirement was altered such that the MDL equaled 150 pounds and was applied only to new supports in the minus vertical direction. This section has remained essentially the same through Revision 12.

The Revision 9 changes concerning MDL were not coordinated with the Employee Concern Program (ECP) prior to implementation. The Hanger and Analysis Update Program qualified the supports to Revision 9 or later of the design criteria. The investigation documented in this report was undertaken to determine what effect the changes in the design criteria, relative to minimum design load, had on the concern brought to the ECP.

## 2.0 PURPOSE

The purpose of this task is to demonstrate compliance with the minimum design load requirements of Revision 7 for the population of pipe supports completed under the Hanger and Analysis Update Program (HAAUP).

## 3.0 SCOPE

The scope for the three-phase evaluation encompasses the HAAUP supports contained within the 319 rigorously analyzed large bore piping problems as listed in the Hanger Tracking Program (HTP). The Phase I scope is 8660 supports.

#### 4.0 REFERENCES / DATA SOURCES

1. "Pipe Support Minimum Design Load Evaluation Phase I and Phase II Report," April, 1991, RIMS L44910418802
2. TVA memorandum from R.O.Hernandez to R.V.Pierce, Feb.27,1991, "Minimum Loads for Pipe Supports," RIMS B26910227100\_
3. WB-DC-40-31.9, Rev.7, "Criteria for Design of Piping Supports Supplemental Steel in Category I Structures," RIMS B41880113001
4. WB-DC-40-31.9, Rev.9, "Criteria for Design of Piping Supports Supplemental Steel in Category I Structures," RIMS B26881229006
5. WB-DC-40-31.9, Rev.12, "Criteria for Design of Piping Supports Supplemental Steel in Category I Structures," RIMS B26910412113
6. Base Design Change Notices (DCN) for the 319 rigorously analyzed large bore piping problems
7. As-built packages for the 319 piping problems
8. Piping analysis computer run of record for the 319 problems
9. Pipe support calculations of record for the HAAUP rigorously analyzed pipe supports
10. Hanger Tracking Program (HTP), date 12-6-90
11. Design Input Memorandum to WB-DC-40-31.9, DIM-WB-DC-40-31.9-12, RIMS B26900206079
12. Administrative Site Procedure/Instructions, AI-3.1, Rev.24
13. Employee Concern Report ECP-86-KX-165-01, RIMS L12880329976
14. "Pipe Support Minimum Design Load Review and Evaluation Documentation," calculation no. TEACEBEMG30, Rev.0

## 5.0 METHODOLOGY

### 5.1 PHASE I and PHASE II

Phase I and Phase II Methodology is presented in the Phase I and Phase II Report (Reference 1). The Methodology and the Special Cases (also in Reference 1) detail the process by which supports were evaluated for MDL during Phase I and II. The Special Cases include: tieback supports, variable & constant supports, uni-directional (vertical) supports, supports adjacent to strain sensitive equipment, and gang supports.

### 5.2 PHASE III

The supports that did not pass Phase I and Phase II evaluations were evaluated in Phase III. This phase involves categorizing the Phase II attributes, assessing each attribute type, qualifying supports by refined analysis, and modifying supports if necessary. (Refer to Attachment A for a listing of the Phase III supports, their Phase II attributes, and their dispositions.)

The Phase III process followed the steps identified below:

1. List the Phase II attributes for all Phase III supports (refer to Attachment A). Identify any attribute type or other recurring design aspect which may be acceptable due to specific task and/or design features.
2. Investigate and assess which attributes are acceptable for MDL with no further actions. (Section 6.0 details the attributes assessed during this step.)
3. All remaining Phase III supports not acceptable under step 2 will be dispositioned by revising the original calculations of record.
4. Analyze the support for the Phase II attribute using refined approaches to determine acceptability. Review other support features with respect to MDL.
5. For supports that are acceptable revise the calculation of record to document the MDL evaluation.
6. For supports which cannot be qualified, a senior level review team consisting of both TVA and ESI engineers will determine if any modifications are required.
7. All documents revised or initiated to disposition the Phase III supports will be identified in the main documentation package (Reference 14).

## 6.0 ATTRIBUTE ASSESSMENT

The Phase III supports were reviewed with respect to Phase II attributes and other design aspects to determine common MDL concerns. Four attributes were determined to be acceptable for MDL with no further actions required. (For a listing of all the Phase III supports and their dispositions refer to the Phase III Summary provided in Attachment A and, also, to Attachment 4.0 of Reference 14.) These attributes with supporting justifications are presented below:

### 6.1 PIPING 1" AND SMALLER

In order to ensure that all HAAUP piping larger than 1" was included, all supports on HAAUP piping were included in the initial screening. Supports for 1" and smaller piping do not require evaluation for MDL per Rev.7 of WB-DC-40-31.9.

### 6.2 DEFLECTIONS LESS THAN OR EQUAL TO 1/8"

Phases I and II evaluated MDL based on a deflection allowable of 1/16". The 1/16" allowable is for seismic/dynamic load and for supports adjacent to strain sensitive equipment. All supports adjacent to strain sensitive equipment have been identified and reviewed for MDL using 1/16" allowable.

For supports not adjacent to strain sensitive equipment, the existing calculation qualifies the seismic/dynamic load from rigorous piping analysis to the 1/16" allowable. Per Section 3.7.1.a of WB-DC-40-31.9, Rev.12:

'In addition, the maximum deflection shall be limited to 0.125" or less (based on total design load).'

Since for the supports in question the MDL is higher than the largest calculated piping analysis load, the MDL is therefore the maximum load. It follows that the MDL deflection should not exceed 1/8". Therefore, all supports with an MDL deflection less than or equal to 1/8" are acceptable, except for supports adjacent to strain sensitive equipment as indicated above.



### 6.3 +Y RESTRAINTS FOR 36" ERCW PIPING ON PROBLEM N3-67-09A

The MDL for 36" piping is 21,500 pounds. Six pipe supports for 36" pipe on problem N3-67-09A have -Y components that meet MDL, however, the +Y loads are less than the MDL. The actual +Y design loads, as determined from rigorous (computer) piping analysis, range from 2,000 to 10,000 pounds. For this specific case the deadweight (-Y) of the 36" pipe governs the actual load of the +Y restraint; therefore, the large MDL load is overly conservative for design of the +Y component.

Additionally, the B31.1 piping spans increase with pipe size yielding a uniform pipe stiffness; however, due to the increase in water weight, the required support capacity will be greatly increased for large-diameter pipes. Therefore, the large MDL values lose significance for large-diameter pipes. Based on a review of the piping location and configuration, the peak accelerations and thermal load cases, and the design of the +Y supports, it is concluded that there are no MDL concerns for this specific piping analysis that warrant evaluation of the +Y supports for the large MDL value. The existing designs for the six +Y supports on problem N3-67-09A are acceptable for the current design loads and do not require further MDL evaluation.

### 6.4 Y-DIRECTIONAL RESTRAINT WITHOUT +Y COMPONENT

Two supports are designed as uni-directional (-Y only) but show +Y loads on design load sheets. The acceptance of the as-built configurations or modification to add +Y components will be dispositioned under Problem Evaluation Report (PER) number WBP910262 which is external to the MDL evaluation task. The current configurations (-Y components) are acceptable for MDL, and the +Y components, if required, will be designed to meet MDL.

## 7.0 RESULTS

For the MDL evaluation the results are:

Phase I - 8660 pipe support design loads were screened against the appropriate MDL and 3721 are acceptable with no further evaluation. 4939 supports were evaluated in Phase II.

Phase II - Engineering evaluations were performed for 4939 pipe supports for the appropriate MDL. 4883 were shown to be acceptable with no further evaluation required. 56 pipe supports were evaluated in Phase III.

Phase III - Attribute assessments and refined analyses were performed for 56 supports. 52 were shown to be acceptable for MDL. 4 supports would require modification to meet the MDL requirements of Revision 7 of WB-DC-40-31.9.

Documentation of Results - The evaluation documentation is provided in Reference 14. The refined analyses were performed by revising the support calculations of record which are also identified in Reference 14. Refer to Attachment A for a summary of the Phase III supports.

## 8.0 CONCLUSIONS

This review has demonstrated that of the 8660 pipe supports evaluated in HAAUP scope 0.05% were found to deviate from the minimum design load requirements of WB-DC-40-31.9, Revision 7.

TVA concludes that the pipe supports are adequately designed, and have demonstrated that 99.95% of the HAAUP supports meet the minimum design load of Revision 7. The following 4 supports would require modification to meet the minimum design load (B31.1 span load for large bore piping) requirement:

1. 47A42708001
2. 47A42708002
3. 47A43503006
4. 701CCR493

Based on the evaluation of 1219 supports for pipe sizes from 1.25" to 2" which demonstrated their acceptability for MDL coupled with the fact that supports for piping 1" and smaller are excluded from the MDL requirements, it is concluded that the Small Bore Program work scope is acceptable.

Revisions to sections 2.3.6, 3.4.4, 3.5.1, and 3.7.1 of WB-DC-40-31.9 have been identified to clarify MDL and to include "source noting" of the ECP concern to prevent recurrence.

A review of the design criteria revisions from 1988 to the present did not reveal any other changes that could possibly invalidate corrective actions.

## PIPE SUPPORT MINIMUM DESIGN LOAD EVALUATION - FINAL REPORT

ATTACHMENT A

WBNP UNIT 1

PHASE III SUMMARY

NO.	SUPPORT NUMBER	PROBLEM NUMBER	PIPE SIZE	PHASE II ATTRIBUTE	PHASE III RESOLUTION	MDL PHASE III DOCUMENTATION
1	170844	2000410	1"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
2	170881	2000411	1"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
3	170918	2000411	1"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
4	162A186	2000807	0.75"	DEFLECTN.	MDL DEFL. < 1/16"- OK *	SECTION 6.2
5	162A806	2000812	1"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
6	47A43506079	2000901	1"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
7	47A42702034	N3-03-01A	8"	DEFLECTN.	REFINED ANALYSIS - OK	47A42702034,R2
8	47A42708001	N3-03-05A	8"	DEFL/PL.STR	MODIFY FOR MDL - OK	47A42708001,R3
9	47A42708023	N3-03-05A	2"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
10	47A42708024	N3-03-05A	2"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
11	47A42708026	N3-03-05A	0.5"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
12	47A42708029	N3-03-05A	6"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
13	47A42708002	N3-03-05A	10"	PL.STRESS	MODIFY FOR MDL - OK	47A42708002,R2
14	47A49108010	N3-26-03A	1.5"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
15	47A91503034	N3-30-03R	8"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
16	47A93007049A	N3-31-09A	6"	PL.STRESS	REFINED ANALYSIS - OK	47A93007049A,R2

\* NOTE: ADJACENT TO STRAIN SENSITIVE EQUIPMENT

## PIPE SUPPORT MINIMUM DESIGN LOAD EVALUATION - FINAL REPORT

ATTACHMENT A

WBNP UNIT 1

PHASE III SUMMARY

NO.	SUPPORT NUMBER	PROBLEM NUMBER	PIPE SIZE	PHASE II ATTRIBUTE	PHASE III RESOLUTION	MDL PHASE III DOCUMENTATION
17	47A92044003	N3-31-11A	12"	PL.STRESS	REFINED ANALYSIS - OK	47A92044003,R4
18	47A92044006	N3-31-11A	12"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
19	47A46211084	N3-61-08R	12"	PL.STRESS	REFINED ANALYSIS - OK	47A46211084,R1
20	47A46211109	N3-61-08R	12"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
21	47A40602012	N3-62-27A	0.75"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
22	47A55518001	N3-62-40A	3"	EVAL. +Y	PER # WBP910262 - OK	SECTION 6.4
23	631SISR089	N3-63-03A	4"	EVAL. +Y	PER # WBP910262 - OK	SECTION 6.4
24	47A43503006	N3-63-07A	24"	PL.STRESS	MODIFY FOR MDL - OK	47A43503006,R3
25	671ERCWR436	N3-67-09A	36"	DEFLECTN.	REFINED ANALYSIS - OK	671ERCWR436,R5
26	47A45002092	N3-67-09A	36"	DEFLECTN.	MDL NR FOR +Y 36"- OK	SECTION 6.3
27	47A45002093	N3-67-09A	36"	DEFLECTN.	MDL NR FOR +Y 36"- OK	SECTION 6.3
28	47A45002094	N3-67-09A	36"	DEFLECTN.	MDL NR FOR +Y 36"- OK	SECTION 6.3
29	47A45002096	N3-67-09A	36"	DEFLECTN.	MDL NR FOR +Y 36"- OK	SECTION 6.3
30	47A45002097	N3-67-09A	36"	DEFLECTN.	MDL NR FOR +Y 36"- OK	SECTION 6.3
31	47A45002099	N3-67-09A	36"	DEFLECTN.	MDL NR FOR +Y 36"- OK	SECTION 6.3
32	47A45008008	N3-67-16A	6"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2

PIPE SUPPORT MINIMUM DESIGN LOAD EVALUATION - FINAL REPORT

ATTACHMENT A

WBNP UNIT 1

PHASE III SUMMARY

NO.	SUPPORT NUMBER	PROBLEM NUMBER	PIPE SIZE	PHASE II ATTRIBUTE	PHASE III RESOLUTION	MDL PHASE III DOCUMENTATION
33	47A45020004	N3-67-24A	1"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
34	47A45004032	N3-67-53A	6"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
35	701CCR324	N3-70-04A	12"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
36	170089	N3-70-05R	1"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
37	701CCR493	N3-70-08A	16"	MEM.STRESS	MODIFY FOR MDL - OK	701CCR493,R3
38	47A46406048	N3-70-30A	1"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
39	47A56018046	N3-77-01R	2"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
40	47A45403002	N3-78-13A	10"	DEFLECTN.	REFINED ANALYSIS - OK	47A45403002,R2
41	17A58601069	N3-82-07D	10"	PL.STRESS	REFINED ANALYSIS - OK	17A58601069,R5
42	17A58601075	N3-82-08D	10"	DEFLECTN.	REFINED ANALYSIS - OK	17A58601075,R2

NOTE: NUMBERS 43 THRU 56 ARE GANG SUPPORTS CONTINUED ON THE NEXT 2 PAGES

PIPE SUPPORT MINIMUM DESIGN LOAD EVALUATION - FINAL REPORT

ATTACHMENT A

WBNP UNIT 1

PHASE III SUMMARY

NO.	PRIMARY GANG SUPPORT NO.	SECONDARY SUPPORT NO.	PIPE SIZE	PHASE II ATTRIBUTE	PHASE III RESOLUTION	MDL PHASE III DOCUMENTATION
43	162A434	---	0.75"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
		162A433	1"			
		170884	1"			
44	170822	---	1"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
		170088	1"			
45	47A06063079	---	0.75"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
		47A43508024	0.75"			
		47A43508027	0.75"			
		47A43508076	0.75"			
46	47A43506008	---	0.75"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
		47A43506087	0.75"			
47	47A45003058	---	6"	DEFLECTN.	REFINED ANALYSIS - OK	47A45003058,R5
		47A45003505	6"			
		47A45003295	6"			
48	47A45003152	---	4"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
		47A45003213	4"			

PIPE SUPPORT MINIMUM DESIGN LOAD EVALUATION - FINAL REPORT

ATTACHMENT A

WBNP UNIT 1

PHASE III SUMMARY

NO.	PRIMARY GANG SUPPORT NO.	SECONDARY SUPPORT NO.	PIPE SIZE	PHASE II ATTRIBUTE	PHASE III RESOLUTION	MDL PHASE III DOCUMENTATION
49	47A45003275	---	2"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
		47A45003261	2"			
50	47A45014010	---	1.5"	DEFLECTN.	REFINED ANALYSIS - OK	47A45014010,R2
		47A45014003	1.5"			
51	47A45021219	---	3"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
		47A45021408	3"			
52	47A45021003	---	4"	DEFLECTN. (1" PIPE)	PER PHASE II: 4" PIPE SUPPORT - OK FOR MDL; 2ND PIPE <or= 1" - OK	SECTION 6.1
		47A45021464	1"			
53	47A46404119	---	3"	DEFLECTN.	MDL DEFL. < 1/8" - OK	SECTION 6.2
		47A46404118	3"			
54	47A55510036	---	2"	DEFLECTN.	REFINED ANALYSIS - OK	47A55510036,R5
		47A55510077	2"			
55	621CVCR240	---	1"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
		621CVCR239	1"			
56	741RHRR078	---	0.75"	DEFLECTN.	PIPE < or = 1" - OK	SECTION 6.1
		741RHRR068	0.75"			